

Stress Index Registration in Dentists Managing Local Anesthesia by ECG Data

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Abstract

To assess the risks of increasing the voltage index of the regulatory systems of dentists when performing local anesthesia.

In the period from 12/2018 to 09/2020, selective monitoring of ECG was carried out at 200 dentists 25-55 y.o. using a wearable monitor. The study was conducted during the day with an emphasis on the 6-hour period, which corresponded to the working time of the dentist and measured the heart rate in normal and in case of local anesthesia. Of the participants, depending on age, 3 groups were formed: the 1st group included 25-34 y.o.; in the 2nd group - 35-44 y.o.; in the 3rd group - 45-55 y.o.

In the first group, the maximum heart rate limit was 188.8-182.5 (185.6); in the second - 181.8-175.6 (178.7); in the third - 174.9-168.1 (171.5). in 1st group for maxillary anesthesia heart rate increased at 6,8% and for mandibular – 9,52%; in the 2nd group data shows 2,22% and 5,99% and in the 3rd group – 1,56% and 3,93%.

In all groups was showed the significant change in heart rate and we can say about role of stress before local anesthesia in hemodynamic changes in dentists.

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Introduction

Treatment at the dentist is often associated with patients feeling a stress of varying severity during an appointment. However, recently, more and more research are devoted to dentists themselves. So, according to the latest data, more than half of doctors point to the negative impact of stress on their practical activities^{1;2;3;4;5;6;7;8}. A high level of responsibility, occupational risks and negative reactions of patients to dental treatment often lead to an increase in the physician's internal stress, which in turn underlies the formation of burnout syndrome^{9;10;11;12;13;14;15}. The findings, regardless of the research methods, indicate the dependence of functional systems, physical and mental health, and professional fitness on the

state of psychological comfort^{16;17;18}. Of interest are studies, the so-called phenomenon of the "caused" disease of the cardiovascular system, when brain control over the brain from the vegetative nervous system is disturbed, causing a sudden onset of heart disease, which is accelerated by acute emotional shocks^{19;20}. The emergence of a general adaptation syndrome^{21;22;23;24;25}, including in a professional environment, can be viewed under the guise of a nonspecific response and is accompanied by a tension of the regulatory system. Possible to find data about health of dentists in direct negative dependence on the adverse influence of working conditions, as well as in a positive connection on the quality of education^{2;26;27}. Noting the direct dependence of the efficacy and safety of the treatment, and especially local anesthesia in dentistry^{28;29}.

Aim: To assess the risks of increasing the voltage index of the regulatory systems of dentists when performing local anesthesia

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Materials and methods

In the period from December 2018 to September 2020, selective monitoring of ECG was carried out at 200 doctors aged 25-55 years using a wearable monitor.

The Ethical Committee of the I.M. Sechenov First Moscow State Medical University (protocol №. 06-17 dated July 12, 2018) and Saratov State Medical University. V.N. Razumovsky (No. 5 dated 06/18/2020) approved the stages of research

The study was conducted during the day with an emphasis on the 6-hour period, which corresponded to the working time of the dentist and measured the heart rate in normal and in case of local anesthesia.

The device is a block of 133 * 70 * 24 mm in size and weighing 160 g, which made it possible to fix the device under the uniform of dentists. Doctors noted the compactness of the apparatus, as well as the absence of discomfort at work.

Of the participants, depending on age, 3 groups were formed (see table 1): 1st - 25-34 years old; 2nd - 35-44 years; 3rd - 45-55 years.

The study aimed to determine the effect of a stressful situation depending on the medical experience of a doctor. This factor is directly proportional to age. Sex separation was not carried out due to the lack of statistical difference.

Group	Age		
	25-34 years	35-44 years	45-55 years
1	N=60	-	-
2	-	N=70	-
3	-	-	N=70

Table 1. The distribution of study participants in groups.

Results

Using a personal finger pulse oximeter, we determined the optimal (working) heart rate (HR) before and after treating the patient under local anesthesia on the maxilla (MX) and mandible (MNB) (Table 2). All patients had previously determined the maximum value of the heart rate using the Robert-Landwehr formula: maximum heart rate= 205.8 - (0.685 * age). Thus, the maximum limits for the heart rate in the groups of subjects were determined. Therefore, in the first group, the maximum heart rate limit

was 188.8-182.5 (185.6); in the second group - 181.8-175.6 (178.7); in the third group - 174.9-168.1 (171.5). The results are presented in Table 3.

Age / HR	Regular heart rate	Maxillary anesthesia		p-value	IAN block		p-value
		Before	After		Before	After	
25-34 y.o.	68,3±0,1	78,5±0,12	73,2±0,12	0,032*	82,6±0,13	79,11±0,06	0,049*
35-44 y.o.	74,4±0,12	77,5±0,08	75,1±0,07	0,012*	82,5±0,09	79,62±0,05	0,037*
45-55 y.o.	74,2±0,05	76,3±0,09	75,1±0,11	0,037*	79,5±0,08	79,2±0,1	0,13

Table 2. The doctor's heart rate indicators before and after the patient's admission.

*p<0.05 - the level of significance of the Mann-Whitney U-test.

Age/heart rate	Lower value	Upper value	Middle value	p-value
25-34 y.o.	182,5±0,2	188,8±0,11	185,6±0,12	4.303 p=0.022484
35-44 y.o.	175,6±0,13	181,8±0,09	178,7±0,2	
45-55 y.o.	168,1±0,13	174,9±0,08	171,5±0,1	

Table 3. Maximum heart rate in groups.

*p<0.05 - the level of significance of the Student's T-criteria.

When assessing the functional state of persons of the 1st group (25-34 years), it was noted that the average heart rate (HR) at the reception was 68.3 beats per minute. At the time when local anesthesia was performed at the mandible, a slight increase in the heart rate to 78.5 per minute was observed. When performing anesthesia on the mandible, there was a persistent increase in the HR values of all subjects to maximum values for the group of subjects 82.6 per minute. Similarly, for both (maxilla and mandible anesthesia), the heart rate indices significantly decreased. In cases of the absence of painful episodes in patients, after carrying out local anesthesia, a reduction in the heart rate to 73.2 during maxillary injection and 79.1 at the mandible was noted. When sudden pain symptoms appeared in patients during treatment, an increase in the heart rate to 88.5 beats per minute was observed during dental treatment at the maxilla and to 89.4 beats per minute during mandibular anesthesia. (Table 4).

Jaw bone / Middle heart rate	During local anesthesia	In case of pain during treatment	p-value
Maxilla	73,23±0,14	78,5±0,12	0,032*
Mandible	79,6±0,08	89,4±0,16	0,051*

Table 4. Results of heart rate measurement in the 1 group.

*p<0.05 - the level of significance of the Mann-Whitney U-test

The value of blood saturation was also determined using a non-invasive technique

(pulse oximeter). Normally considered the limit values of 96-98%. However, we consider it correct to note the introduction of an error of 0.1% due to the constant wearing of a dense polymer mask by a dentist. In group 1, the tendency to a decrease in blood saturation was determined when the pain appeared in patients during treatment during anesthesia, as well as during anesthesia at the mandible. Thus, the results of the study showed that when conducting local anesthesia at the maxilla, the average SpO2 value was 97%, in the mandible - 96.4%, and when pain appeared at the time of treatment against the background of the maxillary anesthesia, SpO2 was 96.3%, mandibular anesthesia - 95.2%. (table 5).

Jaw bone / Mean Heart Rate	Relaxed condition, %	During local anesthesia, %	In case of pain during treatment, %	p-value
Maxilla	97,1±0,12	96,9±0,21	96,8±0,15	0,048*
Mandible		96,7±0,18%	96,4±0,2	0,035*

Table 5. Results of SpO2 measurement in the 1 group.

*p<0.05 - the level of significance of the Mann-Whitney U-test.

Jaw / Mean Heart Rate	During local anesthesia	In case of pain during treatment	p-value
Maxilla	74,75±0,12	79,9±0,06	0,046*
Mandible	78,73±0,17	90,1±0,14	0,052*

Table 6. Results of heart rate measurement in the 2 group.

*p<0.05 - the level of significance of the Mann-Whitney U-test.

When assessing the functional state of persons of the 2nd group (35-44 years), it was noted that the average heart rate (HR) at the reception was 74.4 beats per minute. At the moment when local anesthesia was performed on the maxilla, a slight increase in the heart rate to 75.1 per minute was observed. During mandibular anesthesia, there was a persistent increase in the heart rate at all subjects to maximum values for the group of subjects 81.5 per minute. In cases of the absence of painful episodes in patients after local anesthesia, an increase in the heart rate to 77.5 during maxillary anesthesia and a reduction to 80.3 at the mandible were noted. When sudden pain symptoms appeared in patients during treatment, an increase in heart rate was recorded. (Table 6). In group 2, the tendency to a decrease in blood saturation was determined when the pain appeared in patients during treatment during

anesthesia, as well as during mandibular anesthesia. It was noted that during maxillary anesthesia the average SpO2 value was 97%, at the mandible - 96.6%, and when the pain appeared at the time of treatment (during maxillary anesthesia), SpO2 was 96.4%, during mandibular anesthesia - 95.9%. Results are presented in table 7.

Jaw bone/ Mean Heart Rate	Relaxed condition, %	During local anesthesia, %	In case of pain during treatment, %	p-value
Maxilla	97,4±0,1%	97,3±0,13	96,4±0,14	0,032*
Mandible		96,6±0,15	95,9±0,19	0,036*

Table 7. Results of SpO2 measurement in the 2 group.

*p<0.05 - the level of significance of the Mann-Whitney U-test

When assessing the functional status of persons of the 3rd group (45-55 years), it was noted that the average heart rate at the reception was 74.2 beats per minute. At the moment of maxillary local anesthesia, a slight increase in the heart rate to 75.9 per minute was observed. During mandibular anesthesia, a persistent increase in the heart rate were registered at all subjects to the maximum values for the group of subjects – 79 beats per minute. In cases of the absence of painful episodes in patients after maxillary local anesthesia, an increase in the heart rate to 75 beats per minute and a reduction to 79 beats per minute in cases of treatment of mandibular teeth were noted. When sudden pain symptoms appeared in patients during treatment, an increase in heart rate was recorded. (Table 8).

Jaw / Mean Heart Rate	During local anesthesia	In case of pain during treatment	p-value
Maxilla	75,73±0,09	76,2±0,13	0,039*
Mandible	79,51±0,12	82,71±0,12	0,041*

Table 8. Results of heart rate measurement in the 3 group.

*p<0.05 - the level of significance of the Mann-Whitney U-test.

In group 3, the tendency to a decrease in blood saturation was determined when the pain appeared in patients during treatment during anesthesia, as well as during mandibular anesthesia. It was noted that during maxillary anesthesia the average SpO2 value was 96.8%, at the mandible - 96.3%, and when the pain appeared at the time of treatment (during maxillary anesthesia), SpO2 was 96.6%, during mandibular anesthesia - 96.1%. Results are

presented in Table 9. Thus, despite the lack of statistical significance of indicators of maxillary anesthesia, there is a qualitative tendency to hypoxia due to stress.

Jaw bone / Mean Heart Rate	Relaxed condition, %	During local anesthesia, %	In case of pain during treatment, %	p-value
Maxilla	96,9±0,1%	96,8±0,2	96,6±0,21	0,069
Mandible		96,3±0,15	96,1±0,21	0,046*

Table 9. Results of SpO2 measurement in the 3 group.

*p<0.05 - the level of significance of the Mann-Whitney U-test.

Discussion

The results of this study demonstrate that local anesthesia can be a case of professional stress. The different studies show different results for prevalence in heartrate as the reaction to the stress³⁰. Poor mental well-being and low job satisfaction among physicians can have significant negative implications for the physicians and their patients and may also reduce the cost efficiency in health cary³¹. Even such situation can be a chronic reason of regular complications in work associated with stress. Loss of professional control, autonomy, and flexibility; inefficient processes; disjointed workplace relationships and goals; excessive administrative burdens; poor work-life balance; and frustrations with medical record and order entry systems have all been associated with burnout³².

It was shown in the data of ECG changes in dentists treating awake patients that one of the participants showed any sign of stress induced arrhythmias³³. Järvelin-Pasanen S. in 2018 demonstrate how assessment and analysis methods of occupational stress and HRV were diverse³⁴.

In literature we can find information about pulse oximeter use for high-risk patients or in paediatric dentistry to be a non-invasive method of complications prevention but there is lack of data how this technology can be used for dentist in personal stress measurement^{35,36}.

Dentists are exposed to stress and tension as they have a close contact with the patients. As the findings indicated, anesthetic injection to a nervous infant was the most stressful practice in pediatric dentistry³⁷.

This study shows not only significant change in SpO2 during and after injection at the

maxilla and mandible but also in different ages.

The result of the systematic review of burnout factors in dentists and dental students present this problem as multifactorial phenomenon that can develop early in a dental career³⁸. It was showed that local anesthesia can be a reason of dentist's heart rate change³⁹.

This information was proved by Brand (1999) who mentioned that pain plays an important role in the cardiovascular response during dental treatment⁴⁰. Necessary to mention that higher rates of stress during operative procedures were reported among dental students than among experienced dentists⁴¹. Before it was proved by Rabinovich S.A. in 2017: in all groups greater stress index correlated more with mandible anesthesia events^{42,43}.

Our study shows that in all groups the most stressful for dentist was mandibular anesthesia. Simon JF in 1994 concluded that the administration of anesthetic injections is a rarely discussed but significant contributor to the overall professional stress and difficulty for many, but not all, dentists⁴⁴. Administering a mandibular block to preschool children was the procedure perceived as the most stressful (33.6%) pain control method^{45,46}. It can be concluded that the use of 0.6% ml of 4% articaine is enough to achieve sufficient anesthesia for the extraction of maxillary posterior teeth⁴⁷.

Thus, in 1st group for maxillary anesthesia heart rate increased at 6,8% and for mandibular anesthesia – 9,52%; in the 2nd group data shows 2,22% and 5,99% and in the 3rd group – 1,56% and 3,93%. In all groups was showed the significant change in heart rate and we can say about the great role of stress during performing of local anesthesia in hemodynamic changes in dentists.

Nearest specialization to dentistry, such as anesthesiology also shows risks in burnout stress. van der Wal RAB in 2018 shows how personality consistently influences stress appraisal and coping and consequently the development of burnout. Neuroticism, negative affectivity and cooperativeness all contribute to burnout⁴⁸. We can find that general and anesthesia-specific job stress was significantly higher and job satisfaction was significantly lower in the distressed profile, compared with the resilient profile⁴⁹. Rama-Maceiras P in 2015 reports about almost 50% of anesthesiologist's scored positive for some of the burnout domains

in different surveys, with one-third reporting high levels⁵⁰. Thus, a high correlation between the doctor's professional activity related to anesthesia and the level of stress, up to the development of emotional burnout syndrome, has been determined.

Conclusions

Subjective excitation is accompanied by an objective change in hemodynamics in case of sudden pain in a patient against the background of local anesthesia, which is consistent with the data^{10; 2}. Thus, the implementation of local anesthesia in the maxilla and mandible of dentists of different ages and, as a result, having different working experience, an increase in the heart rate and their reduction in the absence of sudden pain in patients is noted.

Declaration of Interest

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