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Adaptation potential of secretory functional of the small salivary glands and gustatory analyzer besides flying composition of civil aviation

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Abstract

AIM. The feature of adaptive potential of secretory function of the small salivary glands besides flying composition of the civil aviation.

MATERIALS AND METHODS. In the article presented results of the study of secretory function of small salivary glands beside 20 employees of flying and 15 overland compositions of civil aviation at the age 20–50 years with pathology of oral cavity and with sound condition of dentistry status. For achievement delivered purposes have developed and felt the way, concluding in revealing the small salivary glands on emerged secret and fixation its paper pattern in the manner of imprint. About level of the secretions of the small salivary glands witnessed the different diameter an imprint of secret. As a matter of convenience count small salivary glands divided in four orders in depending of diameter heel secret – from the most small, referred to IV order, before the most large (I order).

RESULTS. Amongst flying composition with sound condition of dentistry status at observation of the paper pattern revealed area of the lips with concentration of the small salivary glands only 1-st and 2-nd degree. Beside they comes to light scant few of the small salivary glands II and III order, density their small, on upper lip they, as contrasted with glands IV order, concentrated to medium closer, but on lower lip – on side left and right half. Beside flying composition with dentistry pathology discovered quite other regularity in respect of concentrations of the small salivary glands on upper and lower lip: both on upper and on lower lip practically were not discovered small salivary glands III and IV orders. Together with that quantitative importance of the small salivary glands II order besides flying composition with pathology of oral cavity turned out to be similar to patient without dentistry pathology.

CONCLUSIONS. Beside flying composition with dentistry pathology on amount of the secretions in the first place answer the glands II order, then to them are connected the glands III order. Beside they practically do not exist the appearances of the secret of the small salivary glands IV order that is indicative of absence their reserve function, conditioned stress-induced influence extreme factor of aircraft flight.

Keywords: small salivary gland, flying personnel, non-flying composition, lip, civil aviation, pathology of parodont, aircraft flight

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Адаптационный потенциал выделительной функции малых слюнных желез у летного состава гражданской авиации

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Резюме

ЦЕЛЬ. Дать характеристику адаптационного потенциала выделительной функции малых слюнных желез у летного состава гражданской авиации.

МАТЕРИАЛЫ И МЕТОДЫ. В работе представлены результаты изучения выделительной функции малых слюнных желез у 20 сотрудников летного и 15 наземного состава гражданской авиации в возрасте 20–50 лет с патологией полости рта и интактным состоянием стоматологического статуса. Для достижения поставленной цели разработали и испытали способ, заключающийся в выявлении малых слюнных желез по выступившему секрету и фиксации его бумажным шаблоном в виде отпечатков. Об уровне секреции малых слюнных желез свидетельствовал различный диаметр отпечатков секрета.

Для удобства подсчета малые слюнные железы были поделены на четыре порядка в зависимости от диаметра пятен секрета – от самых мелких, отнесенных к IV порядку, до самых крупных (I порядка).
РЕЗУЛЬТАТЫ. Среди летного состава с интактным состоянием стоматологического статуса при наблюдении бумажного шаблона выявлены участки губ с концентрацией малых слюнных желез только 1-й и 2-й степени. У них визуализируется незначительное количество малых слюнных желез II и III порядка, плотность их невелика, на верхней губе они, в противоположность железам IV порядка, концентрировались ближе к середине, а на нижней губе – по бокам левой и правой половин. У летного состава со стоматологической патологией обнаружена совсем иная закономерность в отношении концентрации малых слюнных желез на верхней и нижней губах: как на верхней, так и на нижней губе практически не были обнаружены малые слюнные железы III и IV порядка. Вместе с тем количественное значение малых слюнных желез II порядка у летного состава с патологией полости рта оказалось схожим с пациентами без стоматологической патологии.
ВЫВОДЫ. У летного состава со стоматологической патологией по количеству секреции в первую очередь отвечают железы II порядка, затем к ним подключаются железы III порядка. У них практически не наблюдается появления секрета малых слюнных желез IV порядка, что свидетельствует об отсутствии их резервной функции, обусловленной стресс-индуцирующим влиянием экстремальных факторов авиационного полета.

Ключевые слова: малые слюнные железы, летный персонал, нелетный состав, губа, гражданская авиация, патология пародонта, авиационный полет

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INTRODUCTION

A number of biological fluids are secreted into the oral cavity, each playing a significant role in the physiology and pathology of the oral tissues and organs. These include saliva from the ducts of the major salivary glands, as well as secretions from the numerous minor salivary glands and mucous glands distributed throughout the oral mucosa [1–3]. The full extent of saliva's importance for oral health has yet to be completely elucidated. The composition and properties of saliva largely depend on the functional state of the central nervous system, the activity of the salivary glands themselves, and the quality of ingested food [4–7].

In light of the above, particular scientific interest lies in the investigation of the functional state of the minor salivary glands under stress-inducing conditions caused by the extreme factors associated with aviation flight.

AIM

To characterize the adaptive potential of the secretory function of minor salivary glands in civil aviation flight personnel.

MATERIALS AND METHODS

The tasks aimed at assessing the adaptive potential of the secretory function of minor salivary glands in civil aviation flight personnel were addressed based on original selective observations of individuals across specific age groups. This study presents the results of an investigation into the secretory function of minor salivary glands in 20 flight crew members and 15 ground personnel of the civil aviation sector, aged between 20 and 50 years, both with oral pathology and with intact dental status.

To achieve the stated objective, we developed and tested a method involving the identification of minor salivary glands through the detection of emerging secretions and their fixation using a paper template to obtain impression marks. A square paper frame with 2 cm sides was applied to the mucosal surface of the lower lip, which had been pre-stained with a 1% solution of methylene blue or brilliant green. Secretory droplets emerging from the ducts of the minor salivary glands were then counted by identifying the decolorized spots.

In professional civil aviation personnel, the level of secretion of the minor salivary glands was reflected by the varying diameters of the secretion prints. According to I.F. Romacheva, the normal number of functioning minor salivary glands within a 2 cm square frame is 20–22. For convenience in quantification, the glands were categorized into four grades based on the diameter of the secretion spots – from the smallest (Grade IV) to the largest (Grade I).

Statistical analysis was performed using Statistica 10.0 and Microsoft Excel. The distribution type was assessed using the Kolmogorov–Smirnov and Shapiro–Wilk tests. The following descriptive statistical parameters were determined: number of observations (n), arithmetic mean (M), standard error of the mean (m), and relative values (P, %). Statistical significance was set at $p < 0.05$.

RESUTLS

The data obtained from the study of the secretory function of minor salivary glands in ground personnel of civil aviation with oral pathology indicate that the number of these glands on the lower lip averaged 71.3±3.4 units, which is 1.5 times higher than on the upper lip (46.9±2.7 units; $p < 0.001$). The vast majority

of minor salivary glands on the upper lip were classified as Grade IV (smallest secretion spot diameter), accounting for 27.1 ± 2.8 units (57.8%), and this number was significantly higher ($p < 0.01$) than that of Grade III glands with medium secretion spot diameters – 16.7 ± 2.3 units (35.6%). It was also highly significantly greater ($p < 0.001$) than the number of Grade II glands characterized by larger secretion spot diameters – 3.1 ± 1.1 units (6.6%) (Fig. 1, *A*).

It should be noted that among the examined ground personnel with dental pathology, sialometry of the minor salivary glands did not reveal any glands of the first grade (Grade I), characterized by the largest secretion spot diameters. The average secretion rate was 0.94 ± 0.46 mg/min.

As mentioned above, the average number of minor salivary glands on the lower lip was 71.3 ± 3.4 units. The grade-wise distribution of minor salivary glands on the lower lip in ground personnel of civil aviation with oral pathology demonstrated the following pattern: Grade IV glands predominated, accounting for 47.3 ± 2.2 units (66.3% of cases), which was significantly higher than the number of Grade III glands – 18.7 ± 2.6 units (26.3%; $p < 0.001$), and Grade II glands – 5.3 ± 0.7 units (7.4%) (Fig. 1, *B*).

In the ground personnel of civil aviation with dental pathology, the assessment of the secretory function of the labial minor salivary glands revealed that although the total number of glands on the lower lip (71.3 ± 3.4 units) exceeded that on the upper lip (46.9 ± 2.7 units), this proportional relationship was not observed across different gland grades, except for Grade IV glands, which were significantly more numerous on the lower lip (47.3 ± 2.2 units) than on the upper lip (27.1 ± 2.8 units; $p < 0.001$). In contrast, the average numbers of Grade III and Grade II glands on the lower lip (18.7 ± 2.6 and 5.3 ± 0.7 units, respectively) did not differ significantly from those on the upper lip (16.7 ± 2.3 and 3.1 ± 1.1 units, respectively).

Among ground personnel with an intact dental status, the total number of minor salivary glands on the lower and upper lips was 78.8 ± 3.7 and 52.4 ± 3.3 units, respectively. The average numbers of Grade II and Grade III glands on the lower lip (9.5 ± 0.8 and 22.7 ± 3.2 units, respectively) were higher than on the upper lip (5.8 ± 1.5 and 17.8 ± 2.6 units, respectively).

Comparative analysis demonstrated that in ground personnel with an intact dental status, the total number of minor salivary glands on the lower and upper lips was approximately 1.1 times higher (78.8 ± 3.7 and 52.4 ± 3.3 units, respectively) than in those with oral pathology (71.3 ± 3.4 and 46.9 ± 2.7 units, respectively). These findings suggest that the presence of pathological conditions in the oral cavity is associated with a certain degree of reduction in the secretory function of minor salivary glands among ground personnel of civil aviation.

A similar study was conducted among flight personnel of civil aviation with an intact dental status. The results in this group revealed a diametrically opposite pattern in the quantitative distribution of minor salivary glands on the upper and lower lips compared to the ground personnel with healthy oral tissues. Specifically, among flight crew members with intact dental status, the number of minor salivary glands on the lower lip was 1.3 times lower (41.1 ± 1.6 units) than on the upper lip (54.7 ± 2.2 units). Moreover, the vast majority of glands on the lower lip were classified as Grade IV (32.5 ± 2.9 units), followed by Grade III (7.3 ± 1.3 units) and Grade II (1.8 ± 0.7 units), accounting for 78.1%, 17.6%, and 4.3% of the total, respectively (Fig. 2).

In flight personnel of civil aviation with an intact condition of oral tissues, structural analysis of the total secretory function of minor salivary glands on the upper lip (54.7 ± 2.2 units) revealed a predominance of Grade IV glands (64.4%; 35.2 ± 2.3 units), followed by Grade III (33.1%; 18.1 ± 1.5 units) and Grade II (2.5%; 1.4 ± 0.2 units).

A comparative evaluation of the secretory function of minor salivary glands in flight crew members without dental pathology clearly demonstrates that although the total number of glands on the lower lip (41.1 ± 1.6 units) was lower than that on the upper lip (54.7 ± 2.2 units), this ratio was also reflected in the number of Grade III (7.3 ± 1.3 vs. 18.1 ± 1.5 units) and Grade IV (32.5 ± 2.9 vs. 35.2 ± 2.3 units) glands on the lower and upper lips, respectively.

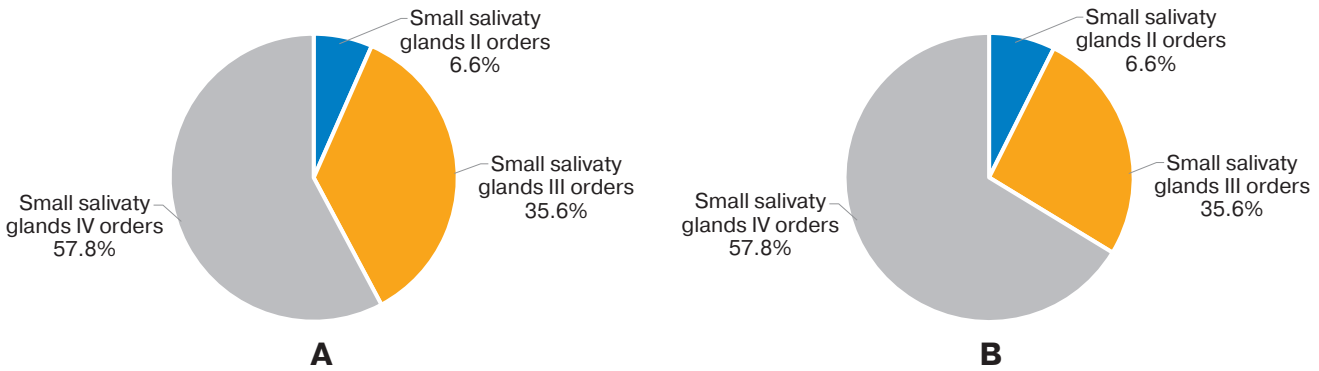

Fig. 1. Quantitative estimation of small salivary glands on upper (*A*) and lower (*B*) lip in depending of diameter heel secret beside non-flying composition of the civil aviation with dentistry pathology

Рис. 1. Количественная оценка малых слюнных желез на верхней (*A*) и нижней (*B*) губах в зависимости от диаметра пятен секрета у нелетного состава гражданской авиации со стоматологической патологией

In the examined cohort of flight personnel with an intact dental status, the secretory output of minor salivary glands was also measured. Upon recalculating the number of glands on the upper and lower lips to the corresponding amount of secreted fluid, it was found that the volume on the lower lip (14.7 ± 1.3 mg/min) was 1.5 times higher than that on the upper lip (9.8 ± 0.7 mg/min; $p < 0.01$). On the upper lip, Grade III and Grade IV glands secreted nearly equal volumes of saliva – 4.9 ± 0.6 mg/min and 4.8 ± 0.5 mg/min, respectively – with the remainder attributed to Grade II glands.

Considering the total secretory output on the lower lip (14.7 ± 1.3 mg/min), Grade IV and Grade III glands accounted for the majority of secretion, with a dominant contribution from Grade IV glands – 9.7 ± 0.8 mg/min (66.0%), which significantly exceeded the secretion from Grade III glands – 3.2 ± 0.5 mg/min (21.8%). A minimal volume of secretion was produced by Grade II glands – 1.8 ± 0.2 mg/min (12.2%). When comparing secretion volumes between the upper and lower lips, a statistically significant difference was observed only for Grade IV glands: 4.8 ± 0.5 mg/min on the upper lip vs. 9.7 ± 0.8 mg/min on the lower lip ($p < 0.001$).

Among flight personnel with intact oral health, recalculation of the number of minor salivary glands on the upper and lower lips in terms of their secretory output revealed that secretion on the lower lip (14.7 ± 1.3 mg/min) was reduced by 1.5 times compared to that on the upper lip (9.8 ± 0.7 mg/min; $p < 0.01$). On the upper lip, Grade III and IV glands produced nearly equal amounts of saliva – 4.9 ± 0.6 mg/min (50.0%) and 4.6 ± 0.5 mg/min (46.9%), respectively – while Grade II glands accounted for the remaining 0.5 ± 0.1 mg/min (3.1%) (Fig. 3).

The average value of the secretory function of minor salivary glands on the lower lip in civil aviation flight personnel with dental pathology was 11.3 ± 0.6 mg/min, which is 1.3 times lower than the corresponding value in pilots with an intact dental status (14.7 ± 1.3 mg/min). Upon evaluating the secretory function of minor salivary glands in this area, it was found that in flight personnel with dental pathology, Grade III and IV glands also constituted the primary source of secretion, with a predominance of

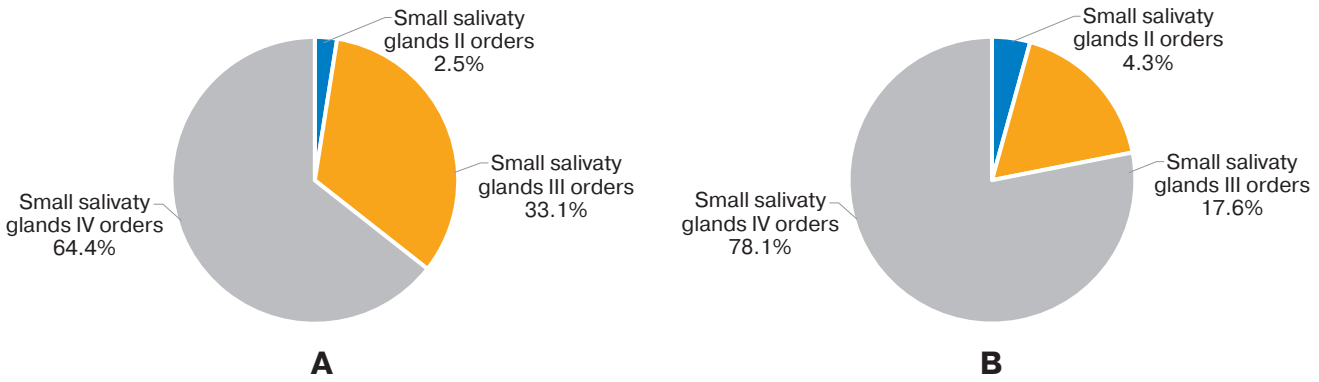

Fig. 2. Quantitative estimation of small salivary glands on upper (*A*) and lower (*B*) lip in depending on diameter heel secret beside flying composition of the civil aviation with sound condition of dentistry status

Рис. 2. Количественная оценка малых слюнных желез на верхней (*A*) и нижней (*B*) губах в зависимости от диаметра пятен секрета у летного состава гражданской авиации с интактным состоянием стоматологического статуса

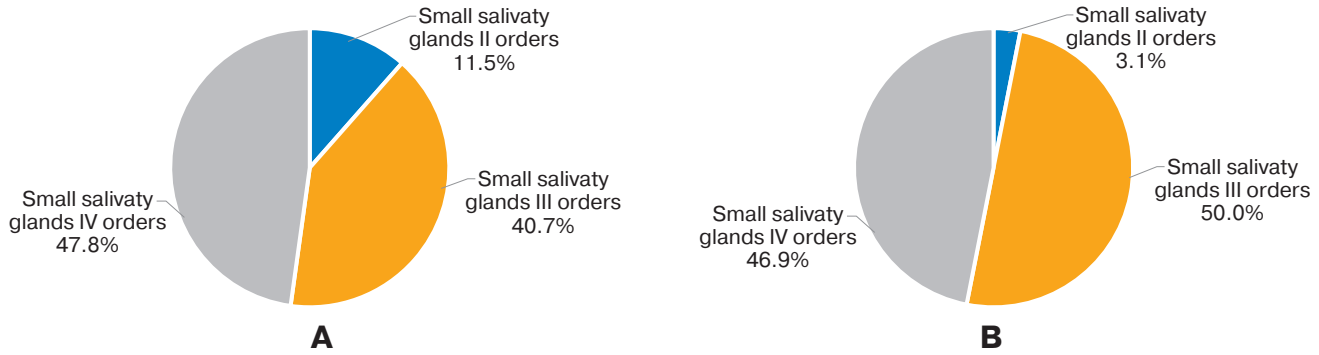

Fig. 3. Value produced secret of small salivary glands II, III and IV order on lip beside flying composition in depending of conditions dentistry status: *A* – patients with dentistry; *B* – patients without dentistry

Рис. 3. Величина продуцируемого секрета малых слюнных желез II, III и IV порядка на губах у летного состава в зависимости от состояния стоматологического статуса: *A* – пациенты со стоматологическим лечением; *B* – пациенты без стоматологического лечения

Grade IV glands – 5.4 ± 0.3 mg/min (47.8%). However, this value was significantly lower than the secretion produced by Grade III glands – 4.6 ± 0.3 mg/min (40.7%; $p < 0.05$). The remaining amount of saliva (1.3 ± 0.2 mg/min; 11.5%) was attributed to Grade II minor salivary glands.

DISCUSSION

In civil aviation pilots with pathology of the oral tissues, analysis of the overall secretory function of minor salivary glands on the upper lip (7.9 ± 0.5 units) also revealed a numerical predominance of Grade IV glands (49.4%; 3.9 ± 0.8 units), followed by Grade III (44.3%; 3.5 ± 0.5 units) and Grade II (6.3%; 0.5 ± 0.2 units). Statistically significant differences in secretion volume between the upper and lower lips were observed only for Grade II glands (11.5% vs. 6.3%) and Grade III glands (40.7% on the lower lip vs. 49.4% on the upper lip).

To investigate the existence of a consistent pattern in the topographical distribution of minor salivary glands depending on the dental status in civil aviation pilots with oral pathology, glandular imprints were transferred onto a paper template using a specialized coordinate grid, allowing for identification of zones with the highest concentration of each gland grade. The concentration density (glands per mm^2) was classified into three levels: less than one gland – Grade I; exactly one gland – Grade II; more than one gland – Grade III.

Among pilots with an intact dental status, observation of the paper templates revealed only Grade I and II concentration levels. Although glands of different orders appeared intermixed, certain areas exhibited pronounced clustering of minor salivary glands consistent across all subjects. On the upper lip, the highest concentration of Grade IV glands was found near the lateral areas of the oral vestibule arch, while on the lower lip, clustering was most prominent in the central zone. Only small numbers of Grade II and III glands were visualized, with low density. These were located more centrally on the upper lip (unlike Grade IV glands) and laterally on the left and right halves of the lower lip.

Conversely, in pilots with dental pathology, a fundamentally different pattern of gland distribution was observed. The coordinate grid analysis showed an almost complete absence of Grade III and IV glands on both the upper and lower lips, indicated by the minimal and moderate secretion spot diameters on the templates. Meanwhile, the number of Grade II glands in these individuals was comparable to that of pilots without oral pathology.

Based on the data regarding the identification of minor salivary glands in flight personnel with and without dental pathology, it is essential to assess not only the total number of glands but also their distribution across functional grades. The results indicate that in pilots with an intact oral status, secretion in response to stimulation is initiated predominantly by Grade II and III glands, with Grade IV glands subsequently contributing to the response.

A fundamentally different pattern was recorded in pilots with oral pathology: secretory response to stimulation was primarily initiated by Grade II glands, followed by Grade III, whereas Grade IV glands – those with the smallest secretion diameters – were virtually absent. This observation likely reflects a loss of their reserve function due to the stress-inducing impact of extreme factors inherent to aviation flight conditions.

CONCLUSION

1. The results of the study on the secretory function of minor salivary glands in civil aviation flight personnel, depending on the condition of their dental status, demonstrated distinct patterns in the spatial distribution and secretory activity of these glands. Their topographical arrangement contributes to more effective salivary coverage of the lower teeth, which corresponds with a lower incidence of dental caries in these regions.

2. The upper teeth, particularly the central incisors, are significantly less exposed to salivary flow, with certain areas remaining entirely unmoistened. The high incidence of carious lesions in these functionally oriented anterior tooth groups, in conjunction with the presented findings, may indicate the existence of a specific interrelationship between these phenomena.

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AUTHOR'S CONTRIBUTION

Gayur G. Ashurov – has made a substancial contribution to the concept or design of the article; revised the article critically for important intellectual content; approved the version to be published.

Mirzoumar K. Shokirov – has made a substantial contribution to the concept or design of the article; the acquisition, analysis, or interpretation of data for the article.

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