EFFECT OF ROUTINE DENTAL PROCEDURES ON THE PULSE RATE AND PERIPHERAL OXYGEN SATURATION IN PEDIATRIC PATIENTS

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ABSTRACT

Dental treatment can cause anxiety in a child further leading to physiological changes that affects the success of dental care. This cross-sectional study was carried out to assess the changes in the pulse rate and peripheral oxygen saturation in children undergoing routine dental treatment. Total 80 patients of 6 to 12 years old were included in the study who were divided into four groups according the dental treatment they receive. Data was analyzed using SPSS-16. It was observed that the patients undergoing extraction (group IV) had higher mean pulse rate before, during and after the procedures; 100.25±9.33, 101.85±13.52, 98.85±7.63 respectively. Lowest SpO_2 was recorded in the patients undergoing pulp therapy before the procedure (96.90±3.66). Pulse rate was higher in females compared to males but it was not statistically significant. The children in extraction group selecting facial image scale 4 had more mean pulse rate before during and after the procedure. The mean pulse rate was high in patients undergoing extraction in both first visit (103.00±9.21) and subsequent visits (101.36±15.28). It was concluded that physiological changes occur during routine dental treatment therefore monitoring should be done in order to prevent any dental emergencies.

KEYWORDS

Dental anxiety, oxygen saturation, pulse rate

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INTRODUCTION

The dental clinic may be linked with fear provoking procedures that involves use of painful needles, local anesthesia, drills and vibratory sounds. The assumptions of these painful conditions cause fear and anxiety in anticipation of threatening stimuli.[1,2] Anxiety in the dental setting is multifactorial in origin, that may be attributed to individual personality characteristics, self-consciousness, fear of the unknown, poor understanding, coping mechanisms.[3] There is a strong relationship between dental anxiety and successful dental treatment.

Dental anxiety is therefore defined as the distressed expectation of a visit to a dentist to the extent where a child might avoid treatment, while dental fear/phobia is defined as when the distressed expectation interferes with normal functioning.[4]

Anxiety can be assessed through self-assessment anxiety scales like Dental Fear Survey (DFS), Corah's Dental Anxiety Scale (CDAS), Modified Dental Anxiety Scale (MDAS), General Geer Fear Scale etc.[5] It is still considered a difficult measurement as it is a subjective issue that may vary among individuals.[6]

It can also be assessed through the physiological response of the body that occurs due to stress with a evidence of positive correlation with moderate-to-severe dental anxiety.[7] Stress/anxiety has the ability to alter physiologic functions like increased cortisol, rapid breathing tachycardia and trembling, changes in the blood pressure, pulse rate and respiratory rate which in time may alter oxygen saturation and or carbon dioxide levels in the blood resulting in hypoxia.[8-11] Anxiety experienced during a dental visit may cause parasympathetic dominance, along with local anesthetics and use of vasoconstrictors, it may increase its undesirable effects on the cardiovascular system.[1,12]

Pulse is part of the work system of the heart, thus in a state of heart pounding in the theory put forward by psychologists is one manifestation of physical symptoms in physiological level of anxiety.[13] The average pulse rate of a child is 80-100 times per minute with a faster rate if someone is anxious or afraid.[14,15]

Blood oxygen saturation as measured by the pulse oximeter has been regarded as the fifth vital sign essential for efficient patient monitoring during medical and dental procedures.[11] Pulse oximetry (PO) is a non-invasive method of measuring peripheral oxygen saturation (SpO_2) based on the differential absorption of red versus infrared light by oxygenated hemoglobin in a narrow tissue segment like hand or foot.[11,16] It is recorded as SpO_2, with a normal range of 95-100%.[17] Hypoxemia is usually defined as SpO_2 less than 90%[18] that usually do not occur with normal physiological conditions.[17]

Emara *et al*[10] have reported that there was a statistically significant decrease in O2 saturation after dental procedures compared to pre-procedure saturation in the healthy individuals. A close affiliation exists between the peripheral oxygen saturation (SpO_2) and pulse rate.[11] In a normal child the pulse rate is frequently found to increase in the dental environment because of anxiety, fear, and/or excitement[15] and type of dental procedure done.[7] Therefore, close monitoring of patients during the dental treatment is advised.[15,18] This study was conducted to assess the pulse rate and oxygen saturation in the patients undergoing routine dental procedure.

MATERIALS AND METHODS

A cross sectional observational study was carried out among the patients visiting the Department of Pedodontics, Nepal Medical College for routine dental treatment from November 2022 till January 2023. The common routine dental treatment includes dental checkup and follow up of the treatment, fluoride application, restoration, pulp therapy, extractions etc.

The age of children ranged from 6 to 12 years. Healthy child who were undergoing dental procedures in the dental clinic giving consent to put the pulse oximeter were included in the study. Children with systemic disorders and not giving the consent were excluded from the study. Sample size was calculated using the formula:

Sample size (n) = $2(Z\alpha+Z\beta)^2S^2/d^2$ = 16.2 per group where, $Z\alpha$ = Z value for α level = 1.96 at 95% confidence interval, $Z\beta$ = Z value for β level = 0.84 for 80% power, S = average standard deviation = (S1 + S2)/ 2 = 2.545, d = difference between the two means = 2.5 {S1 (Standard deviation in extraction group) = 2.97 and S2 (Standard deviation in filling group) = 2.12, mean1 (mean in extraction group) = 88.3 and mean2 (mean in filling group) = 85.8, which are the pulse rate values post treatment taken from a study.[11] Further adding a non-response rate of 20%, the final sample size calculated was 80 (20 patients x 4 groups).

Total 80 patients were included in the study who were further divided in to four groups of 20 patients in each group.

Group I – oral and follow up examination

Group II- restoration

Group III- pulp therapy

Group IV- extraction

Once the patient entered the operatory area, Facial Image Scale (FIS), was explained to the child, and the dentist asked the child to choose one of the five faces that best represented his/her current emotional state as shown in Fig.1.

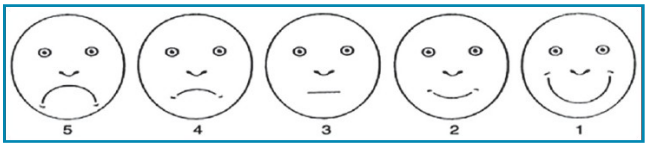

Fig.1: Facial image scale:

The pulse rate and peripheral O_2 saturation were measured using a wireless pulse oximeter (MHI-Safety First). The pulse oximeter was placed on the right index finger (by a single trained examiner) of the patient after the child was seated comfortably on the dental chair. PR and SpO_2 was recorded three times before, during and after the treatment with five-minutes rest interval between each reading so as to minimize a carry-over effect.

Data analysis: Data was entered, coded and edited using Microsoft Excel and transferred to Statistical Package for the Social Sciences (SPSS) version 16 for further analysis. One-way ANOVA was used to compare the mean pulse rate and oxygen saturation among children undergoing different dental procedures. Independent t test was used to find the difference in mean

Table 1: Distribution of patients (n=80)

Group (Procedure)	Gender (n)	No. of visits (n)
Group I (Checkup) n =20	Males = 9 Females =11	First visit =12 visit>1= 8
Group II / Restoration n =20	Males = 10 Females =10	First visit =4 Visit>1=16
Group III / Pulp therapy n =20	Males =13 Females =7	First visit =1 Visit>1=19
Group IV / Extraction n =20	Males = 8 Females =12	First visit = 6 Visit>1=14

Table 2 : Comparison of pulse rate and oxygen saturation changes between the males and females

Study parameter	Procedure	Gender	Group I Mean±SD	Group II Mean±SD	Group III Mean±SD	Group IV Mean±SD
Pulse rate	Before treatment	Males	94.78±16.25	95.10±6.62	91.62±13.74	99.88±12.05
		Females	96.18±17.68	93.30±7.15	100.14±7.27	100.50±7.59
		p-value	**0.86**	**0.57**	**0.09**	**0.89**
	During treatment	Males	95.44±14.92	97.00±7.69	92.77± 15.68	98.00±19.55
		Females	95.27±15.44	98.20±7.63	105.57± 8.66	104.42±7.38
		p-value	**0.98**	**0.73**	**0.06**	**0.40**
	After treatment	Males	94.00±13.68	96.10±6.90	91.46±15.99	97.00±8.42
		Females	93.64±14.48	95.90±4.43	101.29±5.68	100.08±7.15
		p-value	**0.96**	**0.94**	**0.06**	**0.39**
Oxygen saturation	Before treatment	Males	98.33± 1.00	98.50±0.85	98.15±1.82	97.99±1.46
		Females	96.73±3.04	98.20±1.14	94.57±5.09	97.67±2.39
		p-value	**0.12**	**0.51**	**0.12**	**0.83**
	During treatment	Males	97.22±3.27	98.80±0.42	97.77±1.83	97.50±1.85
		Females	97.55±2.25	98.20±1.03	98.71±3.20	98.33±0.99
		p-value	0.79	**0.12**	**0.41**	**0.27**
	After treatment	Males	98.56±0.88	98.50±0.71	98.92±1.75	98.00±1.07
		Females	97.36±2.73	98.30±1.06	95.29±5.19	98.08±1.08
		p-value	0.19	0.63	0.12	0.87

Independent t test

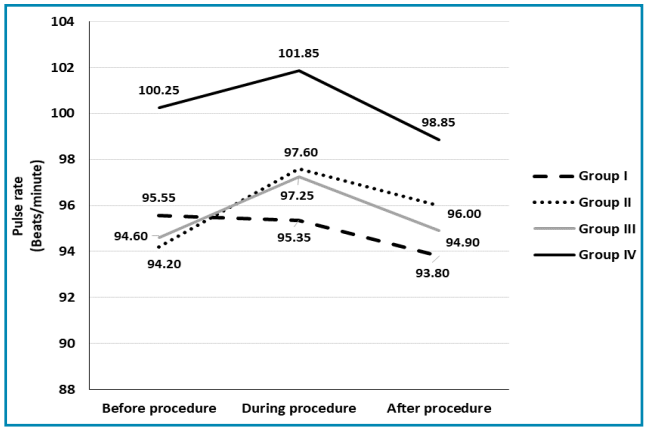

Fig. 2: Pulse rate before, during and after the procedure among different groups

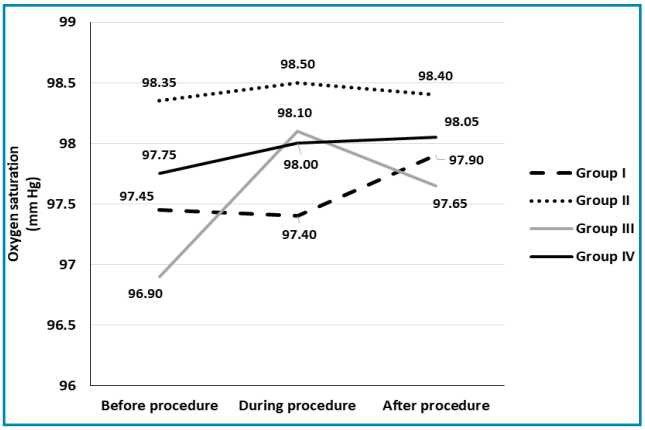

Fig. 3: Oxygen saturation before, during and after the procedure among different groups

pulse rate and oxygen saturation between boys and girls and between those with first and consecutive dental visits. Level of significance was set at p-value <0.05.

RESULTS

A total of 80 participants were included in the study divided into four groups of 20 each for a procedure. Out of the total participants 40 (50.0%) were males and 40 (50.0%) were females. The mean age of the study participants was 8.50±1.90 (6 -12) years (Table 1).

Among the participants, lowest pulse rate recorded was 59 beats per minute and highest was 121 beats per minute. Mean pulse rate of the studied population was 96.15±11.88, 98.01±12.97, 95.89±10.84 for before, during and after the procedures, respectively.

Fig. 2 demonstrates the mean values of pulse rate (PR) in different groups. The mean pulse rate was high in Group IV. This extraction group showed high pulse rate before, during and after the procedures; 100.25±9.33, 101.85±13.52, 98.85±7.63, respectively. The other three treatment groups had higher pulse rate during the procedure compared to before and after. The lowest mean pulse rate was recorded was 93.80±13.75 after the checkup group I.

Table 3: Comparison of pulse rate and oxygen saturation changes between those with first dental visit and consecutive visits

Study parameter	Procedure	Dental visit (n)	Group I Mean±SD	Group II Mean±SD	Group III Mean±SD	Group IV Mean±SD
Pulse rate	Before treatment	1st visit	92.75±18.89	93.50±8.66	97.00±0.0	98.67±2.58
		>1 visit	99.75±12.44	94.38±6.55	94.47±12.71	100.93±11.09
		p-value	0.37	0.82	NA	0.48
	During treatment	1st visit	91.00±17.02	99.75±10.15	103.00±0.0	103.00±9.21
		>1 visit	101.88±7.64	97.06±6.98	96.95±15.11	101.36±15.28
		p-value	0.11	0.54	NA	0.81
	After treatment	1st visit	89.25±15.18	96.00±6.06	93.00±0.0	101.00±7.24
		>1 visit	100.63±7.89	96.00±5.75	95.00±14.33	97.93±7.86
		p-value	0.07	0.99	NA	0.42
Oxygen saturation	Before treatment	1st visit	97.75±2.30	98.75±0.50	98.00±0.00	98.33±1.21
		>1 visit	97.00±2.73	98.25±1.07	96.84±3.75	97.50±2.28
		p-value	0.52	0.19	NA	0.41
	During treatment	1st visit	97.67±2.96	97.75±1.26	99.00±0.00	99.00±0.00
		>1 visit	97.00±2.33	98.69± 0.60	98.05±2.42	97.57±1.51
		p-value	0.60	0.04*	NA	0.004*
	After treatment	1st visit	98.75±1.36	98.25±1.50	98.00±0.00	98.33±0.82
		>1 visit	96.63±2.56	98.44±0.73	97.63±3.79	97.93±1.14
		p-value	0.03*	0.72	NA	0.44

Table 4: FIS response of the participants

Groups	FIS score (n)	Study parameters	Before treatment	During treatment	After treatment
Group I	1 (4)	PR	73.50±16.38	74.00± 10.67	73.50± 9.0
		SpO_2	96.75±3.86	96.75±5.18	100.00±1.41
	2 (9)	PR	97.44 ±10.7	97.67 ±10.4	95.22±6.8
		SpO_2	98.22±1.64	97.89±1.83	97.78±1.64
	3 (5)	PR	103.40±11.6	101.20±7.3	98.60±6.9
		SpO_2	98.80±2.95	97.20±2.49	96.60±2.88
	4 (2)	PR	111.50±13.4	113±8.4	116.00±2.8
		SpO_2	97.00±1.40	97.00± 0.0	97.50±0.7
	5 (0)	–	–	–	–
Group II	1 (3)	PR	90.00±7.93	96.00±4.35	96.00±2.00
		SpO_2	98.33±1.15	98.67±0.57	99.00±0.0
	2 (11)	PR	95.00±7.37	97.55±8.38	94.27±6.84
		SpO_2	98.27±1.10	98.27±1.00	98.18± 1.07
	3 (5)	PR	93.60±4.82	99.60±8.26	100.00±2.00
		SpO_2	98.80±0.44	98.80±0.44	98.60±0.54
	4 (0)	–	–	–	–
	5 (1)	PR	101.00	93.00	95.00
		SpO_2	97.00	99.00	98.00
Group III	1(6)	PR	83.17±13.64	85.17±16.69	82.00 ±18.59
		SpO_2	97.33±2.25	97.67±2.42	98.67±0.51
	2 (9)	PR	99.56 ±9.00	107.11±7.88	102.44±6.78
		SpO_2	95.67±4.92	98.22±3.03	96.22±4.84
	3 (5)	PR	99.40±7.30	94.00±10.6	96.80±4.38
		SpO_2	98.60 ±1.14	98.40±0.5	99.00±3.00
	4 (0)	–	–	–	–
	5 (0)	–	–	–	–
Group IV	1 (0)	–	–	–	–
	2 (11)	PR	100.18±8.80	101.18±11.6	98.82±7.2
		SpO2	98.09±1.44	97.64±1.62	98.27±1.00
	3 (6)	PR	98.00±10.21	99.50±19.18	94.67±5.71
		SpO_2	97.00±3.03	98.17±1.16	98.00±1.26
	4 (3)	PR	105.00±11.3	109.00±6.5	107±7.0
		SpO_2	98.00±1.73	99.00±0.0	97.33±0.57
	5 (0)	–	–	–	–

Independent t test

There was no significant change in the mean values of peripheral oxygen saturation among the groups recorded at different time of the dental procedure. Fig. 3 demonstrates the mean values of peripheral oxygen saturation. Lowest SpO_2 was recorded in the patients undergoing pulp therapy before the procedure (96.90±3.66) and highest was in the restoration group during the procedure (98.50±0.83).

Pulse rate was higher in females compared to males in group III and group IV with highest pulse rate during the treatment 105.57± 8.66 for group III, followed by group IV with mean of 104.42±7.38. The lowest score was observed after procedure in males under group III (91.46±15.99). The difference in the gender was not statistically significant.

The oxygen saturation between the gender was not statistically significant. Minimum and maximum oxygen saturation was recorded in group III for girls 94.57±5.09 (before treatment) and boys after treatment 98.92±1.75 (Table 2).

Compared to other procedures there was increase in the pulse rate in patients undergoing extraction in both first visit (103.00±9.21) and subsequent visits

(101.36±15.28). Mean pulse rate lowered in the children undergoing pulpectomy during the procedure (96.95±15.11). There was single patient undergoing pulpectomy (group III) in the first visit who had higher pulse rate during the procedure (103.00±0.0) compared to before (97.00±0.0) and after (93.00±0.0) the procedure. Other patients receiving same treatment in subsequent visits had less mean pulse rate during the procedure (96.95±15.11).

There was statistically significant difference ($p < 0.05$) in oxygen saturation within the children of group II and group IV (Table 3).

Table 4 demonstrates the mean pulse rate and SpO_2 in the patients according to their response in the Facial Image scale. The mean pulse rate increased with the response of the patient from very happy to very unhappy in group I. The group IV patients with FIS score 4 (unhappy) had the highest mean pulse rate before during and after the procedure.

DISCUSSION

Any stressful situation can result in physiological changes that manifests in corticosteroid release, BP change, hemodynamic and cardiovascular reactions.[12,19,20] Similar physiological changes have been reported in the patients that could be attributed to "white-coat phenomenon".[21] The anticipation of forthcoming, scheduled dental treatment induces a physiologic stress response in patients and increased anxiety has been shown to increase perceived pain in children and can be considered an important barrier to patients receiving dental care.[22]

The response of the children to stressful situation vary[1] in their temperament[23] which is often regarded as innate rather than learned behavior that is often influenced by health, culture, parenting styles, child's age and cognitive level, anxiety and fear, reaction to strangers, pathology, social expectations etc.[7,24] Assessing the dental anxiety and monitoring the vital changes in the child during the routine dental treatment will help the pediatric dentist to carry out proper behavior management techniques preferred for the anxiety provoking dental procedures.[13] The pulse is more sensitive to sympatho-adrenal outflow and the change is immediate than other hemodynamic variables[8] and oxygen saturation is regarded as fifth vital sign.[11] This study was carried out to determine the changes in these vitals in children undergoing routine dental procedures. The dental visit in a child patient includes diagnostic, restorative, surgical, preventive and interceptive procedures. It has been reported that type of dental treatment was found to affect the amount of anxiety that the patient experiences.[7,11,25]

The children undergoing extraction in the study reported with increase in the mean pulse rate (101.85±13.52) compared to the children receiving oral examination and restorative treatments. It is well documented that injection is the most universally feared procedure in dentistry.[8] It has also been reported that exodontia caused increase in heart rate in patients.[18] It can be due to the strong association of administration of local anesthesia and extraction. The children undergoing extraction with Facial image scale score 4 also had higher mean pulse rate in this study. A significant elevation of pulse rate has been reported during local anesthesia administration in patients undergoing extraction[8] and also in restorative procedure.[4] It has been reported in literature that children show a specific anxiety to local anesthesia due to the use of sharp instruments and perceive it as an overwhelming sensory experience.[26] Anticipation of multiple needle penetrations associated with dental procedures could be the possible reason for these physiological changes.[18] It was observed that the patient undergoing pulp therapy that required local anesthesia (group III) in the first visit had higher pulse rate 103 ± 0.0 during the procedure compared to before and after the procedure. Hersa *et al*[14] have reported that children who visit the dental clinic for the first time experience more anxiety and had high pulse rate. The reason for higher values of physiological readings at first visit could be because of a sophisticated looking apparatus and the instruments used by the dentist for the treatment that may influence the child's anxiety resulting in faster pulse rate.[14,24]

Memory to previous dental experience and earlier dental treatments also have a great importance on the child behaviour in subsequent visits,[27] same reason could have attributed to lower values of mean pulse rate in patients in subsequent visit in group III.

It was observed that the mean pulse rate was higher in females than males in group III (pulp therapy) and group IV (extraction); but the difference was not statistically significant. The average pulse rate of females was higher in different population as reported by different authors.[13,18,24] There is a reported evidence which showed high fear in girls was associated with high blood pressure, HR, and SpO_2 than boys.[1]

It was observed that SpO_2 was within the normal range and none of the participants

in this study had hypoxemia. Authors have diverse conclusion regarding trend for the oxygen saturation. SpO_2 remained unaltered[7,28] insignificant desaturations below preoperative baseline,[8,10] at the time of anesthetic delivery[1] and decreased O_2 saturation with increased subjective anxiety[3] also have been reported. Stress and anxiety can alter the respiratory rate which in time may alter oxygen saturation and or carbon dioxide levels in the blood.[10] A drop in SpO_2 levels for stressful procedures like extraction and pulpotomy also have been reported.[11] The mean pulse rate was higher in the children who had selected facial image scale 4 than those with other scores. It is more difficult for dentists to provide satisfactory dental care for tense patients compared to patients who are relaxed and cooperative.[14]

It is evident from this study that there was increase in the pulse rate of the patients during stressful procedures (pulp therapy and extraction in the present study) whereas oxygen saturation was within the normal range in the participants of the study. Short episodes of hypoxia may be of little consequence in healthy subjects, whereas in compromised patients early detection in physiological changes may avoid serious complications.[10] It is not deniable that these medical emergencies can occur even during dental procedures.[7]

Therefore, it is essential that child experiences less distress while undergoing dental treatment with utilization of various behaviour modulation techniques.[19,20,29-31] In addition monitoring the vitals during dental procedure assists dentist to detect and reverse acute medical emergencies that may require an immediate response.[32]

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