Original Article

Stress Interpretation by Using Blood Glucose levels, blood pressure and pulse rate measurement in Patients attending Oral and Maxillofacial Clinic in College of Dentistry at University of Sulaimani

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Abstract

Objective: Based on specific parameters such as blood glucose levels, blood pressure, and pulse rate, a prospective randomized case-control study was conducted to determine the stress during minor oral surgical procedures.

Methods: A total of 200 patients who underwent minor oral surgical procedures were randomly assigned into two groups: group (1) received 2% lignocaine with adrenaline, while group (2) received the same plus an oral intake of 10 mg glucose in 200 mL water after administration of local anesthesia. Before starting the operation and after the procedure was completed, the blood glucose level, blood pressure, and pulse rate were taken at the chairside, with the time difference for each phase noted.

Results: In group (1), blood glucose levels were found to decrease before operations and then increase to a value higher than the preoperative value, while in group (2), blood sugar levels remained constant before eventually rising to a higher postoperative value. Blood pressure increased gradually in all classes, and a rise in pulse rate was observed.

Conclusions: We found a temporary decrease in blood glucose levels preceding an increase in blood glucose levels, lasting no more than four or five minutes in minor intraoral operations under local anesthesia. Mild hypoglycemia may trigger episodes of psychogenic syncope, so this brief hypoglycemia is of great clinical importance. At the same time, pulse rate and blood pressure gradually increase with the procedures' progress, which is due to sympathetic nervous system excitation that promotes norepinephrine-induced changes in many systems.

Keywords: *Blood glucose, Blood pressure, Pulse rate, Adrenaline, Hypoglycemia.*

Submitted: March 30, 2022, Accepted: May 12, 2022, Published: June 1, 2022.

Cite this article as: Abdalkarim KM, Hamaamin KA, Mahmud BJ. Stress Interpretation by Using Blood Glucose levels, blood pressure and pulse rate measurement in Patients attending Oral and Maxillofacial Clinic in College of Dentistry at University of Sulaimani. Sulaimani Dent J. 2022;9(1):13-20.

DOI: https://doi.org/10.17656/sdj.10144

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Published by College of Dentistry, University of Sulaimani

Introduction

Minor oral surgical procedures are one of the basic and most frequent dental procedures, which is considered a stressful and painful intervention[1,2]. If a patient's discomfort can be eased, surgical treatments can be done in a more relaxed setting, and the patient's pain level may rise[3]. Lidocaine is the most widely used local anesthetic solution in dentistry. Nils Lofgren first introduced lidocaine in 1943, and it was first used as a local anesthetic material in 1948. However, the systemic complications of local anesthetic injection are one of the most serious concerns[4].

Vasovagal shock, hyperventilation syndrome, tachycardia, shivering, and loss of consciousness are the most common complications after lidocaine injection[2-4]. In addition, injection procedures trigger pain and cause the release of endogenous catecholamine, which can have a synergistic effect with the anesthetic vasoconstrictors, resulting in certain complications[5,6]. Using epinephrine and local anesthesia can also induce metabolic changes[7].

Some people have adverse reactions to local anesthetic injections, such as paleness and loss of consciousness, and one of the helpful substances in these cases is glucose[8]. Stress before and during an injection can stimulate the sympathetic nervous system, boosting blood glucose levels in patients undergoing minor oral procedures. In addition, catecholamine release, blood glucose, and insulin levels can all be increased by dental surgery with a local anesthetic injection[9].

The stress response is responsible for the hormonal and metabolic changes that occur as a result of injury or trauma, and it includes a wide range of endocrinological, immunological, and hematological events as a state of discord or disruptions in homeostasis brought about by psychological, environmental, or physiological stressors[10]. In addition, these conditions trigger immune-inflammatory and metabolic responses that are intricately intertwined since the cells involved in these main events ontogenetically derive from a special primordial organ combining both immune and metabolic roles[11].

The net effect of the endocrine response to stress due to surgery is an increase in catabolic hormone secretion as blood glucose levels rise after surgery starts. As a result of increased hepatic glycogenolysis and gluconeogenesis, cortisol and catecholamines aid glucose production. Furthermore, the intake of peripheral glucose is limited and decreased[12].

Adrenaline has systemic and hemodynamic effects like an increase in blood pressure, heart rate, and blood glucose levels due to the release of endogenous adrenaline and injected exogenous adrenaline.[13] Hyperglycemia may result from both the direct and indirect action of adrenaline. Insulin secretion is suppressed as an indirect effect. Direct activities resulted from increased hepatic glucose release and decreased glucose consumption. A physiological increase in adrenaline will promote glycogenolysis and glyconeogenesis. Although its impact on glycogeno-lysis varies rapidly, hyperglycemia continues because of gluconeogenesis[14-19].

Although hyperglycemia is a feature of acute stress, this effect in the initial phase of stress shows that subjects who have undergone more stress have a lower hyperglycemic response to adrenaline injection. A psychogenic stimulation may be the direct cause of the drop in blood sugar. The parasympathetic nervous system induces insulin release through the vagus nerve, which regulates glucose homeostasis by affecting the pancreatic islet of Langerhans cells[20-24].

Patients and methods

Over six months, from December 2019 to June 2020, a randomized, prospective, case-control study was performed in the Department of Oral and Maxillofacial Surgery, College of Dentistry, University of Sulaimani. In this study, patients who underwent minor dental procedures such as therapeutic extractions and impactions, patients with no underlying systemic problems that would make the procedure unsafe are included in the research. In addition, patients with systemic diseases such as diabetes and hypertension, steroid therapy three months before the study, pregnant and lactating mothers, and subjects with intolerance to local anesthetics or nonspecific drugs were excluded.

After obtaining written informed consent, 200 patients who needed regular minor oral surgical procedures and met this study's inclusion requirements were chosen. Patients were divided randomly into two groups. Before and after local anesthesia administration and after the procedure was completed, the patient's blood pressure, blood glucose levels, and pulse rate were monitored at the chairside, with the time difference for each phase noted. In group (2), after administering local anesthesia to all patients, 10 milligrams of glucose in 200 milliliters of water were provided, and the same parameters were reported. Before local anesthesia administration, after local anesthesia administration, and after procedure completion, both patients' blood pressure and blood glucose levels were registered on a chair, with the time gap for each phase noted. Three surgeons took those patients randomly with the same inclusion criteria and used the same protocol or method for both groups of patients. One of the fingers was prepared and pricked with a disposable lancet to extract blood after being disinfected with an alcohol swab. A drop of blood was placed on the test strip, and the glucometer's readings were registered. Blood pressure and pulse rate were monitored using an automated sphygmomanometer. All the collected data were analyzed for statistically significant correlations using the Shapiro-Wilk normality test, Mann-Whitney U test, and the Friedman test to assess the statistical difference between blood glucose and blood pressure pulse rate before and after local anesthesia application after the procedure is completed.

Results

A total of 200 patients who sought minor oral surgical procedures were randomly assigned to one of two groups: test group (1) and control group (2). group (1) had 52% female patients and 48% male patients, while group (2) had 32% male patients and 68% female patients, Table 1.

Table 1: Number of males and females per group.

Groups	Groupe (1)	Groupe (2)	Total
Male	48%	32%	80
Female	52%	68%	120
Total	100%	100%	200

In test group (1), blood glucose levels declined before the procedure and then gradually increased to a value higher than the preoperative value. At the same time, in the group (2), blood sugar levels remained stable without decline and gradually increased to a higher postoperative value; the range of blood glucose levels on the chair varied from the highest value of 178 mg/dl to the lowest of 80 mg/dl. In contrast, the blood glucose level after administration of local anesthesia ranged from a peak value of 163 mg/dl to a lowest of 78 mg/dl, the final evaluation of blood glucose level was immediately posted extraction revealed a range of values from the highest of 183 mg/dl to a lowest of 74 mg/dl, Table 2.

The blood glucose level in the control group (2) ranged from a maximum of 147 mg/dl to a minimum of 91 mg/dl, while the blood glucose level after administration of local anesthesia ranged from a maximum of 162 mg/dl to a minimum of 100 mg/dl, and about the blood glucose level in the group (2) the final measurement of blood glucose levels immediately after the procedure showed a range of values from a maximum of 162 mg/dl to a minimum of 100 mg/dl, Table 2.

Both patients' pulse rates and blood pressure gradually rose during the operations. The pulse rate was observed to increase until stage three of the procedures, after which it started to decrease to a value higher than the start time. However, according to the Shapiro-Wilk normality test, the data is not normally distributed. As a result, non-parametric tests were used in the present study.

According to the Mann-Whitney u test, there is a statistically significant difference (p=0.00) between the blood glucose levels before and after local anesthesia application between groups (1) and (2), but no statistically significant difference (p=0.084) between groups (1) and (2) for the blood glucose levels after the treatment. According to the Friedman Test, there is a substantial statistical difference between blood glucose levels before and after local anesthesia application and after the procedure is completed, with the maximum level of blood glucose level occurring before local anesthesia application, followed by after local anesthesia application, and finally, after the procedure is completed, Figure 1.

Pulse rate

According to the Friedman Test, there is a statistically significant difference (p=0.00) in pulse rate (PR) before, during, and after the operation, with the highest level of pulse rate after local anesthesia (LA) application, followed by before local anesthesia application, and finally after procedure completion, Table 3, Figure 2.

Blood pressure

According to the Friedman Test, there is a statistically significant difference (p=0.034) in systolic blood pressure before, during, and after the operation, with the highest level of systolic blood pressure before local anesthesia application, followed by after local anesthesia application, and finally after procedure completion, Table 4.

According to the Friedman Test, there is a highly statistically significant difference (p=0.00) in diastolic blood pressure before, during, and during the operation, with the highest diastolic blood pressure level after local anesthesia treatment.

Table 2: Descriptive statistical analysis for the blood glucose level of both groups.

Group		Blood Glucose Before anesthesia	Blood Glucose After anesthesia	Blood Glucose Final evaluation
Without	No.	100	100	100
	Minimum	80	78	74
	Maximum	178	163	183
	Range	98	85	109
	Median	111.00	110.00	109.50
With sugar	No.	100	100	100
	Minimum	91	100	82
	Maximum	147	162	208
	Range	56	62	126
	Median	125.00	123.00	115.00
Total	No.	200	200	200
	Minimum	80	78	74
	Maximum	178	163	208
	Range	98	85	134
	Median	121.00	116.00	111.00

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	Minimum	91	100	82
	Maximum	147	162	208
	Range	56	62	126
	Median	125.00	123.00	115.00
Total	No.	200	200	200
	Minimum	80	78	74
	Maximum	178	163	208
	Range	98	85	134
	Median	121.00	116.00	111.00

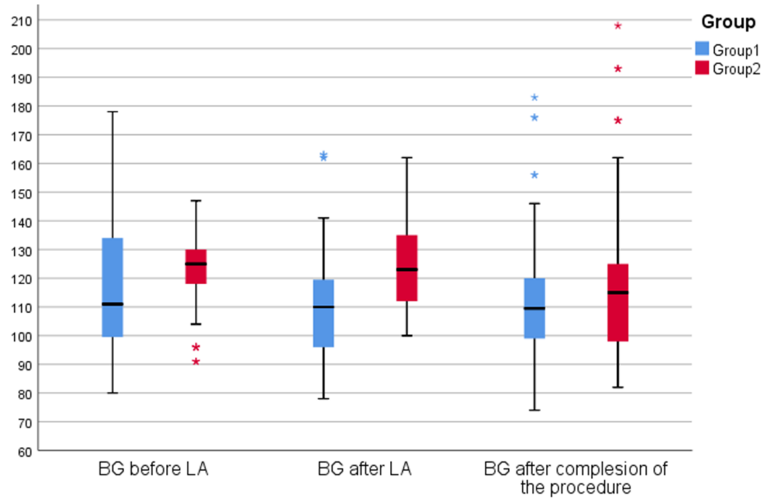

Figure 1: Blood glucose levels before, after local anesthesia, and at the completion of procedure (BG=Blood glucose, LA=local anasthesia).

Table 3: Descriptive statistical analysis for pulse rate.

	Pulse rate Before anesthesia	Pulse rate After anesthesia	Pulse rate Final evaluation
No.	200	200	200
Minimum	53	55	61
Maximum	120	119	151
Range	67	64	90
Median	84.50	89.00	81.00

Table 4: Descriptive analysis for both systolic and diastolic blood pressure levels.

	Systolic Blood Pressure before LA.	Diastolic Blood Pressure before LA.	Systolic Blood Pressure after LA.	Diastolic Blood Pressure after LA.	Final systolic Blood Pressure	Final diastolic Blood Pressure
No.	200	200	200	200	200	200
Minimum	90	11	86	12	86	44
Maximum	178	114	184	791	185	109
Range	88	103	98	779	99	65
Median	124	76	123	74	120	75

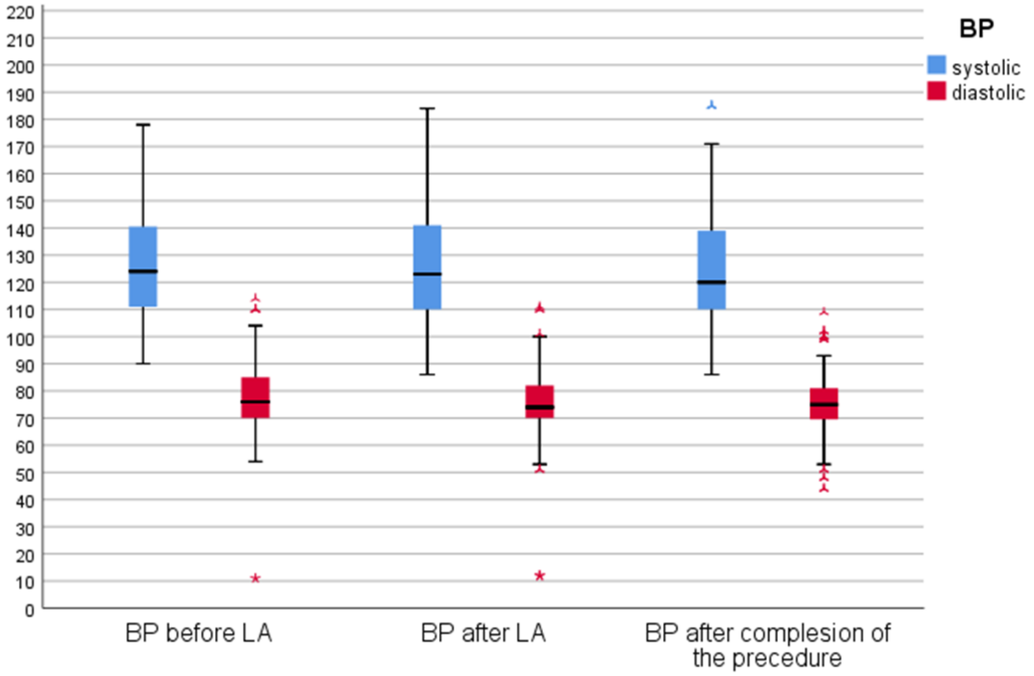

Figure 2: The difference in Blood Pressure during local anesthesia and at the completion of the procedure.

Discussion

This clinical trial analyzed glucose levels in 200 patients before, after local anesthesia, and after tooth extraction. There was no evidence of hypoglycemia, which may be attributed to the release of catecholamine and cortisol in reaction to anxiety, fear, and pain throughout the injection[1,2,3].

The stress response to surgery is characterized by increased pituitary hormone production and sympathetic nervous system activation, which have secondary effects on the adrenal glands, resulting in a hormone cascade[4-9].

During the stress response, hypothalamic sympathetic nervous system activation results in increased catecholamine secretion from the adrenal medulla and release of norepinephrine and cardiovascular effects such as tachycardia and hypertension[10-16].

Surgery is one of the most effective activators of cortisol secretion, resulting in protein catabolism, gluconeogenesis, and inhibition of glucose uptake by peripheral cells, both of which contribute to higher blood glucose levels[17-20].

The most effective method of inhibiting stress responses is neuronal blockade with local anesthetics, emphasizing active anesthetic and analgesic regimens[21-24]; catabolism of stored body fuels is the ultimate metabolic reaction. The severity and length of the response are usually proportional to the surgical injury and the incidence of complications such as sepsis[25-27].

Our research focused on quantifying and assessing stress in patients undergoing minor oral surgical procedures using blood glucose as a primary parameter and blood pressure and pulse rate as adjuvant parameters. Then, in the group (1), it gradually increased to a value higher than the preoperative value, while in the group (2), blood sugar levels remained stable without declining and gradually increased.

A prospective study by Paul C Salins et al.[13] measured the glucose level in capillary blood of 16 patients who experienced vasovagal syncope during exodontia with local anesthesia. Syncope can be caused by hypotension (especially in patients with poor nutrition or those who are fasting). Loser et al.[18] conducted a retrospective analysis in which glucose metabolism is significantly altered in acute conditions. Stress-induced hyperglycemia is an adaptive response to stress with altered glucose metabolism resulting in the redistribution of glucose intake into other metabolic pathways such as lactate development.

Murugan et al.[24] found that the blood glucose levels declined before extraction and then increased to a value higher than the preoperative value in the test group (1). At the same time, in the control group (2), the blood sugar values maintained a steady state without decline until they progressively increased to a higher postoperative value. In their research, the blood pressure was found to elevate gradually. An increase in pulse rate was observed in all stages until the administration of local anesthesia, after which there was a marked decline.

Jason Radley et al.[25] found that physiological stress responses are initiated rapidly. Sympathetic nervous system excitation promotes norepinephrine-induced changes in numerous bodily systems, including increases in heart rate and blood pressure and epinephrine release[29-32], promoting hepatic glycogenolysis which will introduce glucocorticoid hormones into the circulation to provide further redistribution of energy resources (like hepatic gluconeogenesis), while also serving to limit the duration and impact of the initial stress response [24,33-36]. these findings are agreed with the results of our study.

Conclusions

A transient drop in blood glucose levels occurs, lasting no more than four or five minutes, before a dramatic increase in blood glucose levels. Mild hypoglycemia can also cause psychogenic syncope; therefore, this transient hypoglycemia is significant in therapeutic practice, which is true to some extent, but it is especially relevant in malnourished or fasting patients. And both blood pressure and pulse rate were found to increase gradually with the progression of the procedure because the stress leads to increase epinephrine release by adrenal glands due to sympathetic system stimulation.

Acknowledgment

The authors would like to acknowledge the University of Sulaimani/Oral and maxillofacial department and those who participated in the progress of this study.

References

1. Yusa, H., Onizawa, K., Hori, M., Takeda, S., Takeda, H., Fukushima, S., et al. Anxiety measurements in university students undergoing third molar extraction. Oral Surg Oral Med Oral Pathol Oral Radiol Endod. 2004;98(1):23-7.

2. López-Jornet P, Camacho-Alonso F, Sanchez-Siles M. Assessment of general pre and postoperative anxiety in patients undergoing tooth extraction: A prospective study. Br J Oral Maxillofac Surg. 2014;52(1):18-23.
3. Abdeshahi SK, Hashemipour MA, Mesgarzadeh V, Payam AS, Monfared AH. Effect of hypnosis on induction of local anaesthesia, pain perception, control of haemorrhage and anxiety during extraction of third molars: a case-control study. J Craniomaxillofac Surg. 2013;41(4):310-5.
4. Gordh T, Gordh TE, Lindqvist K. Lidocaine: the origin of a modern local anesthetic. Anesthesiology. 2010;113(6):1433-7.
5. Kämmerer PW, Palarie V, Daubländer M, Bicer C, Shabazfar N, Brüllmann D, et al. Comparison of 4% Articaine with epinephrine (1: 100,000) and without epinephrine in inferior alveolar block for tooth extraction: double-blind randomized clinical trial of anesthetic efficacy. Oral Surg Oral Med Oral Pathol Oral Radiol. 2012;113(4):495-9.
6. Bronzo AL1, Cardoso CG Jr, Ortega KC, Mion D JR. Felypressin increases blood pressure during dental procedures in hypertensive patients. Arq Bras Cardiol. 2012;99(2):724-31.
7. Kalra P, Rana AS, Peravali RK, Gupta D, Jain G. Comparative evaluation of local anaesthesia with adrenaline and without adrenaline on blood glucose concentration in patients undergoing tooth extractions. J Maxillofac Oral Surg. 2011;10(3):230-5.
8. Cholewa M, Sobaniec S, Sobaniec P, Sendrowski K, Żochowska M. Sudden episodes of loss of consciousness in dental practice. Neurologia Dziecięca. 2012;21(43):71-8.
9. Hansen O, Johansson BW, Nilsson-Ehle P. Metabolic, electrocardiographic, and hemodynamic responses to increased circulating adrenaline: effects of selective and nonselective beta adrenoceptor blockade. Angiology. 1990;41(3):175-88.
10. Bortoluzzi MC, Manfro R, Nardi A. Glucose levels and hemodynamic changes in patients submitted to routine dental treatment with and without local anesthesia. Clinics. 2010;65(10):975-8.
11. Siddiq M, Rao S, Rai G, Hiregoudar JS, Pitale U. Study on blood glucose concentration in patients with diabetes undergoing dental extraction under local anesthesia with and without adrenaline. Journal of basic and clinical physiology and pharmacology. 2012;23(4):169-71.
12. Desborough JP. The stress response to trauma and surgery. British Journal of Anesthesia. 2000;85(1):109-17.
13. Salins PC, Kuriakose M, Sharma SM, Tauro DP. Hypoglycemia as a possible factor in the induction of vasovagal syncope. Oral Surg Oral Pathol. 1992;74(5):544-549.
14. Gounaris A, Zagouri F, Sergentanis TN, et al. Vacuum-assisted breast biopsy: insight into stress-induced endocrine events. In vivo. 2007;21(6):1081-4.
15. Zografu GC, Zagouri F, Sergentanis TN, et al. Excisional breast biopsy under local anesthesia: stress-related neuroendocrine. metabolic and immune reactions during the procedure. In vivo. 2009;23(4):649-52.
16. Black PH- Central nervous system-immune system interactions Psychoneuroendocrinology of stress and its immune consequences Antimicrob agents and Chemother. 1994;38(1):1-6.
17. Jern S- Effects of acute carbohydrate administration on central and peripheral hemodynamic responses to mental stress. Hypertention. 1991;18(16):790-7.
18. Loser MR, Damoisel C, Payen D. Bench-to-bedside review: glucose and stress conditions in the intensive care unit. Crit Care. 2010;1(2):231
19. Knoop K, Stack LB, Storrow AB, Thurman RJ. The atlas of emergency medicine. 4th ed, USA: Mcgraw Hill Professional; 2009.1-1008.
20. Seelig E, Bilz S, Keller U, Meienberg F, Christ-Crain M. Concentrations of the stress hormone copeptin increase upon hypoglycaemia in patients with type I diabetes dependent of hypoglycaemia awareness. PLOS ONE. 2013;8(8):e72876.
21. Kambalimath HV, Dixit UB, Thyagi PS. Salivary cortisol response to psychological stress in children with early childhood caries. Indian J Dent Res. 2010;21(2):231-7.
22. Kalman BA, Grahn RE. Measuring salivary cortisol in the behavioral neuroscience laboratory. J Undergrad Neurosci Educ. 2004;2(2):41-9.
23. Hempenstall PD, Campbell JP, Bajumow AT. Cardiovascular. biochemical, and hormonal responses to intravenous sedation with local analgesia versus general anesthesia in patients undergoing oral sugary. J Oral ,Maxillofac Surg. 1986;44(6):441-6.
24. Aparna Murugan, Farah kulsum, Neelakandan RS, Titus K Thomas. Using blood glucose estimation to interpret stress in patients undergoing minor oral surgery procedures. J Dent Health Oral Disord Ther. 2017;8(2):461-4.

25. Radley JJ, Williams B, Sawchenko PE. Noradrenergic innervation of the dorsal medial prefrontal cortex modulates hypothalamo-pituitary-adrenal responses to acute emotional stress. J Neurosci 2008;28 (22):5806-6.
26. Bellucci CC, Kapp-Simon. Psychological considerations in orthognathic surgery. Clin Plast Surg. 2007;34(3):1l-6.
27. McEwen BS, Stellar E. Stress and the individual. Mechanisms leading to disease. Arch Intern Med. 1993;153(18): 2093-101.
28. Munck A, Guyre PM. holbrook NJ- Physiological functions of glucocorticoids in stress and their relation to pharmacological actions. Endocr Rev. 1984;5(1):25-44.
29. McE"en BS. Plasticity of the hippocampus: adaptation to chronic stress and allostatic load. Ann N Y Acad Sci. 2001:933; 265-77.
30. Depke M, Fusch G, Domanska G, Geffers R, Völker U, Schuett C, et al. Hypermetabolic syndrome as a consequence of repeated psychological stress in mice. Endocrinology. 2008;149(6):2714-23.
31. Eaton WW, Armenian H, Gallo J, Pratt L, Ford DE. Depression and risk for onset of type II diabetes. A prospective population-based study. Diabetes Care. 1996;19(10):1097-102.
32. Finger BC, Dinan TG, Ciyan JF. The temporal impact of chronic intermittent psychosocial stress on high-fat diet-induced alterations in body weight. Pchychoneuroendocrinology. 2012;37(6):729-41.
33. Germain A, Nofzinger EA, Meltzer CC, Wood A, Kupfer DJ, Moore RY, et al. Diurnal variation in regional brain glucose metabolism in depression. Biol Psychiatry. 2007;62(5):438-45.
34. Vázquez LR, López ER, Centelles AV, Otero AB, Otero FV, Centelles PV. Stress amongst primary dental care patients. Med Oral Patol Oral Bucal. 2008;13(4):253-6.
35. Waldstein SR, Siegel EL, Lefkowitz D, Maier KJ, Pelletier Brown JR. Stress-induced blood pressure reactivity and silent cerebrovascular disease. Salute. 2004;35(6):1294-8.
36. Jabbar JK, Hani Radhi. Ahmad F Hassan. Influence of dental extraction on patient's stress and anxiety level by assessing the salivary cortisol concentration at different time points during the extraction procedure. Assessment. 2012;9(2):208-17.