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Original Article

Evaluation of hemodynamic and SpO_2 variability during different stages of periodontal surgery

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Abstract:

Background: Changes in pulse rate and blood pressure are common consequences during oral surgeries. Hypoxia during surgical process is another side effect. The objective of the present study was evaluation of blood hemoglobin oxygenation and hemodynamic changes during periodontal surgery. **Materials and Methods:** This clinical trial study was conducted upon 50 subjects aging 30-55 years who referred to the clinic of dental faculty of Babol University and needed periodontal surgery with modified widman flaps in the anterior section of the maxilla. Pulse rate, blood pressure, and pulse oximetric evaluations were recorded in five stages during surgery. **Results:** The average of systolic and diastolic blood pressure had been in their maximum amount in the second stage of evaluation and minimum amounts were in the first one; while pulse rate changes were greatest in the second stage and lowest in the fifth stage. Analyzing the data revealed no significant difference in SpO_2 measurements in none of the stages evaluated. **Conclusions:** Blood pressure and heart rate increased significantly after the injection of anesthetic drug and in further phases they were decreased after the elimination of stimulating effect of adrenaline. SpO_2 changes were not significantly prominent.

Key words:

Hemodynamic changes, pulse oximetry, periodontal surgery, SpO_2

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INTRODUCTION

Successful management and treatment of periodontal disease depend on simple medical procedures such as health education, prophylaxis, scaling and root-planning, gingivectomy, gingival graft, and different types of gingival flaps.[1]

Periodontal pocket refers to the pathological increase in the depth of gingival sulcus, and is one of the main clinical features of periodontal disease. Elimination of pathological changes of the pocket wall is among the objectives of surgical treatment for periodontal pockets, so that a stable and sustainable situation can be achieved. Currently, several flap techniques have been applied for the treatment of pocket, among which modified Widman flap is worth mentioning. This technique facilitates the use of equipment, in which pocket lining is removed with no effect on reducing the pocket depth.

Dental treatments are accompanied by patients' hemodynamic changes; for instance, increase in blood pressure and heart rate during dental treatment are influenced by various factors such as physical and physiological stress, painful stimuli, and activity of catecholamines present in local anesthetic solutions.[2] Heart rate, which is indicative of ventricular contraction, changes in different conditions, including pain, anxiety, stress, heart diseases, metabolic and endocrine disorders and heart muscle diseases, and is evaluated by peripheral pulse measurement or the electrocardiogram and pulse oximetry. For the measurement of blood pressure, different methods are applied, from which Riva-Rocci, Korotokoff, Dinamap, and Finometer techniques can be enumerated. Due to the risk of hypoxia in oral surgeries, pulse oximetry is also recommended to be used in these cases.[3] Pulse oximeter is a reliable and sensitive apparatus in detecting small amounts of blood oxygen saturation, and in all patients, SpO_2 normal percentage is not less than 95%.[4]

A dental patient is exposed to stressors, such as physiological responses to emotional factors and/or pain. Pain and anxiety, are important stimuli for the secretion of endogenous adrenaline, which plays a significant role in cardiovascular responses during dental treatment.[5]

Local anesthetics mainly affect the limited area; however, they will be absorbed from the injection site and exert general effects, especially on cardiovascular or central nervous system. General effects are pronounced particularly in cases with high dose administrations.[6]

Lidocaine along with epinephrine is the most common anesthetic used in oral surgeries. It is obvious that more the concentration of

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epinephrine, the better the control of bleeding, but there will be more cardiovascular changes. In spite of the effect of local anesthetics on vital signs, their accurate application is able to dramatically reduce stress.[7]

Given the above bodies of evidence and the importance of monitoring patients' hemodynamic changes during oral surgery, the present study has been conducted to investigate these alterations during periodontal surgery outside the operating room with local anesthesia.

MATERIALS AND METHODS

This practical clinical trial study was carried out on patients with gingival disease referred to the clinic of Dental Faculty of Babol University of Medical Sciences, and underwent modified Widman flap surgery on anterior maxillary region in Periodontology Department. The equipments used in the study included (1) Finger pulse oximeter (Soor Afarinesh Company), and (2) Automatic sphygmomanometer (Omron Company)

Study design

According to the following inclusion criteria, 50 patients ranging from 30 to 50 years participated in this study. In all patients, changes in heart rate, blood pressure, and also pulse oximetry were examined during five steps; the first step before injecting the anesthetic, the second step after the anesthetic injection and before the incision, the third step after the incision, the forth step after debridement, and the fifth step following stitching and the end of the operation.

It should be noted that all the operations were performed by one surgeon, and all patients received two anesthetic cartridges containing lidocaine (2%) and epinephrine (1:80000) (Darou Pakhsh Company), using the infiltration technique into the vestibular depth and interdental papilla and also hard palate mucosa, in anterior 1/6 region and incisive canal; no additional anesthetic cartridge was used during surgery, and those in need of re-injection were excluded from the study.

SpO_2 and hemodynamic alterations were assessed using the automatic sphygmomanometer and pulse oximeter attached to the patient's finger during surgery.

Inclusion criteria

- Having no systemic disease to be considered as contraindication of periodontal surgery or affecting the heart rate and blood pressure
- Having no sensitivity to anesthetics
- Not being in pregnancy or lactation period.

Statistical analysis

Data were analyzed by SPSS statistical software using ANOVA repeated measure test, and $P < 0.05$ was considered as statistically significant level.

RESULTS

The present research has been implemented on 50 patients referring to Periodontology Department of Dental Faculty for periodontal surgery. Among the study participants with the mean age of 42.58 ± 7.14 years, ranging from 30 to 55 years old, there were 22 men and 28 women. In all cases, systolic and diastolic blood pressure, heart rate, and SpO_2 were evaluated during five stages; the first step before injecting the anesthetic, the second step after the anesthetic injection and before the incision, the third step after the incision, the forth step after debridement, and the fifth step following stitching and the end of the operation.

The Mean±SD systolic blood pressure

The mean systolic blood pressure was highest in the second stage and lowest in the first one. In the five steps studied, there was a significant difference between the first step and the second ($P < 0.0001$) and the third ($P = 0.001$), the second step and the first ($P = 0.001$) and the fourth and the fifth ($P < 0.0001$), the third step and the first ($P = 0.001$) and the fourth ($P = 0.010$), the fourth step and the second ($P < 0.0001$) and the third ($P = 0.010$), and also the fifth step and the second ($P < 0.0001$) [Table 1 and Figure 1].

The Mean±SD diastolic blood pressure

The maximum and the minimum diastolic blood pressures were, respectively, obtained in the second and the first stage. Statistical analysis showed significant difference between the first stage and the second ($P = 0.001$), the second stage and the first ($P = 0.001$) and the third ($P < 0.0001$) and the fourth ($P = 0.003$), the third stage and the second ($P < 0.0001$), and the fourth step and the second ($P = 0.003$); however, no meaningful relationship was found between the fifth step and the other stages [Table 2 and Figure 2].

The Mean±SD heart rate

According to statistical analysis, the maximum and the

Table 1: Comparison of the Mean±SD SBP* during the five stages of modified Widman flap surgery

SBP	Minimum	Maximum	Mean±SD	*P* value
Surgical steps				<0.0001
First step	109	154	128.84±1.496	
Second step	104	164	137.84±1.729	
Third step	102	179	135.28±2.060	
Fourth step	100	159	131.18±1.617	
Fifth step	100	164	131.10±1.739	

*SBP – Systolic blood pressure

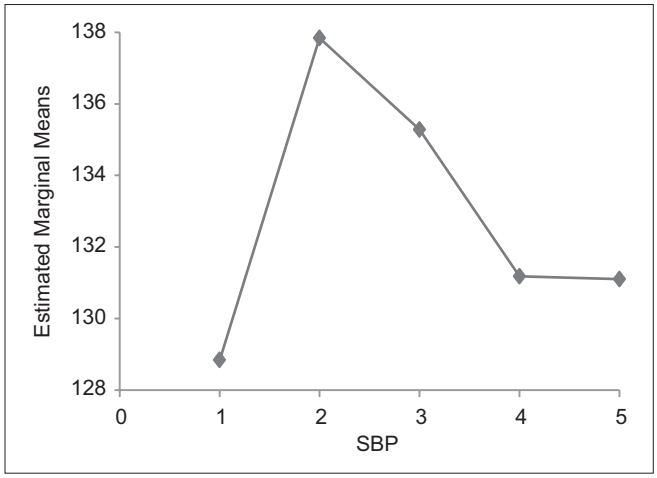

Figure 1: SBP changes during the five stages of modified Widman flap surgery

minimum heart rate was respectively observed in the second and the fifth stage. Significant differences were found between the first step and the second and the third ($P < 0.0001$), the second and the third steps and the other stages, the fourth step and the second and the third ($P < 0.0001$) and the fifth ($P = 0.001$), and also the fifth step with the second and the third ($P < 0.0001$) and the fourth ($P = 0.001$) steps [Table 3 and Figure 3].

The Mean±SD SpO_2

Similarly, based on statistical analysis, no significant difference has been achieved in the mean SpO_2 during the five stages studied ($P > 0.05$) [Table 4 and Figure 4].

DISCUSSION

Hemodynamic changes during dental treatment have long been one of the main concerns among practitioners and researchers.[8] Increase in blood pressure and heart rate during surgery is inevitable; however, the effect of sympathetic nervous system is not well-identified on this augmentation. Since the use of local anesthesia does not merely contribute to increased concentration of plasma noradrenaline without dental treatment, blood pressure response appears to be depending on dental treatment process itself.[9]

As mentioned earlier, elevated blood pressure during oral surgery is attributed to the sympathetic nervous system. Due to possessing vasoconstrictors and anesthetic components, local anesthesia exerts different effects. Adrenaline is used as a vasoconstrictor along with lidocaine to increase the amount and duration of anesthesia. Besides, adrenaline acts as hemostats during surgery and leaves several hemodynamic effects.[10] Moreover, many researchers have pointed to changes probably effective on normal patients' physiological stability. Sedative drugs and local anesthetics can be used to control the

Table 2: Comparison of the Mean±SD DBP* during the five stages of modified Widman flap surgery

DBP	Minimum	Maximum	Mean ± SD	*P* value
Surgical steps				<0.0001
First step	67	105	81.52±1.233	
Second step	71	118	86.00±1.457	
Third step	67	106	82.80±1.268	
Fourth step	67	97	87.76±1.199	
Fifth step	67	102	84.42±1.162	

*DBP: Diastolic Blood Pressure

Table 3: Comparison of the Mean±SD HR* during the five stages of modified Widman flap surgery

HR	Minimum	Maximum	Mean ± SD	*P* value
Surgical steps				<0.0001
First step	68	113	87.64±1.620	
Second step	81	122	101.14±1.590	
Third step	71	109	93.44±1.307	
Fourth step	70	102	87.76±1.199	
Fifth step	67	102	84.42±1.162	

*HR: Heart Rate

Table 4: Comparison of the Mean±SD SpO_2 during the five stages of modified Widman flap surgery

SpO_2	Minimum	Maximum	Mean±SD	*P* value
Surgical steps				2.714
First step	93	98	96.58±0.210	
Second step	88	99	96.66±0.266	
Third step	91	99	97.04±0.206	
Fourth step	94	98	96.88±0.158	
Fifth step	88	98	96.54±0.287	

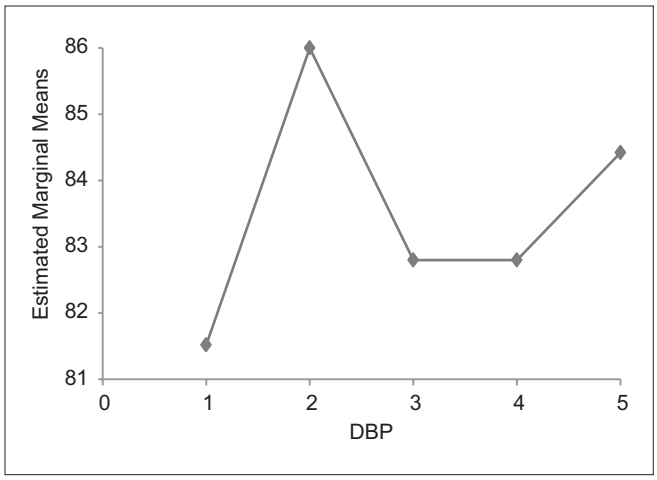

Figure 2: DBP changes during the five stages of modified Widman flap surgery

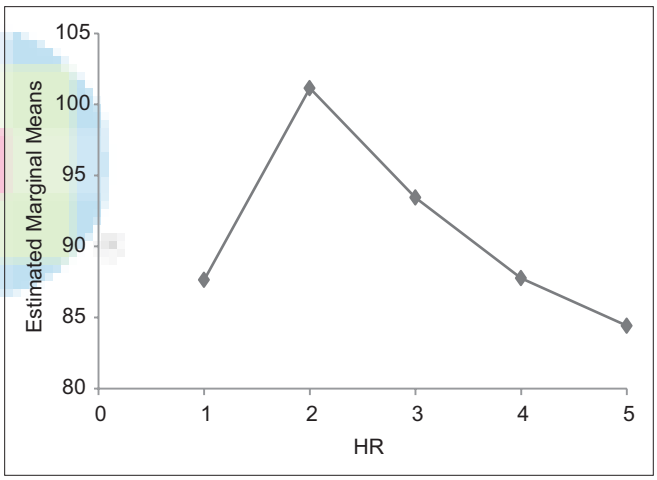

Figure 3: Changes in HR during the five stages of modified Widman flap surgery

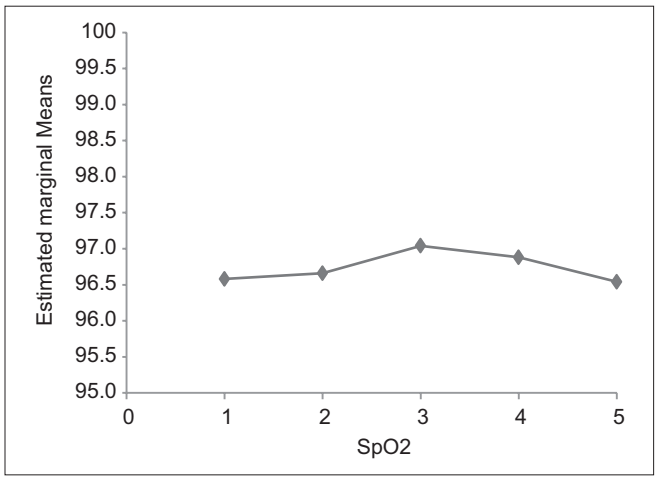

Figure 4: SpO2 variability during the five stages of modified Widman flap surgery

autonomic nervous system responses and help to reduce the cardiovascular alterations.[8] In addition, different people react differently to anxiety and pain, which could be significantly influential on their hemodynamic alterations.

In the present study, blood pressure and heart rate were remarkably increased after injection of anesthesia ($P < 0.05$). According to Figures 1, 2, and 3, a meaningful difference has been found in the second step and following the anesthetic injection containing lidocaine and epinephrine (1:80000) ($P < 0.0001$) in systolic and diastolic blood pressure and heart rate, on which the result was almost predictable. This can be associated with hemodynamic effects of adrenaline, as well as alpha-adrenergic effects to peripheral vasoconstriction and beta-adrenergic effects to increased cardiac contraction. Furthermore, patient's physiological stress before surgery and also painful stimulus following injection might lead to increased sympathetic activity and subsequently blood pressure and heart rate. Thus, application of anxiety-reducing protocols such as psychological sedatives during treatment and minimizing patient's waiting time can greatly control endogenous secretion of adrenaline. The study figures present a reduction in systolic and diastolic blood pressure following the second step and during the third, fourth, and fifth steps, indicating the elimination of stimulatory effect of adrenaline on blood pressure and heart rate and showing insignificant impact of other surgical steps on vital signs in cases of no anesthetics injection. Furthermore, over time and acceptance of treatment processes by patient, the initial anxiety will be diminished and the person will reach to a relatively stable cardiovascular balance.

Since the peak effects of local anesthetics and alpha and beta epinephrine impact elimination occur in the third and the fourth steps, decrement in heart rate and blood pressure seems to be obvious in these stages.

According to Figure 2, diastolic blood pressure has been slightly elevated in the fifth step, after stitching at the end of the operation, which is probably due to feeling of pain by patient and decrease in the effect of anesthetic.

In a study by Matsumura *et al*. investigating changes in blood pressure and heart rate during dental surgery, the results revealed an increase in both parameters after anesthesia with lidocaine (2%) and epinephrine (1:80000), which is compatible to findings of the present research.[2]

In Faraco *et al*. survey on the effect of anesthetics containing lidocaine and epinephrine on cardiovascular changes during dental implant surgery, blood pressure was evaluated using the automated noninvasive oscillometric technique during ten steps; the results showed no significant difference in blood pressure and heart rate variability,[7] which is not in accordance to the findings achieved in this research.

In another study by Gedik *et al*. on blood pressure, heart rate and temperature variability during periodontal surgery, patients were divided into four groups according to types of surgery, and blood pressure and heart rate were measured after anesthetic injection and the end of the operation; blood pressure and heart rate were decreased in patients undergoing gingivectomy and periodontal flap, which is in consistence with the results obtained in the present research. However, no changes in heart rate and blood pressure have been observed following frenectomy and curettage,[9] indicating that the difficulty in treatment process is an effective factor in blood pressure.

As shown in Figure 4, no statistically significant difference has been found in the mean SpO_2, measured by pulse oximetry, in different stages ($P > 0.05$). In other words, conventional periodontal surgery with technical and safety observations does not bring hypoxia in healthy subjects.

In an investigation by Kaviani and Birang, nausea, vomiting, decreased or increased blood pressure and other hypoxia complications following the use of nitrous oxide inhalation sedation during periodontal treatment have only been observed in 1 out of 32 cases, which was probably due to patient restlessness and movement during treatment.[11]

Matthews *et al*. have addressed to pulse oximetry during oral surgery with and without intravenous sedation and found out a significant reduction in arterial blood oxygen levels in the group receiving midazolam. This study illustrates remarkable sedative effect of midazolam on anxious patient prior to the surgery; nonetheless, this effect does not sustain during the operation.[4]

As mentioned, findings of various studies in terms of hemodynamic changes following dental treatments are contradictory, and such discrepancies could be related to different research approaches and different local anesthetics applied.

CONCLUSION

Different surgical stages will be accompanied by diverse effects on hemodynamic variability and pulse oximetry. According to the present study, blood pressure and heart rate are significantly increased after anesthetic injection and are decreased in the following stages by the elimination of adrenaline stimulatory effect. Moreover, no significant alteration has been observed in SpO_2 during the operational steps in this research.

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Clinical Relevance

Based on the acquired data of the present study, due to the hemodynamic alterations obtained during various stages of periodontal surgery (Modified widman flap), it is preferred for the patients, particularly cardiovascular sufferers to be monitored. Therefore, the re-injection of anesthetic drug can be performed in various stages of the surgery appropriately and be avoided from sudden changes in vital signs to some extents.

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