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Evaluation of Salivary PH levels as Dental Stress Biomarker for Children Undergoing Extraction - An in Vivo Study

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Abstract

Introduction: Dental fear and anxiety (DFA) is a prevalent concern in pediatric dentistry, impacting a significant portion of children. This emotional state manifests in physiological changes, including xerostomia (dry mouth) due to reduced salivary flow and altered salivary pH levels. The potential to quantify stress levels in children undergoing dental treatment through the measurement of salivary pH warrants further investigation.

Methods: The study aims to examine the association between dental fear and salivary pH in children aged 6-8 years undergoing tooth extraction. A total of 22 children participated, providing salivary samples twice: once in the waiting room prior to any dental procedures (Sample A) and again just before local anesthetic injection (Sample B). Anxiety levels were measured using a

Visual Analogue Scale (VAS), while salivary pH was assessed using a digital pH meter. The obtained values were compiled, tabulated and analysed statistically.

Conclusion: This study represents a novel contribution to the field with evidence for an inverse relationship between salivary pH and anxiety levels, suggesting its potential as a non-invasive and cost-effective chairside biomarker for stress assessment.

Keywords: Anxiety, Cardiovascular, Endocrine, Xerostomia

Introduction

Tooth decay is an ancient ailment that has plagued humanity from the prehistoric period, according to archaeological data. According to Anand Hiremath et al, The overall caries prevalence was 78.9%[1] and is the primary reason of tooth loss. Unpleasant smell, pricky pokes, dangerous drills and fear of separation are the prime factors that causes dentophobia in child indicated for dental treatment. Delaying dental care due to dental fear and anxiety can lead to tooth extraction, a more invasive procedure compared to the potential for a straightforward restoration or root canal treatment.

All major physiological systems are impacted by anxiety and stress, including the neurological, muscular, reproductive, endocrine, digestive, respiratory, and cardiovascular.

Acute stress causes the endocrine system to create more cortisol and other steroid hormones, which raises heart rate, causes more powerful heart contractions, and causes rapid, laborious breathing. Stress affects all glandular secretions, including salivary gland secretions. The autonomic nerve systems of the sympathetic and parasympathetic branches regulate salivary flow, composition, and function.[2]

Korot'ko et al., Komarova LG[3] and other researchers conducted investigations on stress-induced alterations in saliva characteristics. Saliva production decreases and salivary acidity is increased when under stress, fear or anxiety due to increased concentration of hydrogen ions (pH).[3]

When under stress dry mouth occurs due to reduced secretion of saliva [4]. The faster the salivary secretion, the higher the salivary pH; conversely, the slower the salivary secretion, the lower the pH [5]. Bicarbonate is one of the components that has a significantly impacts on variations in salivary pH.[6]

According to research published in 2008, measuring the pH of saliva can be a useful and affordable way to examine the psychological impacts of stress [7].

In addition to pulse and blood pressure, salivary pH can be utilized to detect the presence of dental anxiety in patients who would be undergoing tooth extraction[8,9]. Given the link between dental anxiety and treatment delay, this is a first study that aims to compare the association between anxiety and salivary pH holds promise. By potentially offering a chairside, non-invasive measure of anxiety (salivary pH), clinicians may be better equipped to assess dentophobia severity in children. This could pave the way for the development of targeted behavior management strategies, ultimately improving patient cooperation, fostering positive dental attitudes leading to behaviour shaping and leading to better overall healthcare delivery.

Materials and Methods

After obtaining the ethical clearance from Institutional Ethical committee,

The study was conducted at the Department of Pediatric and Preventive Dentistry, BVDU, DCH Pune, with a sample size of 44 in January 2024.

Inclusion criteria

1. Patients aged between 6-8 years of age,
2. Children indicated for extraction requiring injection of Local anaesthesia
3. Frankel behaviour rating scores between 2-3 i.e. positive and negative.

Exclusion criteria

Medically unfit patients were excluded from the study.

44 salivary samples were collected from 22 patients; namely,

Sample A: 22 [in waiting area]

Sample B: 22 [just before injection of LA chairside]

The tools required were saliva collecting cups for salivary sample collection, a digital pH meter for recording pH levels and Visual analogue scale to record anxiety levels. Unstimulated 5-7ml saliva will be collected into cup by expectoration within a duration of 1 hour between 10am -12 am.

The procedure of the study is described in the following flowchart.

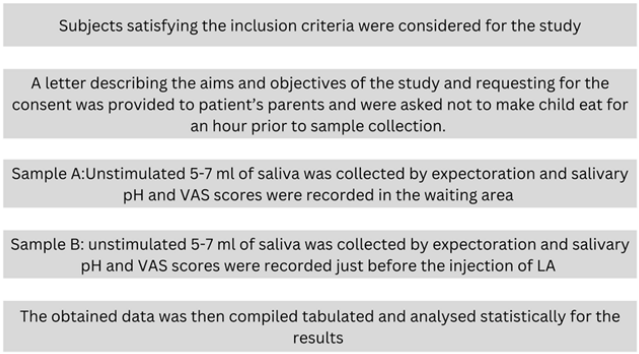

Fig. 1 Digital pH meter

Fig. 2 Saliva collecting cups

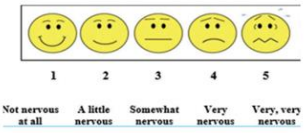

Fig. 3 Visual Analogue Scale [VAS] [10]

Figure 1-3:

Results

Table 1: Comparison of change in VAS score

Interval	Mean VAS	SD	Difference	p-value
Pre	2.20	0.62	-2.00	<0.001*
Post	4.20	0.62		

Using Wilcoxon signed rank test; * indicates a significant difference at $p \leq 0.05$

The VAS scores of samples A and B are contrasted in this table. Samples A and B had mean VAS scores of 2.20 and 4.20, respectively. The two VAS scores differed significantly from one another.

Table 2: Comparison of change in pH

Interval	Mean pH	SD	Difference	p-value
Pre	7.51	0.35	1.28	<0.001*
Post	6.43	0.49		

Paired t test; * indicates a significant difference at $p \leq 0.05$

This table compares the pH levels of samples A and B. Sample A had a mean pH of 7.51, while Sample B had a mean pH of 6.43. There was a substantial difference in pH score between samples A and B.

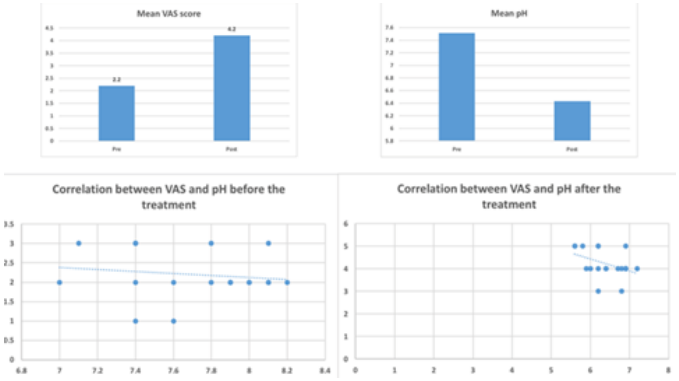

Table 3: Correlation between VAS score and pH

Interval	R value	P-value
Pre	-0.150	0.528
Post	-0.422	0.064

The correlation test results between pH and VAS for sample A revealed a moderately negative association, while sample B revealed a weakly negative correlation. In other words, the VAS score rises as pH falls.

Discussion

According to the current research, Sample B's average VAS was 4.2, which is extremely nervous, compared to Sample A's 2 slightly nervous. This drastic shift in VAS could be explained because of Needle related fear which is common, particularly in children[11] Patients who required a local anesthetic injection for extraction were therefore included in the designed inclusion criteria.

According to Rensburg (1995), salivary pH varies between 6.2 to 7.6 with an average pH of 6.7[12] Based on research data, it is observed that as the anxiety increases, the salivary pH levels decreases. The lowest pH observed in Sample B was 5.6 whereas 7.6 being the highest,, and VAS score 3 was lowest and 5 being the highest meaning increasing anxiety to very very nervous. Hence we can infer that with increasing anxiety, salivary pH decreases lesser than physiologic pH levels.

Using Pearson correlation test, between VAS and pH in sample A showed a weak negative correlation; whereas in sample B showed a moderate negative correlation. It means as the pH decreases, VAS score increases.

This is also consistent with the theory, which states that emotional responses such as dental anxiety cause physiological changes, one of which is dry mouth caused by reduced salivary flow, which causes a decrease in salivary pH because salivary pH is heavily dependent on salivary secretion.[4,12]

Salivary secretion can alter the composition of saliva, including the pH-affecting component bicarbonate, so the slower the secretion, the lower the pH. The pH of saliva will decrease when salivary production decreases because salivary bicarbonate content decreases as well.[6]

Anxiety experienced by the patient before tooth extraction is a self-defense response to an unpleasant thing that will happen[13] The sympathetic nervous system is more active during anxiety than the parasympathetic nervous system. Greater salivary viscosity, higher salivary protein levels, and decreased salivary volume are all results of this sympathetic nerve activity acting on the salivary glands via the noradrenaline neurotransmitter and beta-adrenergic receptors.[14]

This decrease in salivary volume will cause a decrease in salivary pH, hence, more acidic during dental anxiety. The reduction in salivary secretion or hyposalivation in patients with dental anxiety is only temporary and will return to normal when the emotional response is lost [15]

Furthermore, because salivary pH can be measured with inexpensive, user-friendly pH paper, it can also be used as an indication. This study demonstrated that dental anxiety preceding tooth extraction influences salivary pH.

Behavior management is the key component that distinguishes a pediatric dentist from other specialties. We deal with a population belonging to Generation Alpha, those youngsters born from 2010 to 2025, and because of the current social context, they are focused on technology and can become digital influencers with unique experiences in this regard, despite their young age.[16]

Given the energy and technological sophistication of this generation, a pediatric dentist needs to be skilled enough to overcome dentophobia and provide a pleasant dental experience simultaneously instilling positive dental attitude. It is very important for a child to have a painless and pleasant dental visit to create an individual who is more aware towards dental and medical healthcare.

Conclusion

The present study suggests that salivary pH has the potential to be a non-invasive, chair-side biomarker for the assessment and management of dental anxiety. This approach could contribute to improved patient experiences within the dental setting, potentially leading to positive downstream effects on public health through the promotion of preventative healthcare practices in adulthood.

Future Scope of the Research

Further more study to ascertain the association between dental anxiety and factors such as education levels, prior dental experience, frequency of dental visits could be done to select best practices for managing anxiety.

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