





## Variations in heart rate, body temperature and blood pressure in patients undergoing dental implant surgery

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### Abstract

**Objective.** To determine the variations in heart rate, blood pressure and temperature in patients undergoing dental implant surgery. **Methods.** Series of clinical cases that included 26 patients aged 20 to 60 and treated at the Naval Medical Center "Cirujano Mayor Santiago Távara" (Lima, Peru). The temperature, heart rate, and blood pressure were recorded five minutes before implant surgery, five minutes after local anesthesia, and five minutes after surgery. A digital thermometer and a digital wrist monitor were used to take measurements. **Results.** Body temperature in the preoperative period was  $36.9 \pm 0.3$  °C, while in the intra- and postoperative phase, it was  $36.7 \pm 0.07$  °C ( $p > 0.05$ ). The heart rate increased in the intraoperative period ( $80.3 \pm 8$  beats/min) and was restored in the postoperative period ( $72.5 \pm 7.4$  beats/min) ( $p < 0.05$ ). The mean arterial pressure in the intraoperative period and on average was  $100.14 \pm 6.35$  mmHg, while in the postoperative phase, it was  $93.97 \pm 7.57$  mmHg ( $p < 0.05$ ). **Conclusion.** The main variations were found from the intraoperative to the postoperative moment in terms of heart rate, mean, systolic, and diastolic blood pressure. Therefore, these are relevant parameters for clinical consideration.

**Keywords:** blood pressure, heart rate, body temperature, dental implants.

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## Introduction

Implant surgery can be supplemented with additional treatments such as exodontics, maxillary sinus floor augmentation, soft tissue grafts, etc. Events such as stress, anxiety, and fear occur while performing these procedures. Therefore, procedures could be associated with an intense cardiovascular response, often harmless in healthy patients but potentially harmful in individuals with heart disease.

The stress-related increased sympathetic activity could trigger an unfavorable cardiac response, as there is a vagal response and alpha beta-adrenergic

stimulation. This can cause myocardial ischemia due to elevated cardiac output and possibly cause decreased left ventricular function<sup>(1)</sup>. It is essential to know the systemic physiological responses that oral surgical procedures, such as dental implant placement, can trigger. Circulating catecholamines can increase in surgical stress events, leading to higher blood pressure (BP) to a potentially harmful degree<sup>(2-3)</sup>.

Physiological responses are the body's reactions to stressful stimuli. Therefore, a series of physiological reactions activate the autonomic nervous system and the hypothalamic-pituitary-adrenal axis<sup>(4)</sup>. Both systems produce substances made in the glands transported through the blood and inhibit, excite, or regulate organ activity (hormones)<sup>(4)</sup>. These physiological responses can have a more significant effect on medically compromised patients as those at increased risk of interactions between disease and implant surgery, which entails higher medical risk<sup>(5)</sup>.

The right diagnosis and planning for each patient are necessary to ensure that dental implants and treatments only cause manageable and temporary pain or discomfort. It is essential to monitor blood pressure, temperature, and heart rate in dental surgeries. An increase in heart rate is associated with an increased risk of heart disease. Furthermore, excessively high or decreased temperature can cause tissue deterioration, disturb organ function, or alter metabolic rates. In addition, a hypertensive crisis due to increased blood pressure can cause a stroke or an acute myocardial infarction.

Surgical dental implant procedures modify patients' physiological responses, as they are subjected to stressful stimuli and therefore release hormones. These sustained physiological responses lead to a set of symptoms such as high blood pressure, precordial pain, increased body temperature, stomach disorders (indigestion, diarrhea), insomnia and anxiety, dry mouth and throat, tension, and muscle pain<sup>(4)</sup>. These symptoms do not appear frequently during dental implant placement. However, it is essential to consider whether systemic physiological responses are affected during the surgical procedures of implant placement; this would show us if such parameters are affected so professionals can monitor the patient and the surgical event more closely. Therefore, this study assessed whether physiological responses (body temperature, blood pressure, and heart rate) are altered before, during, and after dental implant placement.

## **Method**

An observational and descriptive study (series of clinical cases) with multiple measurements was designed for the same study object (longitudinal type). The population included adult patients treated at the Periodontics Service of the Naval Medical Center "Cirujano Mayor Santiago Távara" (Lima, Peru) from June to December 2018. The sample size was determined through mean estimation and considering a 95% confidence level, a 5% accuracy error, and an expected variance of 13.02, as obtained by Carrasco et al.<sup>(6)</sup>, to estimate blood pressure variation. A minimum of 25 patients was required, according to the calculation. Sample selection was performed through systematic sampling; it had an evaluation constant of  $K=2$ . The patient list for dental implant placement was

provided by the operating room of the hospital's Department of Stomatology. Patients had to meet the following criteria: adults aged between 20 and 60, planned placement of a maximum of two dental implants, and good general health (ASA I). Excluded patients: individuals with systemic conditions, a history of surgeries, under pharmacological treatment, totally edentulous, and having undergone oral and facial surgeries.

The same periodontist treated all patients. Lidocaine 1 was used as local anesthesia: 80,000 (Scandicaine®, Austria) with epinephrine (maximum three cartridges; if more was administered, the patient was excluded from the study). Five minutes before entering the operating room, patients were asked to take a seat and lift their tongue to insert the digital thermometer and close their mouth normally, without clenching their teeth or lips. A minute later, after the beep, the thermometer was removed. The temperature was taken with a digital thermometer (Citizen®, Japan), ensuring that the screen displayed no previous measurements. After this, heart rate, and blood pressure were assessed with a digital wrist monitor (Citizen®, Japan) (Fig. 1A). The patient remained seated and placed their elbow on a table. The cuff was placed over the wrist, checking that the monitor was in the right position.

Simple and fenestrated sterile fields were placed, asepsis and antisepsis were performed, and lidocaine was administered with 1:80000 vasoconstrictor (Scandicaine®, Austria). Five minutes later, the temperature was retaken with the digital thermometer and the digital wrist monitor. This was done with the patient lying, as it was more comfortable for both examiner and patient (Fig. 1B). After the dental implant surgery, examiners waited five minutes for the patient to sit up straight in the surgery room. Then, they took the patient's temperature and blood pressure with the digital thermometer and digital wrist monitor (Fig. 1C).

**Figure 1:** A. Presurgical recording of parameters (preoperative phase). B. Recording five minutes after local anesthesia (intraoperative phase). C. Recording five minutes after surgery has been completed (postoperative phase)



The Student t test for independent groups was used to compare numerical data and group by age, sex, and type of surgical technique (implant placement and

implant placement with guided bone regeneration). The ANOVA test and a post-hoc Bonferroni analysis were used to compare evaluation times for related measures. Both tests were conducted after demonstrating the assumptions of normal distribution and homogeneity of means. A statistical significance of 0.05 was set to disprove the null hypothesis. Patients were not obliged to cooperate; each person freely chose to participate in the study by signing an informed consent. The study did not create any differences of any kind (equality). The research did not include names or individual reports. The information analyzed was shown accurately and as it was found. The study was approved by the Ethics Committee of the School of Tropical Medicine of Universidad Nacional Mayor de San Marcos, as well as the Ethics Committee of the Naval Medical Center "Cirujano Mayor Santiago Távara" (Lima, Peru).

## Results

Twenty-six patients with a mean age of  $51.69 \pm 11.06$  were evaluated, of which 65.4% were male (mean age  $52.65 \pm 11.59$ ) and 34.6%, female (mean age  $49.89 \pm 10.4$ ).

A dental implant was placed on each patient, 92.3% were delayed, and 7.7% were immediate; 73.1% had no additional procedure, and 26.9% had guided bone regeneration procedures.

The evaluation of variations in body temperature showed that in the preoperative period, the average temperature was  $36.9\text{ }^{\circ}\text{C}$ , while in the intra- and postoperative phase, it was similar:  $36.7\text{ }^{\circ}\text{C}$ . Heart rate increased before the procedure (80.3 beats/min) and was restored postsurgically (72.5 beats/min). The average intraoperative blood pressure was 100.14 mmHg on average, while postoperative blood pressure was 93.97 mmHg (Table 1 and Figure 2).

**Table 1:** Changes in systemic parameters according to assessment times

Variables	Statistics	Time of assessment			p
		Preoperative phase	Intraoperative phase	Postoperative phase	
Body temperature (°C)	X and S.D.	36.9 ± 0.3	36.7 ± 0.07	36.7 ± 0.08	0.061
	Median	36.8	36.8	36.7	
	Range	36.7-38.8	36.6-36.9	36.6-36.9	
Heart rate (beats/minute)	X and S.D.	70.5 ± 8	80.3 ± 8*	72.5 ± 7.4	0.002
	Median	69	80	72	
	Range	60-89	66-91	61-89	
Mean blood pressure	X and S.D.	88.44 ± 9.78	100.14 ± 6.35	93.87 ± 7.57	0.012†
	Median	86.33	99.33	92.67	
	Range	74.33-108.67	92-117	82-106.67	
Systolic pressure (mmHg)	X and S.D.	113 ± 15.4	130.9 ± 9.7	122.4 ± 11.7	0.001†
	Median	109	128	121	
	Range	90-144	120-150	104-146	
Diastolic pressure (mmHg)	X and S.D.	76.1 ± 8	84.7 ± 6.6	79.5 ± 7.25	0.001‡
	Median	76	83.5	80.5	
	Range	61-91	69-102	62-90	

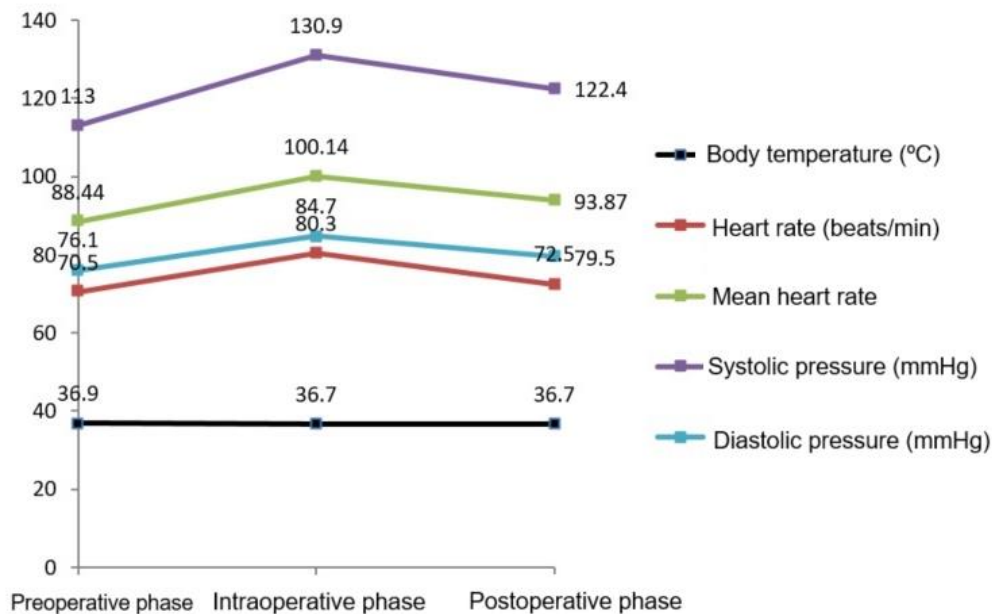
X= Average                      S.D.= Standard deviation

\* Friedman test. Significantly different value from the two readings

† Friedman test. Significantly different values when comparing the three readings

‡ ANOVA test for repeated measurements. Significantly different values when comparing the three readings

**Figure 2:** Changes in average values according to assessment times



## Discussion

Low or high body temperatures can alter metabolic rates, organ function and cause tissue damage<sup>(7)</sup>. Hemodynamic changes such as heart rate must be considered in the clinical examination. Extreme tachycardia or bradycardia could have fatal consequences<sup>(8)</sup>. An increase or decrease in blood pressure is subject to certain factors and poses a considerable risk to the patient's health if proper care is not provided during surgery<sup>(9)</sup>.

In this paper, we evaluated how these parameters are modified during implant surgery; other studies evaluated partial pressure of oxygen (SpO<sub>2</sub>)<sup>(8,10-11)</sup>, as well as the degree of anxiety<sup>(12)</sup> and the patient's character<sup>(13)</sup>. Implant placement was the dental procedure where temperature, blood pressure, and heart rate were assessed in this and other studies<sup>(6,12-14)</sup>. Other authors did so during exodontics<sup>(1,9-11,15-16)</sup>, endodontics<sup>(17)</sup>, and routine dental treatments (root planing, prophylaxis, operative and impressions)<sup>(18)</sup>.

This research studied changes in mean blood pressure and found evidence of a significant increase in subjects from intraoperative time. Although it decreased postoperatively, the reading was not equal to the baseline. Carrasco et al.<sup>(6)</sup> also found a significant increase in mean blood pressure during implant surgery; this may be due to surgical stress that can increase circulating catecholamines<sup>(4)</sup>. However, Masahiro et al.<sup>(13)</sup> found a correlation between neuroticism and increased mean blood pressure in people who received implants, while Weber et al.<sup>(19)</sup> reported that an individual with a high degree of neuroticism tends to choose situations that could lead to adversity and distress and modify their systemic parameters. Richmond et al.<sup>(20)</sup> also found an increase in mean blood pressure in people undergoing routine dental treatments without local

anesthesia. This may be because, when a procedure is performed without anesthesia, there is a greater chance of feeling discomfort or pain. These variations increase with age because the elasticity of the artery walls decreases; this increase is more frequent in people over 40<sup>(18)</sup>. Nakamura et al.<sup>(21)</sup> mention that the administration of local anesthesia activates the adrenal sympathetic system, so it could lead to higher blood pressure.

When studying changes in systolic and diastolic blood pressure, this paper found that they increase during the surgery (five min after anesthesia is administered) and show a slight decrease postsurgically, which is significantly different in the intraoperative phase. In this regard, Nagao et al.<sup>(14)</sup> found that systolic blood pressure increased significantly, and diastolic blood pressure did not change significantly throughout the surgery compared to the preoperative reading. Tiwari et al.<sup>(10)</sup> found an increase in systolic blood pressure during anesthesia administration and a minimal change in diastolic blood pressure during dental extraction. Nuñez et al.<sup>(15)</sup> found that blood pressure variation most frequently occurred five minutes after administering anesthesia for tooth extractions.

Regarding heart rate, we found a significant increase in pulse rate only in the intraoperative phase, and it returned to its baseline values after surgery. Tiwari et al.<sup>(10)</sup> and Matsumura et al.<sup>(22)</sup> found an increase in heart rate during local anesthesia administration in extractions. Arias et al.<sup>(8)</sup> found that heart rate increased significantly after administering anesthesia and remained stable during flap lifting, decreased again during osteotomy, and remained the same during suture and discharge during extractions. Nagao et al.<sup>(14)</sup> found that it increased just after local anesthesia was administered and decreased in the course of dental implant surgery.

Fuentes et al.<sup>(5)</sup> report that catecholamines produced in surgical stress situations increase blood pressure and heart rate. However, Vintanel et al.<sup>(11)</sup> state that the degree of stress is a variable to consider at the onset of systemic variations (heart rate and diastolic blood pressure). Nagao et al.<sup>(14)</sup> say that increased age, surgical time, and the number of implants are linked to increased variations in systemic parameters (heart rate, systolic, and diastolic blood pressure).

Regarding temperature, there was a significant decrease compared to intraoperative time and it remained constant after surgery, although this was not clinically significant. In this regard, there is a marked decrease in temperature when general and regional anesthesia is used, but not with local anesthesia<sup>(23)</sup>. However, Kimberger and Quast<sup>(7)</sup> indicate that patients typically undergo accidental cooling when the surgical procedure begins. External factors such as wearing few clothes or low temperatures in the environment induce the involuntary temperature to decrease. While it is generally true that air conditioning provides surgeons with a pleasant and comfortable environment, it is also an external factor during all dental implant treatments. Air conditioning must have the right technical qualities since many surgical procedures performed in hospitals require an aseptic environment.

The limitation of this study is that partial pressure of oxygen (PpO<sub>2</sub>) could not be evaluated because measurement materials were not available. Therefore, we recommend considering this critical variable in the different surgical processes as it reflects saturation of hemoglobin and, therefore, oxygen supply to the tissues. Only healthy patients receiving a maximum of two implants were

evaluated; it is necessary to conduct studies evaluating patients with systemic diseases—provided bioethical considerations or expert opinions are respected—and requiring more complex dental implant placement procedures. It should be noted that the variable “pain” must also be considered in future studies as it could affect blood pressure values. It is advisable to analyze the patients’ degree of anxiety; we recommend using psychometric scales or tests before placing a dental implant. Additionally, the main antecedents were considered for the sample size. However, this number was small, and data generalization is not applicable, so we recommend a larger sample size for future studies.

## **Conclusion**

There is a non-significant decrease in temperature as of intraoperative time, and it becomes constant until completing the dental implant placement. Heart rate increases from intraoperative time, and although it decreases in the postoperative phase, it does not match the baseline value. Something similar happens when the average blood pressure is evaluated in healthy patients who have had one or two dental implants placed.

Authors' contribution note:

1. Conception and design of study
2. Acquisition of data
3. Data analysis
4. Discussion of results
5. Drafting of the manuscript
6. Approval of the final version of the manuscript.

AQA has contributed in: 1, 3, 5 y 6.

LRO has contributed in: 2, 4 y 6.

YCR has contributed in: 2, 4, 5 y 6.

SGP has contributed in: 2, 4, 5 y 6.

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