

Vanilmandelic acid: an alternative for measuring dental stress in children

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Abstract

Past research has indicated that stressful situations can cause heightened adrenal activity. This increased adrenal activity causes an increased urinary excretion of vanilmandelic acid (VMA), the major urinary by-product of epinephrine and norepinephrine. The purpose of this study was to determine if the measurement of VMA in urine could be a simple objective means to biochemically measure dental stress in children. Twenty (62.5%) of the 32 children who participated in this study demonstrated a VMA value measured during dental treatment that was greater than the VMA value measured in the home. The mean dental treatment VMA level was found to be 19.1% greater than the mean home VMA level. A dependent t-test was calculated for the home and dental treatment VMA values and was found to be significant at the 0.1 level. Both the home and dental school VMA levels were correlated against the age and sex of the children. In addition, the dental school VMA level was correlated against the number of dental appointments the children received at the pediatric dentistry clinic. The dental school VMA levels correlated positively with age and were significant at the 99% confidence level.

The dental literature includes numerous experiments dealing with stress produced before and during dental procedures.¹ The fear of stressful situations may keep the patient from visiting a dentist, and makes otherwise routine procedures difficult for the patient as well as the dentist. This dilemma takes on added dimensions when dealing with children. The child patient often has not reached a level of maturity that allows him to understand the benefits received from dental care. While dentists try to provide pain-free health care some discomfort is experienced occasionally. A poor dental experience during childhood may create a harmful, lasting impression that often is carried into adulthood.

Stress due to dental care has been found to be a

very difficult entity to measure. In the vast majority of articles, stress has been measured subjectively or physiologically. Subjective measurements of stress have been produced by using rating scales (Bailey et al. 1973; Frankel et al. 1982). The difficulty with rating scales is that they require observers who have been trained and whose subjective observations are replicable. In order to score physiological stress measurements the patient must be monitored by instrumentation which may be intimidating. When children can see the instrumentation or are attached to instruments not in view, the environment itself becomes stressful. A biochemical measurement would ensure an objective, nonintimidating means to measure dental stress in children (Venham et al. 1978).

It is known that the sympathetic nervous system is stimulated in stressful situations. One important response to sympathetic stimuli is increased epinephrine output by the adrenal medulla. Epinephrine has a dramatic effect on the body; it is the most potent stimulant of adrenergic alpha- and beta-receptors, resulting in increased heart rate and force of contraction, vasoconstriction or vasodilation, relaxation of bronchiolar and intestinal smooth muscle, glycogenolysis, lipolysis, and other metabolic effects.²

Measurements in urine of the catecholamines epinephrine and norepinephrine or their metabolic products have become important for diagnosing catecholamine-secreting tumors.³ In 1957, Armstrong et al. identified vanilmandelic acid (4-hydroxy-3-methoxy-mandelic acid or VMA) as the major urinary metabolite of the catecholamines. It is now recognized that VMA is the chief urinary excretion product of epinephrine and norepinephrine.

² Nichoff et al. 1964; Searey 1969; Von Euler 1966.

³ Carmon and Brashear 1968; Nelson 1964; Rosteen and Engleman 1963; Sunderman et al. 1960; Sunderman 1964; Von Studnitz et al. 1963; Voorhress and Gardner 1962.

¹ Bailey et al. 1973; Simpson et al. 1974; Thompson and Law 1958.

TABLE 1. Vital Statistics of Children in the Study

Age	Sex	Total Number of Dental Appointments
5-7 years, 9	Males, 14	1-10, 13
8-9 years, 8	Females, 18	11-20, 7
10-12 years, 15		20 or more, 12

Research on world class athletes also has revealed that VMA levels are markedly elevated in periods of physical and emotional stress.⁴ The purpose of this research was to study the difference between VMA levels in children immediately after completion of a dental procedure and the level of VMA of children in their home (control) environment.

Methods and Materials

Thirty-two children, ages 5 to 12 years who were patients at the University of Nebraska College of Dentistry were asked to participate in this study. No child included in this study was taking medication or under the care of a physician for any illness. The children were selected randomly; no attempt was made to select only those children who displayed overt behavior patterns.

Urine samples were collected by having the child empty their bladder on entering the dental college and again at the conclusion of their dental appointment. The time interval between voidings was recorded to allow the VMA levels to be expressed as a function of time rather than volume.

The dental appointment selected for the collection of the urine sample met with certain criteria; they assured that the appointment was at least 1 hr long and that the procedure performed required a local anesthetic injection. There was no attempt to quantify the emotional quality of the dental visit or to perform specific treatment modalities. To ensure that an extrinsic source of epinephrine was not introduced, the local anesthetic utilized was 3% Carcaine® without vasoconstrictor.

After the dental appointment the parents were sent home with a collection bottle, a storage bottle, and detailed instructions for collecting home urine samples. The procedure used to collect the home urine sample was similar to the postdental sample collected at the dental appointment. To ensure replicability, the home urine samples were collected at the approximate same time of day as the dental school sample; in addition, the time interval between voidings was recorded carefully by the parent and the total volume of urine voided by the child was collected. The home urine specimen indicated the state of the adrenal gland when the child was in the home

TABLE 2. Home and Dental School VMA Measurements

Group	Number of Cases	Mean	Deviation Standard
Home VMA	32	0.1153 mg/hr	0.078
School VMA	32	0.1425 mg/hr	0.075
<i>t</i> -value 1.540 <i>t</i> -critical value at 0.10 level and 31 degrees of freedom + 1.130*			

* Significant at the 99% confidence level ($P \leq 0.1$).

environment. This home sample was collected on a Saturday or Sunday to eliminate any influences that school may have had on the child's emotions.

Since the determination of VMA by colorimetric or UV methods appears to be more reliable than attempting to directly measure the catecholamines, the VMA level was assayed using the Sigma Chemical Kit Number 481-UV. This is a colorimetric technique requiring the use of a spectrophotometer. Before the VMA assays were conducted, it was necessary to run a series of calibration curves. New calibration curves were developed whenever a new reagent was used with a change of lot number (Sigma Chemical Company 1981).

In addition to home and dental school VMA levels, other variables were recorded. These variables included sex, age, and number of appointments the subjects had in the pediatric dentistry clinic.

To verify data by computer, the ages were broken down into the following groups: Group I, 5-7 years; Group II, 8-9 years; and Group III, 10-12 years. Nine of the children were in Group I, 8 in Group II, and 15 in Group III. The dental appointments each child received were grouped as follows: Group I, 2-10 appointments; Group II, 11-20; and Group III, 21 or more. Thirteen of the children had fewer than 10 appointments, 8 had between 10 and 20, and 11 had more than 20 (Table 1).

The data collected in this study were statistically evaluated at the University of Nebraska Computer Center using the SPSS Statistical Program Package. From the data collected a dependent *t*-test was calculated for the home and dental school VMA values. In addition to the *t*-test, a Pearson Correlation coefficient was utilized correlating the dental school VMA levels with the age, sex, and number of dental appointments in the pediatric dentistry clinic. The home VMA levels were correlated with age and sex only.

Results

Twenty of the 32 children who participated in the study showed a dental school VMA value which was greater than the home VMA value. The mean VMA level for the dental school readings was 0.1425 mg/hr. The remaining 12 children, who showed a greater VMA level in the home sample readings, demonstrated a mean VMA level of 0.1153 mg/hr. A de-

⁴ Frankenhaeuser and Rissler 1970; Jarsumbek 1975; Levi 1972.

TABLE 3. Correlation of Study Factors to Dental School VMA levels

		Age	Sex	Number of Appointments
Dental School VMA levels	Coefficient	*0.4670	-0.0450	0.1982
	Cases	32	32	32
	Significance	$P = 0.004$	$P = 0.403$	$P = 0.138$

* Significance at the 95% confidence level ($P \leq 0.05$).

pendent *t*-test was calculated for the home and dental school VMA values and was found to be significant at the 0.1 level (Table 2).

The Pearson Correlation coefficient demonstrated no significant correlations between home VMA levels and the children's age or sex. Dental school VMA levels also showed no significant correlation with sex or number of dental appointments. However, dental school VMA levels correlated positively with age and were significant at the 0.05 level (Table 3).

Discussion

Individual children in this study who demonstrated heightened VMA values were biochemically more responsive than in their home environment. The relatively low significance of the *t*-test (0.1 level) may lead the reader to conclude that little difference exists between the home and dental school VMA values when looking at the participants of this study as a group.

When evaluating the significance of these data it is important to emphasize two points. First, the children included in this study were selected at random; no attempt was made to secure patients who showed signs of being stressed over the impending dental appointment. Assay values on such a population may have led to a much different *t*-test value. Secondly, no attempt was made in this study to restrict a child's activity prior to the home urine collection period. Since physical activity increases the amount of epinephrine excretion, children in a more quiescent state before the home urine collection period may have led to a more significant difference between home and school VMA values.

In future studies it may be more pertinent to look at participants of VMA studies individually, restricting a patient's activity in the control environment and quantifying other parameters of stress to VMA levels.

The dental school VMA levels were correlated with age, sex, and number of dental appointments the child received in the pediatric dentistry clinic. In addition, home VMA levels were correlated with age and sex. The home VMA levels did not correlate significantly with either of the variables. This result was to be expected. If the home VMA demonstrated sig-

nificant correlations, then future investigations which utilize home VMA values as controls would have to acknowledge these effects.

Important to this study is the positive and significant ($P \leq 0.05$) correlation of dental school VMA levels with age of the patient (there was no significant correlation with sex or number of dental appointments). This result implies that as the children became older their biochemical responses to the dental experience were greater; or simply, older children were more stressed during the dental experience.

This fact is contrary to the beliefs of many pediatric dentists. Great emphasis is placed on conditioning the young patients so that they may learn to become good dental patients, and less concern is directed toward the older child who is presumed to no longer fear the dental experience. One may speculate on many reasons for this positive correlation. For example: (1) younger children tend to have a lower VMA output because they do not know what to expect during the dental appointment; (2) dentists may be inadequate in teaching school-age children not to fear dentistry; or perhaps (3) dentists may not recognize emotional upset in older children since the children seem to feel secure in a dental setting and have thus learned to manage their stress. This result should make the dentist more aware of the needs of school-aged dental patients who require treatment.

Also of importance to this study is the apparent lack of any correlation between the dental school VMA level and number of dental visits. Most pediatric dentists believe children who have experienced numerous dental visits should be more relaxed and thus demonstrate a lower VMA output in the dental school as compared to home (negative correlation). The correlation value for the number of dental appointments as compared to school VMA values is +0.1982, which is far from the negative correlation which may have been expected. The belief that chil-

TABLE 4. Correlation of Study Factors to Home VMA Levels

		Age	Sex
Home VMA levels	Coefficient	0.2037	-0.0770
	Cases	32	32
	Significance	$P = 0.132$	$P = 0.338$

No significance demonstrated.

dren with treatment experience should be less anxious than new patients with less dental experience may be a falsehood.

Conclusion

It is apparent from previous research that the dental experience produces biochemical and physiological changes that can be recorded by a variety of techniques. This investigation utilized a new technique to aid in better understanding the effect of dental stress on children by measuring biochemical changes which are the result of stress. This study is believed to be the first attempt to quantify dental stress by measuring indirectly the secretion of epinephrine. As with any new procedure, additional investigations must be completed before the measurement of VMA is regarded as a reliable diagnostic tool. The results of this preliminary study should question some of our beliefs concerning dental stress in children. It is hoped that the questions which arise as a result of this study will prompt further investigations into the study of VMA secretion as well as other means to better understand stress.

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