Evaluation of Pulse Rate and Arterial Oxygen Saturation ($Sa0_2$) Levels in Children During Routine Dental Procedures

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Abstract

Aim: The aim of this study was to evaluate changes in pulse rate and arterial oxygen saturation in unsedated paediatric dental patients undergoing routine dental procedures using pulse oximeter. **Materials & Method** : A sample of one hundred and fifty patients in the age group of 4-7 years were selected based on the inclusion and exclusion criteria. Pulse rate and arterial oxygen saturation values were recorded before the start of either of the procedure (oral prophylaxis, restorative (cavity preparation and restoration) or extraction), during and after the completion of the procedure using pulse oximeter. **Statistical Analysis :** The data was analysed using one-way ANOVA and Least significance multiple range test. **Results** : During all routine dental procedures, the pulse rate values increased intraoperatively from the preoperative baseline values and then decreased in the postoperative phase.The arterial oxygen saturation (SaO_2) values remained unaltered during all routine dental procedures. **Conclusion:** Dental anxiety and fear may have an effect on the normal physiologic parameters during routine dental procedures.

Keywords: Arterial Oxygen Saturation, Dental Anxiety, Pulse Rate, Pulse Oximeter

Introduction

Dental fear is one of the most common problems seen in the general population. Children are known to have unfounded fear and anxiety thus managing dental anxiety and fear is considered to be a challenge for successful component of dental treatment.

Management of disruptive and uncooperative children receiving dental treatment continues to represent a special challenge to dentists. A behavior analysis suggests that "anxiety" is a complex of behaviours and that the disruptive behaviours exhibited by children of any age are a function of specific antecedent or consequent stimuli.[1] There is a strong relationship between a child's dental anxiety and successful dental treatment and also between anxiety and pain.

Painful conditions cause fear, whereas fear and anxiety increases the amount of perceived pain.[2] Pain sensations may be experienced during dental treatment by the conditioned stimulus such as prick of the needle during local anaesthesia injection, sound and vibrations of the handpiece, vibration from the ultrasonic scaler and tightness of the rubber dam clamp. These are some of the stressful situations which have the ability to alter physiologic functions like blood pressure, pulse rate and respiratory rate. Constant

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monitoring of these functions are essential in order to detect and treat any emergency situation.

Monitoring is continuous observation of data from specific organ systems to evaluate the status of physiologic function with the purpose to permit prompt recognition of any deviation from normal, so that corrective therapy can be instituted before morbidity ensues.[3]

Health care has undergone a vast revolution in vital sign-monitoring technology over the last decade with the advent of pulse oximeter. One of the major functions of pulse oximeter is to monitor the patient's per cent oxygen saturation of haemoglobin (oxyhemoglobin) as an estimate of arterial oxygen saturation (SaO2).[4] Pulse oximeter provides an accurate, continous and a non-invasive monitoring of variations in pulse rate and arterial oxygen saturation in both sedated and unsedated patients without interfering with the dental procedures.

The purpose of this study was to evaluate changes in pulse rate and arterial oxygen saturation in unsedated pediatric dental patients undergoing routine dental procedures.

Materials & Method

The study was conducted in the Department of Pedodontics and Preventive Dentistry,ITS – Center for Dental Studies and Research, Muradnagar, Ghaziabad.. The study consisted of one hundred and fifty patients, randomly selected ranging in age from 4 to 7 years. There was no discrimination with respect to their age and socio-economic status. Previous dental experience of the patient was not considered during patient selection.

The inclusion criteria for the selection of subjects was: (1) Healthy child with no physical or mental disability (2) Presence of parents. (3) Child indicated for either of the routine dental procedures that is either oral prophylaxis, restorative procedures (cavity preparation and restoration) or extraction.

Patients with any systemic diseases, history of any medication or traumatic dental history were excluded from the study.

The parents/guardians were informed about the aims of the study and to choose at will, whether to take part in the study without affecting the dental care provided to the child. Written informed consent was obtained from all the parents. Vital signs which included pulse rate and arterial oxygen saturation (SaO_2) were recorded during different phases of the treatment using fingertip pulse oximeter.

The children were divided into three groups of 50 each and one of the either routine dental procedures like oral prophylaxis, restorative (cavity preparation and restoration) or extraction was carried out.

Prior to the operative procedure, each child was seated in the dental chair and allowed sometime to adjust to the dental environment. Pulse oximeter was applied to right forefinger. The pulse rate and arterial oxygen saturation (SaO_2) values were recorded at three moments –before commencing the procedure (pre-operative baseline value), during the procedure (intra-operative value) and after the completion of the procedure (post-operative value).

The statistical analysis of data was done by using Software SPSS version 18. The values obtained were tabulated and one-way ANOVA used to compare the significant difference of the means of pulse rate and

arterial oxygen saturation (SaO_2) between these procedures. For multiple comparison. LSD method was used. The confidence interval was at 95% and for significant results $p<0.05$ that was level of significance is 5%.

Results

The results are summarized in Tables 1 to 6.

Table 1: Mean scores and standard deviation of SaO_2 pre-operatively, intra-operatively and post-operatively

		N	Minimum	Maximum	Mean ±Std. Deviation	95% Confidence Interval for Mean	
						Lower Bound	Upper Bound
Pre-operative PR	Restorations	50	90	99	95.88±2.918	95.05	96.71
	Extraction	50	90	99	96.12±2.655	95.37	96.87
	Scaling	50	90	99	96.04±3.213	95.13	96.95
	Total	150	90	99	96.01±.919	95.54	96.48
Intra-operative PR	Restorations	50	88	99	95.82±3.550	94.81	96.83
	Extraction	50	89	99	96.80±2.688	96.04	97.56
	Scaling	50	89	99	96.92±2.968	96.08	97.76
	Total	150	88	99	96.51±3.108	96.01	97.01
Post-operative PR	Restorations	50	87	99	96.04±3.276	95.11	96.97
	Extraction	50	88	99	96.26±2.933	95.43	97.09
	Scaling	50	88	99	95.86±3.785	94.78	96.94
	Total	150	87	99	96.05±3.331	95.52	96.59

Table 2: Mean scores and standard deviation of pulse rate pre-operatively, intra-operativel and post-operatively

		N	Minimum	Maximum	Mean ±Std. Deviation	95% Confidence Interval for Mean	
						Lower Bound	Upper Bound
Pre-operative PR	Restorations	50	68	99	89.70±9.072	87.12	92.28
	Extraction	50	76	100	89.68±9.108	87.09	92.27
	Scaling	50	76	98	91.08±9.422	88.40	93.76
	Total	150	68	100	90.15±9.163	88.67	91.63
Intra-operative PR	Restorations	50	82	118	108.06±9.360	105.40	110.72
	Extraction	50	119	139	128.36±5.228	126.87	129.85
	Scaling	50	81	105	96.08±9.625	93.34	98.82
	Total	150	81	139	110.83±15.715	108.30	113.37
Post-operative PR	Restorations	50	77	99	92.18±6.977	90.20	94.16
	Extraction	50	80	102	91.66±7.615	89.50	93.82
	Scaling	50	79	99	92.68±8.622	90.23	95.13
	Total	150	77	102	92.17±7.727	90.93	93.42

Table 3: One –way ANOVA for SaO_2 (pre-operatively, intra-operatively and post-operatively)

ANOVA						
		Sum of Squares	df (degree of freedom)	Mean Square	F	p value
Pre-operative SaO2	Between Groups	1.493	2	.747	.087	.917
	Within Groups	1268.480	147	8.629		
	Total	1269.973	149			
Intra-operative SaO2	Between Groups	36.413	2	18.207	1.908	.152
	Within Groups	1403.060	147	9.545		
	Total	1439.473	149			
Post-operative SaO2	Between Groups	4.013	2	2.007	.179	.836
	Within Groups	1649.560	147	11.221		
	Total	1653.573	149			

Table 4:One –way ANOVA for pulse rate (pre-operatively, intra-operatively and post-operatively)

ANOVA						
		Sum of Squares	df (degree of freedom)	Mean Square	F	p value
Pre-operative PR	Between Groups	64.413	2	32.207	.380	.684
	Within Groups	12447.060	147	84.674		
	Total	12511.473	149			
Intra-operative PR	Between Groups	26626.813	2	13313.407	192.397	.000
	Within Groups	10172.020	147	69.197		
	Total	36798.833	149			
Post-operative PR	Between Groups	26.013	2	13.007	.216	.806
	Within Groups	8869.480	147	60.337		
	Total	8895.493	149			

Table 5: Least significance multiple range test comparison (SaO_2)

Multiple Comparisons							
LSD							
Dependent Variable	Procedure(I)	Procedure(II)	Mean Difference (I-II)	Std. Error	p value	95% Confidence Interval	
						Lower bound	Upper bound
Pre-operative SaO_2	Extraction	Restorations	.240	.588	.683	-.92	1.40
	Extraction	Scaling	.080	.588	.892	-1.08	1.24
	Scaling	Restorations	.160	.588	.786	-1.00	1.32
Intra-operative SaO_2	Extraction	Restorations	.980	.618	.115	-.24	2.20
	Scaling	Restorations	1.100	.618	.077	-.12	2.32
	Scaling	Extraction	.120	.618	.846	-1.10	1.34
Post-operative SaO_2	Restoration	Extraction	-.220	.670	.743	-1.54	1.10
	Restoration	Scaling	.180	.670	.789	-1.14	1.50
	Extraction	Scaling	.400	.670	.551	-.92	1.72
*. The mean difference is significant at the 0.05 level.							

Table 6: Least significance multiple range test comparison (Pulse rate)

Multiple Comparisons							
LSD							
Dependent Variable	Procedure(I)	Procedure(II)	Mean Difference (I-II)	Std. Error	p value	95% Confidence Interval	
						Lower bound	Upper bound
Pre-operative PR	Restorations	Extraction	.020	1.840	.991	-3.62	3.66
	Extraction	Scaling	-1.400	1.840	.448	-5.04	2.24
	Scaling	Restorations	1.380	1.840	.455	-2.26	5.02
Intra-operative PR	Restoration	Scaling	11.980*	1.664	.000	8.69	15.27
	Extraction	Restoration	20.300*	1.664	.000	17.01	23.59
	Extraction	Scaling	32.280*	1.664	.000	28.99	35.57
Post-operative PR	Restoration	Extraction	.520	1.554	.738	-2.55	3.59
	Scaling	Restorations	.500	1.554	.748	-2.57	3.57
	Scaling	Extraction	1.020	1.554	.512	-2.05	4.09
*. The mean difference is significant at the 0.05 level.							

Discussion

Anxiety and fear is the most common emotional disturbance seen in children during dental treatment. Anxiety may be defined as either a cognitive, emotional and physical reaction to a dangerous situation or the anticipation of threat that induces a physiologic stress response that manifests in corticoid release, blood pressure changes and hemodynamic and cardiovascular changes.[5]

Pulse oximeter is one of the most acceptable and widely used electronic devices for measuring variations in pulse rate and arterial oxygen saturation. It is based on the concept that pulsatile changes in light transmission through living tissues are due to alteration in the arterial blood volume. It functions by placing a pulsating vascular bed between a 2-wavelength light source and a silicon photodetector diode. The light source consists of two different light emitting diodes (LEDs), one emitting red (=660nm) and the other infrared (=940nm) light. Light absorption varies with arterial pulsation, the wavelength of light used, and the oxyhemoglobin saturation.[5,6] Absorbance characteristics of haemoglobin varies in red and infrared region. In the red region, oxyhaemoglobin absorbs less light than deoxyhaemoglobin and vice versa in the infrared region.[7] Using spectrophotometric analysis, the pulse oximeter determines the ratio of oxygenated (red) haemoglobin to deoxygenated (blue) hemoglobin and displays oxyhemoglobin saturation (SaO2).[6] In dental practice, it is currently being used to measure variations in pulse rate and arterial oxygen saturation in sedated and unsedated pediatric dental patients due to its atraumatic nature.

Pulse Oximeter is easy to use as it requires no calibration, warm-up time or tissue preparation and multiple probes are available for use at different sites like ear, finger, toe and nose.[3] In this study, fingertip pulse oximeter was used.

In the present study, it was observed that there was an increase in pulse rate during all the routine dental procedures (i.e. extraction, restoration and oral prophylaxis) from the pre-operative baseline values. Thereafter it decreased gradually in the post-operative phase.

The largest increase in pulse rate was seen during extraction followed by restorations and oral prophylaxis. Simpson[9] and Myers[10] also reported an increase in pulse rate in a group of children and they attributed this increase to anxiety, fear and excitement. Baldwin et al[11] also showed peak of anxiety during stressful event of extraction. Similar findings were also reported which showed peak of anxiety during extraction. Sanadhya et al[5] also reported that with the delivery of local anaesthetic, the pulse rate increased significantly, showing the association of emotional stress and fear with the enhanced sympathetic activity to be the cause of this increase.

Prabhakar[12] in his study also observed increased anxiety in children during cavity preparation and restoration and he attributed that the reason for this increase is the sound and sight of the handpiece. Kleinknecht[13] also observed similar findings in his study.

Rayen[14] also concluded in his study that the most anxiety promoting situation in the dental operatory was the period of extraction followed by the initial waiting in the reception area.

The study also shows that there is a statistically significant difference in pulse rate (intra-operatively) between different procedures like extraction and restoration, extraction and oral

prophylaxis and restoration and oral prophylaxis. This is in accordance with the study done by Prabhakar et al[12] which showed a statistically significant difference between oral prophylaxis and extraction in the control group where no non-aversive behaviour management therapy was instituted.

In the present study, the arterial oxygen saturation (SaO_2) levels remained unaltered during routine dental procedures. Observations of this study show that there is no significant change in the arterial oxygen saturation in the pre-operative, intra-operative and post-operative phases of dental treatment. In a study done by Bello[7], he also observed an insignificant change in arterial oxygen saturation(SaO_2) throughout the operative procedure. Rayen[14] also observed that arterial oxygen saturation(SaO_2) remained unaltered during various dental procedures. Sanadhya[5] also observed insignificant change in arterial oxygen saturation (SaO_2) at the time of anaesthetic agent delivery in her study. Prabhakar[12] observed that there was a decrease in arterial oxygen saturation (SaO_2) levels in children during dental procedures.

From the present study, it may be concluded that stress produces anxiety which further initiates a chain of physiological reactions which in turn produce variations in the physiologic parameters. Pulse rate is more sensitive to these changes. There was an increase in pulse rate during all the routine dental procedures and maximum increase was seen during extraction. There was no significant change observed in the values of arterial oxygen saturation (SaO_2) during all the procedures.

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