ORIGINAL RESEARCH

Evaluation of Hemodynamic Changes in Third Molar Surgery: An Observational Study

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Abstract

Aim: To evaluate the hemodynamic changes during third molar surgery and also to assess whether these changes are associated with anxiety of patients towards the surgery.

Materials and methods: A prospective study was done on 40 healthy patients (14 male and 26 female) with a mean age of 28.48 years (Age range 19–48 years) who underwent surgical extraction of the third molar. Patient anxiety and fear were assessed by Corah's dental anxiety scale (DAS) and Kleinknecht's dental fear scale (DFS) while the level of pain was evaluated by a visual analog scale. During a surgical procedure, hemodynamic parameters like systolic blood pressure (SBP), diastolic blood pressure (DBP), heart rate (HR), and oxygen saturation (SpO_2) were evaluated on different surgical events.

Results: Hemodynamic parameters showed significant changes with different phases of a surgical procedure. The peak value of blood pressure was evident during the ostectomy/tooth sectioning phase while the highest value of heart rate was recorded four minutes after the administration of local anesthesia.

Conclusion: Dental anxiety was found to have a significant influence on the hemodynamic parameters of patients who had undergone third molar surgery, however these were within normal limits.

Clinical significance: Monitoring the vital signs during surgical procedures enables the surgeon to instantaneously recognize a state of higher risk, evaluate, and prevent emergency situations during surgical procedures. Preoperative information on the recovery process/counseling will result in a significant anxiety reduction in patients.

Keywords: Dental anxiety, Hemodynamic changes, Pain, Surgical procedure.

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Introduction

The presumption of pain and discomfort during dental treatment makes several patients feel anxious especially during oral surgical procedures, which has been accounted to induce the utmost level of anxiety.[1] Dental anxiety may have an influence on the perceived pain threshold leading to more pain experience than predicted. This intensifies the anxiety and set a feedback cycle of anxiety and pain.[2]

Extraction of a third molar tooth is the most common surgical procedure performed in oral and maxillofacial surgery. The procedure involves trauma to soft tissue as well as hard tissue structures which can lead to substantial pain, swelling, and trismus. Anticipation of these postoperative sequelae, intraoperative pain, and discomfort may cause distress to the patient.[3,4]

It is sensible to monitor hemodynamic changes of the patient during surgical procedure especially when it is likely to be invasive or when the psychological state of the patient leads to such control desirable for a secure surgical procedure. Basic monitoring gives crucial information for evaluating vital signs and basically involves blood pressure, heart rate, and oxygen saturation. Monitoring the vital signs during surgical procedure allows the operator to instantly recognize the state of higher risk, ascertain a timely diagnosis, avert likely complications, and perform a surgical procedure in a safe manner.[5–7]

Anxiety and stress due to pain experienced throughout the surgical procedure leads to secretion of endogenous catecholamines, which may adversely affect the cardiovascular system.[5–9] Patient's anxiety or fear related to surgery can lead to considerable deviation in these parameters.[5] Therefore, this study was conducted to assess the hemodynamic changes in third molar surgery.

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Materials and Methods

A prospective observational study was performed on 40 healthy and normotensive patients reported to Out Patient Department (OPD) of Oral and Maxillofacial Surgery, Maharishi Markandeshwar College of Dental Sciences and Research, Mullana, who were indicated for surgical extraction of the third molar. Ethical approval was taken from Institutional Research Committee and Ethics Committee M.M. Deemed to be University, Mullana, Haryana.

Patients who necessitate an ostectomy procedure in terms of surgical intervention were selected for this study. The inclusion criteria for the study were based on the necessity of an ostectomy procedure in terms of surgical intervention. Patients having any systemic disease or receiving any medication were excluded from the study. The duration of surgery was calculated from the administration of local anesthesia (LA) till the completion of suturing. Lignocaine (2%) with vasoconstrictor (adrenaline 1:200,000) was used as local anesthesia in all patients. The quantity of local anesthetic solution used was a maximum 5 mL. The patient's case history was taken followed by oral and panoramic radiographic examination. The difficulty of molar extraction was evaluated with Pell and Gregory and Winter's classifications.[10]

Informed consent was taken from all the patients. A preoperative patient's anxiety and fear level was assessed by using Corah's dental anxiety scale (DAS) and Kleinknecht dental fear scale (DFS) respectively while the Visual analog scale (VAS) was used to measure the pain.[11,12] Evaluation of hemodynamic changes was done by monitoring systolic blood pressure (SBP), diastolic blood pressure (DBP), HR, and SpO_2 by a pulse oximeter device (Multi-parameter monitor BPL model no.: MPM 5553). These hemodynamic changes were recorded during nine events, i.e., preoperative, one minute and four minutes following LA injection, during incision, during ostectomy, on tooth removal, beginning and finish of suturing, and finally after end of the surgery. The data collected was subjected to statistical analysis.

All surgical procedures were done by the experienced maxillofacial surgeon of the same unit. The entire surgical procedure was performed under all aseptic conditions. Local anesthesia was administered, then an incision was made in the retromolar trigone region. A standard ward's incision was used. Mucoperiosteal flap elevation were performed. Ostectomy procedure were performed, and tooth sectioning was done whenever required. Extraction of the third molar was performed with gentle elevation. The surgical site was irrigated with saline and betadine and final closure was achieved by 3/0 silk which was then removed after a week.

Statistical Analysis

The data recorded were tabulated in a Microsoft Office Excel worksheet (version 2007) and statistical analysis was done with Statistical Package for Social Sciences (SPSS) version 19.0. The p-value < 0.05 were represented as statistically significant. The hemodynamic changes were compared between genders and also at various events during a surgical procedure by using two-way analysis of variance (ANOVA).

Result

The present study included 40 normotensive healthy patients (14 males and 26 females), mean age of 28.48 years (Age range 19–48 years, Standard deviation (SD) 7.531). The mean duration of surgery was 35 minutes (range 25–45 minutes).

Parameters Evaluation

Mean SBP, DBP, HR, and oxygen saturation values were recorded on nine events during the third molar surgery for the global sample. Significant changes were observed in SBP and the peak value was evident at the ostectomy procedure and/or tooth section phase, then a gradual decline was observed in the readings till the completion of the surgical procedure. Similarly, the highest value for DBP was observed during ostectomy procedure. The lower value of HR was observed in the preoperative phase, whereas the maximum rate was recorded four minutes after the administration of local anesthesia. However, SpO_2 showed no significant changes. The values of hemodynamic changes are presented as mean along with standard deviation (SD) (Table 1).

Systolic Blood Pressure

The global mean SBP is 125.956 mm Hg, with an SD of 4.715 mm Hg. In terms of gender, the mean SBP is 124.43 mm Hg with an SD of 2.87 mm Hg for males versus 126.77 mm Hg with an SD of 5.32 mm Hg for females. It was not found statistically significant (p-value 0.137) (Table 2).

The SBP differs with surgical time ($f = 15.505$; df = 8; $p = 0.000$*) and in gender ($f = 19.318$, df = 1, $p = 0.000$*) showed a significantly high value at the time of ostectomy procedure (f = test statistics from f test, df = degree of freedom).

Diastolic Blood Pressure

The global mean DBP was 81.83 mm Hg (SD = 2.70 mm Hg). For gender, mean DBP was 80.47 mm Hg in males (SD = 2.60 mm Hg) versus 82.47 mm Hg in females (SD = 2.51 mm Hg) was observed; the difference was found statistically significant (p-value < 0.05) (Table 2).

The DBP differ with surgical time ($f = 24.788$; df = 8; $p = 0.000$*) and in gender ($f = 45.311$, df = 1, $p = 0.000$*) showed a significant value and observed higher during ostectomy/tooth sectioning phase.

Heart Rate

The global mean HR was 84.30 beats/minute (SD = 3.098). On gender comparison, mean HR was 83.19 beats/minutes in males (SD = 2.82) versus 84.89 beats/minutes in females (SD = 3.12). Though statistically not significant but females showed higher heart rate as compared to males (p-value = 0.097) (Table 2).

Heart rate changed with surgical time ($f = 59.244$, df = 8, $p = 0.000$*) and in gender ($f = 17.215$, df = 1, $p = 0.000$*) showed significant value and observed higher value at 4 minutes after local anesthesia.

Oxygen Saturation

The global mean SpO_2 is 98.49 with an SD = 0.382 (Table 2). The mean SpO_2 value in male is 98.51 with SD = 0.37 and in females is 98.48 with SD = 0.39. This difference was not found statistically significant ($p = 0.824$) (Table 2).

SpO_2 variation with surgical time ($f = 4.568$; df = 8; $p = 0.000$*) and in gender ($f = 0.286$; df = 1; $p = 0.593$) is not statistically significant.

Anxiety and Fear

The mean anxiety level in males was 10.5 ± 0.76 and in females was 10.69 ± 1.22. Females showed higher anxiety levels than males, although it was not observed as statistically significant. Patients with anxiety showed a significantly high mean value of HR

Table 1: Mean BP, HR, and SpO_2 values at different time points during the surgical procedure

	A1	*A1*	*A2*	*A3*	*A4*	*A5*	*A6*	*A7*	*A8*	*A9*
SBP	121.63 ± 5.14	121.63 ± 5.14	122.28 ± 5.17	124.48 ± 5.41	127.15 ± 5.32	130.43 ± 4.72	129.95 ± 4.39	127.65 ± 4.24	125.75 ± 4.69	124.30 ± 4.77
DBP	79.08 ± 3.01	79.08 ± 3.01	79.58 ± 3.03	81.33 ± 3.12	83.00 ± 2.96	85.58 ± 2.87	84.73 ± 2.91	82.45 ± 2.82	80.90 ± 3.01	79.85 ± 2.72
HR	77.25 ± 3.04	77.25 ± 3.04	81.90 ± 3.48	91.18 ± 4.80	89.28 ± 4.38	88.78 ± 4.59	86.33 ± 4.09	83.35 ± 3.11	80.95 ± 2.89	79.70 ± 2.92
SPO_2	98.250 ± 0.43	98.250 ± 0.43	98.350 ± 0.48	98.575 ± 0.50	98.775 ± 0.42	98.725 ± 0.45	98.475 ± 0.50	98.450 ± 0.50	98.450 ± 0.50	98.425 ± 0.50

Measurement time points: A1, baseline; A2, 1 minute after anesthesia; A3, 4 minutes after anesthesia; A4, incision; A5, ostectomy and/or tooth sectioning; A6, completion of extraction; A7, start of suturing; A8, end of the surgical procedure; A9, removal of the surgical drapes

Table 2: Comparison of SBP, DBP, Heart rate and Oxygen saturation between genders

	Male		*Female*			
Variables	*Mean*	*SD*	*Mean*	*SD*	*p-value*	*Significance*
Global SBP	124.43	2.87	126.77	5.32	0.137	NS
Global DBP	80.47	2.60	82.47	2.51	0.018	S*
Global HR	83.19	2.82	84.89	3.12	0.097	NS
Global SpO_2	98.51	0.37	98.48	0.39	0.824	NS

*p-value was <0.05

Table 3: Mean systolic blood pressure, diastolic blood pressure, heart rate, and oxygen saturation values by Dental Anxiety scale score

DAS	*SBP*	*DBP*	*HR*	*SPO_2*
Low ≤ 12	125.71 ± 4.51	81.71 ± 2.87	83.80 ± 2.92	98.47 ± 0.39
High ≥ 12	126.93 ± 5.69	82.29 ± 2.00	86.29 ± 3.16	98.58 ± 0.34
p-value	0.520, NS	0.597, NS	0.040*, S	0.483, NS

*Significant using *t*-test

Table 4: Mean systolic blood pressure, diastolic blood pressure, heart rate, and oxygen saturation values by dental fear scale score

DFS	*SBP*	*DBP*	*HR*	*SPO_2*
Low ≤ 35	125.901 ± 4.580	81.740 ± 2.724	84.088 ± 2.996	98.494 ± 0.378
High ≥ 35	127.000 ± 9.428	83.556 ± 2.357	88.333 ± 2.828	98.556 ± 0.629
p-value	0.752, NS	0.362, NS	0.058, NS	0.828, NS

(Table 3) whereas no significant changes were seen with a degree of fear on other parameters (Table 4).

Pain experienced throughout the surgery was found usually on the lower side and it was in the range of approximately two points on the visual analog scale of ten points.

Discussion

Anxiety is a complex experience that is influenced by various parameters like age, gender, education, personality, etc. Even a previous negative experience can also make someone anxious throughout the surgical procedure and/or in the postoperative phase.[1]

Dental treatment that involves the use of anesthetic injection, drills, or surgical procedures are the most common reasons for dental anxiety.[13] In consistent with this, extraction of a third molar usually provokes anxiety and this is the more frequently performed surgical procedure. P Earl[14] in his study on patients' anxiety with third molar surgery found that pain is the single most feared factor. Highly anxious patients may perceive surgical treatment as a very stressful experience due to anticipation of postoperative sequelae like pain, bleeding, restricted mouth opening, and swelling or it may be associated with the actual nature of the surgical procedure.[1] However, the use of local anesthesia enables surgical procedure reasonably painless, and the intervention often results in different clinical implications.[2] The anxiety and stress due to pain perception in the intraoperative phase also stimulate the secretion

of endogenous catecholamines, which leads to adverse effects on the cardiovascular system.[5]

Oral surgical procedures are performed under local anesthesia, possibly resulting in elevation of blood pressure even in normotensive patients. This is intensified by stress, painful stimuli, and adrenalin present in local anesthetics.[9,15] Somatic changes induced by anxiety may occur due to the initiation of the hypothalamus-pituitary-adrenal axis, leading to an augmented release of cortisol. Secretion of catecholamine was documented 10-fold due to stress. This endogenous and/or exogenous epinephrine may lead to hemodynamic as well as cardiac changes.[16] Salonen et al.[17] favored the result of the present study and noted increased heart rate after the administration of LA with adrenaline and concluded that the adrenaline is one of the contents of local anesthesia is a main cause of adrenergic activation during minor oral surgery.

Local anesthesia with vasoconstrictor appears to be a source of exogenous catecholamine along with unmarked endogenous catecholamine (release due to increased anxiety) may additionally intensify the condition, and thereby facilitates the crucial need of monitoring the cardiac status of the patient.[18] Sharma A et al.[18] reported that significant cardiovascular changes take place owing to dental anxiety while giving local anesthesia for dental extraction in the Indian population. The anticipation of surgical procedures leads to a stress response which results in a release of corticosteroids, and changes in hemodynamic and cardiovascular response.[16]

Dental anxiety scale is intended to assess the patient's overall dental anxiety status while the DFS helps to evaluate the patient's autonomic responses, avoidance, and fear of specific stimuli during dental treatment procedures.[11,12] In the present study, females tended to be more anxious than males which was found consistent with the study done by Gadve et al.[15] Similarly, patients with high dental anxiety had raised HR and DBP during surgical procedures. Heart rate increases after administration of the local anesthetic injection. This result is in agreement with the study done by Liau et al.[16] The elevation in heart rate and variation in blood pressure during the injection occurred to some extent because of the release of endogenous epinephrine which in turn resulted due to stress and not due to the effect of local anesthetic.[16]

The study performed by Alemany-Martínez et al.[5] reported that significant changes occurred in both systolic and DBP, and observed higher values during ostectomy procedure/tooth section phase.[5] Correspondingly Gadve et al.[15] also found significant changes in blood pressure during ostectomy/tooth sectioning. They also noticed a maximum heart rate of 4 minutes after local anesthetic injection. This study also found the similar results in which both systolic and diastolic blood pressure was raised during ostectomy procedure/extraction phase. A significant increase in heart rate was noted 4 minutes after local anesthesia and then gradually declines. These findings are also concomitant with the study done by Meyer[6] who observed an increase in heart rate and changes in blood pressure before LA injection and during extraction are likely an expression of an endogenous catecholamine release due to stress and are no pharmacological effects. These hemodynamic changes due to stress mask the variations caused by exogenously active catecholamines. Fear, anxiety, expectation, or experiences of pain are particular stress factors in this state.[6]

Paramaesvaran and Kingon[19] observed in their study that the alterations in the cardiovascular parameters may signify a risk to patients with cardiac disorders especially with previously undiagnosed. They also emphasized the importance of eliminating pain and minimizing patient anxiety. To decrease cardiovascular events associated with anxiety, behavioral control/anxiety reduction protocol seems to play a vital role. In addition to these, anxiolytics and conscious sedation can also aid in maintaining hemodynamic stability.[5]

Conclusion

The present study concluded that dental anxiety influenced the hemodynamic parameters of patients that had undergone third molar surgery however these were within normal limits. Preoperative counseling, anxiety reduction protocol, and assurance for safe clinical practice are crucial in terms of minimizing anxiety and fear towards dental treatment especially third molar surgical procedures.

Clinical Significance

Monitoring the vital signs during surgical procedures enables the surgeon to instantaneously recognize a state of higher risk, evaluate, and prevent emergency situations during surgical procedures. Both pre and postoperative stress management are crucial for the successful delivery of surgical treatment under local anesthesia. Preoperative information on the recovery process/counseling will result in a significant anxiety reduction in patients.

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