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Original Article

Impact of Prenatal and Post Natal Factors on the Eruption Time of First Primary Tooth among Healthy Infants in Kottayam, Kerala – A Longitudinal Study

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ABSTRACT

Introduction: Eruption of primary teeth is an orderly, sequential, and age-specific event. A wide range of variation is seen in eruption time as a part of human evolutionary changes in different populations and geographic areas. Although this variation is strongly controlled by genes, certain environmental factors also play a significant role in it.

Purpose: The standards for tooth eruption time and pattern derived from one group of children of different genetic pools and environmental conditions cannot be extrapolated to another group residing at other geographic locations. Hence, the present study was carried out to find the impact of certain pre-natal and post-natal factors on the first tooth eruption time in the Kerala population.

Methods: This prospective study was carried out among 250 healthy infants of 3-month-old who were randomly selected from the vaccination center. Pre-natal factors (socioeconomic status, maternal age, gestational age, and self-reported maternal systemic diseases) and post-natal factors (gender of child, birth weight, feeding practice, use of pacifiers, milestones of developments, and history of oral intubation) were collected by questionnaire. Children were followed up in 6, 9, 12, and 15 months until the first primary tooth eruption. Statistical analysis was done by Pearson's correlation, *t*-test, ANOVA, and multivariate linear regression.

Results: The mean age of first tooth eruption was found to be 10.28 ± 2.627 months. Bivariate analysis showed maternal age, gestational age, and self-reported maternal systemic disease, birth weight, feeding practice, and history of oral intubation had a statistically significant association with eruption time. On multivariate linear regression analysis, maternal, gestational age, birth weight, and history of oral intubation were found to be a good predictor of time of tooth eruption. The first erupted tooth for a greater proportion of children was lower central incisors (80%).

Conclusion: There was a significant delay in primary tooth eruption. Maternal age, gestational age, birth weight, and history of oral intubation was found to be a good predictor of time of tooth eruption.

Keywords: Delayed eruption, Eruption time, First primary tooth, Pre-natal, Post-natal

INTRODUCTION

Deciduous teeth are important biological markers of maturity and they play a significant role in dentomaxillofacial complex.[1] Tooth eruption is a natural physiologic process involving the interplay of regulating genes and a series of interactions between the cells of dental follicles and alveolus.[2] It is an orderly, sequential, and age-specific event. Dental age is utilized in various studies of the relationship between dental and skeletal maturation rates for anthropological as well as clinical use in dentistry. Developmental norms of the emergence of teeth are important for child health care planning and for accurate diagnosis of local and systemic growth disturbances, preventive dentistry procedures, archaeological, anthropological, and paleontological studies and may have

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legal as well as forensic applications.[3] Alteration in tooth eruption trend cause suspicion of underlying systemic disease[4] which evoke parental anxiety which leads to futile laboratory investigations as well as radiographs. Late eruption may cause nutritional problem,[5] malocclusion, and crowding which can cause poor oral health.[6]

Human dentition has undergone several evolutionary changes and children are maturing earlier than they did at the beginning of this century.[7,8] It is reported that a wide variation is seen in the eruption time in the present generation.[9,10] Several variables are thought to be influencing the eruption time such as race, gender, ethnicity,[11] genetic factor,[5] nutritional status,[5] socioeconomic status,[12] feeding practice,[13] gestational age,[14] birth weight,[14] post-natal growth,[15] obesity,[15] and head circumference.[16] Many studies were focused to find the eruption time and factors associated to it in various populations and geographic locations. The standards for tooth eruption time and pattern derived from one group of children of different genetic pools and environmental conditions cannot be extrapolated to another group residing at other geographic locations. Hence, the present study was carried out to find the impact of certain pre-natal and post-natal factors on the first tooth eruption time in the Kerala population.

MATERIALS AND METHODS

This longitudinal study was conducted among 3-month-old infants with their mothers who attended the Vaccination Centre at Government Medical College, Kottayam, from November 2018 to November 2019. The study protocol was approved by the Institutional Ethical Committee. Informed consent was taken from all parents of children who were participating in the study in their preferred language either in Malayalam or English. The study participants were selected by a random sampling method from the vaccination clinic which was accessed by a wide range of people seeking treatment from a rural and urban area with different cultural backgrounds and having low and high socioeconomic levels. The minimum sample size was 172. The sample number was increased up to 250 to compensate for missing cases and dropouts. The selected children were planned to examine on subsequent visits to find out the primary tooth eruption time in each subject. Hence, we adopted a longitudinal study design. Three-month-old infants who were natives, without any systemic disease, were included in this study. Infants with congenital birth defects, chronic illness, and with natal or neonatal teeth and mothers who were not willing to participate in this study were excluded from the study.

Data Collection

A semi-structured questionnaire was developed and validated based on the factors influencing first tooth eruption according to previous study reports. The questionnaire contained demographic data collection followed by pre-natal and post-natal variables which may influence the eruption time of first primary tooth in infants. Self-reported socioeconomic status was recorded by the Kuppuswamy scale based on the modification 2019. Pre-natal factors considered in this study were socioeconomic status, maternal age, gestational age (<37 weeks and more than 37 weeks), and self-reported maternal systemic diseases (none, nutritional, endocrine, and others). Post-natal factors such as gender of child, birth weight (less than 2.5 kg, 2.5–3.5 kg and more than 3.5 kg), feeding practice up to 6 months (breastfeeding, bottle feeding, and combination) use of pacifiers, milestones of developments, and history of oral intubation were also recorded by interviewing mother. Data were also collected and verified from children's health records which mothers bring during their routine vaccination.

Parents were instructed to examine children's mouth frequently. A pictorial tooth eruption record chart was given and parents were asked to mark the date on which the edge of tooth was seen on gums. Eruption of teeth was defined as any tooth with any part of its crown penetrating the gingiva and visible in the oral cavity. Recording of parents was checked for accuracy by clinical examination in the next follow-up visit. The child was made to sit on mothers lap and tooth eruption was checked in daylight by the investigator in the vaccination clinic. Site of tooth erupted first, either in the maxillary or mandibular arch, was also recorded. Children were followed up in 6, 9, 12, and 15 months until the eruption of the first primary tooth. On each visit, oral health instructions were given to mothers along with oral hygiene demonstration.

Statistical Analysis

Data obtained were coded, entered in, and analyzed using IBM SPSS version25. Frequency distribution of pre-natal and post-natal factors was explained by descriptive analysis. Considering bivariate analysis, the association between eruption time with categorical pre-natal and post-natal variables were analyzed using independent *t*-test and ANOVA. *Post hoc* Tukey test was used to assess the significance of the difference between the risk factors and eruption time. Pearson's correlation test was used to explore the correlation between the age of the mother and first tooth eruption time. Multivariate linear regression model was employed to determine the significant predictors linked to the eruption time of the first tooth. The minimum significant level adopted was 5% (0.05).

RESULTS

The study participants comprised 250 healthy children of 3-month-old who were reported for routine vaccination. The mean age of mothers of the participants included in the study was 28.68 ± 5.650 years. There was the statistical significance of the correlation between age of the mother and the age of eruption of the first tooth (Pearson's correlation, $r = 0.777$) [Table 1]. There was no significant association between socioeconomic status and eruption time ($P = 0.693$). Among study participants, 45.6% had gestational age <37 weeks and 54.4% reported more than 37 weeks. The mean eruption time (MET) of the first tooth was found to higher (12.65 ± 1.563) among the children with <37 weeks of gestation when compared to those with more than 37 weeks of gestational age (8.29 ± 1.393) which was significant ($P = 0.000$). When the self-reported maternal systemic disease was taken into account, 37.6% mothers reported themselves to have nutritional disorders during pregnancy. Endocrine problems and other diseases were 31.2% and 15.6%, respectively. About 15.6% mothers were free from any illness and MET was 8.28 ± 1.905 in their children. MET was more in children with mothers having an endocrine problem (11.03 ± 2.711). In the case of nutritional problems, MET was 10.54 ± 2.500 and in other diseases (10.13 ± 2.441). There was statistically significant association between systemic disease of mothers and eruption time of first tooth ($P = 0.000$). Among pre-natal factors, maternal age, gestational age, and self-reported maternal systemic disease showed statistically significant association with mean eruption time of the first tooth in children on bivariate analysis [Table 2] and [Table 3].

Table 1: Correlation values between maternal age and first tooth eruption time

		Age of mother	Time of first tooth eruption
Age of mother	Pearson correlation	1	0.777
	Sig. (2-tailed)		0.000*
	N	250	250
Time of first tooth eruption	Pearson correlation	0.777	1
	Sig. (2-tailed)	0.000*	
	N	250	250

r=0.777. *Significance

The current sample consists of 49.2% boys and 50.8% which demonstrate almost equal gender distribution. There was no significant difference ($P = 0.473$) in MET between boys (10.15 ± 2.580) and girls (10.39 ± 2.676). About 34.4% children included in the study weighed above 3.5 kg at birth and 27.6% were having 2.5 kg to 3.5 kg at birth. About 38.4% were reported birth weight <2.5 kg. MET was found to be highest for participants with birth weight between <2.5 kg (12.84 ± 1.510) followed by weight between 2.5 and 3.5 kg (9.32 ± 1.867) and the lowest for birth weight above 3.5 kg (8.15 ± 1.484). Weight at birth was found to be significantly associated with the mean eruption age of first tooth ($P = 0.000$). When the association between feeding practice up to 6 months and eruption time are considered, statistically significant result was obtained ($P = 0.004$). Different feeding practices such as breastfeeding, bottle feeding, combinations were considered. A greater proportion of the children included in the study was practiced exclusive breastfeeding (75.2%) and MET was 9.96 ± 2.536. Only 2.8% children were bottle-fed (MET 11.43 ± 2.299) and combination feeding was practiced by 22.0% (MET 11.20 ± 2.751). The participants were almost equally distributed in terms of their use of pacifiers (50.4% and non-user 49.6%) and there was no significant association with eruption time ($P = 0.782$). The majority of the participants (94%) had normal milestones of development (MET 10.22 ± 2.632) and there is no significant association between eruption time ($P = 0.193$). History of oral intubation was seen in 18.4% (MET 13.52 ± 1.225) and 81.6% of children were not orally intubated (MET 9.54 ± 2.281). History of oral intubation was found to have a significant association with the mean age of eruption of first tooth ($P = 0.000$). Among post-natal factors, birth weight, feeding practice, and

Table 2: Relationship between pre-natal factors and first tooth eruption time

Variable		*n* (%)	Mean±SD	SE	Sig.
Socioeconomic status	Upper	19 (7.6)	10.47±2.756	0.632	0.693
	Upper middle class	28 (11.2)	9.93±2.734	0.517	
	Lower middle class	45 (18.0)	10.64±2.664	0.397	
	Upper lower class	145 (58.0)	10.16±2.527	0.210	
	Lower class	13 (5.2)	10.77±3.320	0.921	
Gestational age	<37 weeks	114 (45.6)	12.65±1.563	0.146	0.000*
	>37 weeks	136 (54.4)	8.29±1.393	0.119	
Systemic disease of mother	None	39 (15.6)	8.28±1.905	0.305	0.000*
	Nutritional	94 (37.6)	10.54±2.500	0.258	
	Endocrine	78 (31.2)	11.03±2.711	0.307	
	Others	39 (15.6)	10.13±2.441	0.391	

N: Number, SD: Standard deviation, SE: Standard error, *Significance

history of oral intubation showed statistically significant association with mean eruption time of the first tooth in children on bivariate analysis [Tables 3 and 4].

Table 3: ANOVA *post hoc* Tukey HSD analysis of pre-natal and post-natal variables

Variable	Mean±SD	Tukey HSD		
Systemic disease		None	Nutritional	Endocrine
None	8.28±1.905			
Nutritional	10.54±2.500	0.000*		
Endocrine	11.03±2.711	0.000*	0.581	
Others	10.13±2.441	0.006*	0.816	0.254
Birth weight		<2.5 kg	2.5–3.5 kg	>3.5 kg
<2.5 kg	12.84±1.510			
2.5–3.5 kg	9.32±1.867	0.000*		
>3.5 kg	8.15±1.484	0.000*	0.000*	
Feeding practice		Breast feeding	Bottle feeding	Combination
Breastfeeding	9.96±2.536			
Bottle feeding	11.43±2.299	0.304		
Combination	11.20±2.751	0.006*	0.973	

SD: Standard deviation. *Significance

Multivariate linear regression analysis pointed out that maternal age and gestational age were significant predictors among pre-natal factors. Among post-natal factors, birth weight and history of oral intubation were found to be a significant predictor of time of tooth eruption. [Table-5]. The mean age of first tooth eruption was found to be 10.28 ± 2.627 months. It was also noted that lower central incisors was erupted first in 80% of children.

DISCUSSION

Variation in the eruption time of primary teeth may potentially indicate pathology of local tooth relating factors as well as a link to systemic imbalance at a cellular, molecular, or genetic level. These variations are multifactorial of which events occur simultaneously, consecutively or intermittently in the pre-natal or post-natal period of child.

The current longitudinal study was designed for easy subject recruitment and retention by reducing inconvenience to

Table 4: Relationship between post-natal factors and first tooth eruption time

Variables		*n* (%)	Mean±SD	SE	Sig.
Gender	Male	123 (49.2)	10.15±2.580	0.233	0.473
	Female	127 (50.8)	10.39±2.676	0.237	
Birth weight	<2.5kg	96 (38.4)	12.84±1.510	0.154	0.000*
	2.5 kg–3.5 kg	69 (27.6)	9.32±1.867	0.225	
	>3.5 kg	85 (34.4)	8.15±1.484	0.161	
Feeding practice	Breastfeeding	188 (75.2)	9.96±2.536	0.185	0.004*
	Bottle feeding	7 (2.8)	11.43±2.299	0.869	
	Combination	55 (22.0)	11.20±2.751	0.371	
Use of pacifier	yes	126 (50.4)	10.23±2.623	0.234	0.782
	no	124 (49.6)	10.32±2.640	0.237	
Milestones of development	Normal	235 (94.0)	10.22±2.632	0.172	0.193
	Delayed	15 (6.0)	11.13±2.475	0.639	
History of oral intubation	yes	46 (18.4)	13.52±1.225	0.181	0.000*
	No	204 (81.6)	9.54±2.281	0.160	

N: Number, SD: Standard deviation, SE: Standard error, *Significance

Table 5: Multiple regression analysis for various predictors of first tooth eruption time

		Unstandardized coefficients		Standardized coefficients			95% confidence interval for B	
		Beta	Std. error	Beta	t	Sig	Lower bound	Upper bound
(Constant)		5.385	0.560		9.616	0.000*	4.282	6.488
Age of mother		0.121	0.021	0.260	5.703	0.000*	0.079	0.162
Gestational age	<37 weeks	1.935	0.295	0.368	6.569	0.000*	1.355	2.515
	>37 weeks[a]	-	-	-	-	-	-	-
Systemic disease	None[a]	-	-	-	-	-	-	-
	Nutritional	0.330	0.240	0.061	1.374	0.171	−0.143	0.802
	Endocrine	0.189	0.255	0.033	0.740	0.460	−0.314	0.692
	Others	0.069	0.282	0.009	0.243	0.808	−0.486	0.623
Birth weight	<2.5 kg	0.899	0.278	0.167	3.230	0.001*	0.351	1.447
	2.5–3.5 kg[a]	-	-	-	-	-	-	-
	>3.5 kg	−0.501	0.205	−0.091	−2.444	0.015*	−0.905	−0.097
Feeding practice	Breastfeeding[a]	-	-	-	-	-	-	-
	Bottle feeding	−0.396	0.479	−0.025	−0.826	0.409	−1.339	0.547
	Combination	−0.148	0.195	−0.023	−0.759	0.448	−0.533	0.236
Oral intubation	Yes	1.210	0.242	0.179	4.993	0.000*	0.732	1.687
	No[a]	-	-	-	-	-	-	-

A: Reference group r^2-0.798, adjusted r^2-0.789. F-24.928 P = 0.000

them and thus tried to reduce the possibility of missing cases. Although this study design requires long time interval and frequent examinations, it was the best design for reducing recall bias.

The present study revealed that maternal childbearing age had an important role in primary tooth eruption time. The correlation between the mean age of the mother and the mean age of eruption of the first tooth was good and was statistically significant ($r = 0.777$). This is in accordance with the findings of Savage *et al.*[17] and Un Lam *et al.*[18] However, the reports of Alnemer *et al.*[19] and Vejdani *et al.*[20] suggested that there was no association between maternal childbearing age and eruption time of first primary tooth. Many studies reported a well-established relationship between maternal age and child growth parameters. Moreover, skeletal growth influence on eruption was also studied.[21] Hence, the correlation between maternal age and eruption may due to the interplay of growth factors and underlying metabolic pathways.

The findings of this study showed no significant association between mean age of eruption of the first tooth and the socioeconomic status ($P = 0.693$). The results were similar to previous studies presented by Ahmadi-Motamayel *et al.,*[22] Sing *et al.,*[23] and Bambach *et al.*[24] In contrast to this finding, Clemens *et al.* reported that early tooth eruption in the high socioeconomic status group.[25]

Maternal systemic disease was also considered as a pre-natal factor for this study and it was found that there was a statistically significant association with a mean age of tooth eruption ($P = 0.000$). A similar finding was reported by many authors.[26-30] Majority of the mothers reported themselves to have nutritional disorders during pregnancy which reinforces the hypothesis that maternal nutritional problems can cause alteration in the eruption of tooth germ in the oral cavity. Multiple linear regression analysis indicated that maternal systemic disease is not a good predictor of tooth eruption time statistically. It may be due to the confounding effect of maternal age on the eruption time of teeth in their children. The importance of this pre-natal factor is very relevant in a clinical scenario. Categorization of various systemic diseases and inclusion of all maternal illness was not done and exact vitamin D as well as calcium level was also not checked in mothers, which was a limitation of our study. Further research is needed to explore the significance of maternal systemic disease on tooth eruption time of their children.

The result of this study explored that gestational age acts as a strong predictor of eruption time ($P = 0.000$). The finding of this study is consistent with several previous studies.[31,32] Seow *et al.* reported that infants with the lowest birth weight and shortest gestational age had the lowest rates of dental development.[33] Viscardi *et al.* studied the low birth weight and preterm babies and cited that there was a significant delay of first tooth eruption among children of gestational age <30 weeks.[34]

Considering sexual dimorphism, our study showed that the difference in MET between boys and girls was not found to be statistically significant ($P = 0.473$). Similar results were reported by Liversidge *et al.,*[35] Woodroffe *et al.,*[36] and Un Lam *et al.*[18] which showed no gender predilection in tooth eruption time. In contrast, Huaying *et al.*[37] among Chinese children, Al-Jasser *et al.*[38] among Saudi children, and Gunashekhar *et al.*[39] among Indian children reported that male child having early eruption time. However, in studies of Agarwal *et al.*[40] and Kaul *et al.*,[41] it was reported that girls exhibit early eruption. Hence, sexual dimorphism of primary tooth eruption needs further research.

Infant's birth weight was widely used as a marker for assessing the intrauterine environment and low birth weight was indicative of poor fetal nutrition. Multivariate analysis showed that birth weight was a strong predictor for tooth eruption time ($P = 0.000$). Our study finding is running with several studies when birth weight is taken into consideration.[42-46]

A number of different studies tried to investigate the link between eruption time and feeding practice. Our study observed that on bivariate analysis, feeding practice up to 6 months such as breastfeeding, bottle feeding, and combination had a significant association with tooth eruption time ($P = 0.004$). It was evident that early sucking activity influences the total growth of craniomaxillofacial complex. It was also proposed that breastfeeding is an ideal stimulus for the physiological development of musculoskeletal components of dentofacial complex. However, results of multivariate analysis showed that feeding practice is not a good predictor of tooth eruption time, it may be due to the confounding effect of birth weight on eruption time. This is in accordance with the study report of Folayan *et al.*[47] and Zarabadipour *et al.*[42] Contrary to the results of our study, Holman *et al.*[48] cited that late eruption of some teeth in children who were not breastfeed. Ahn *et al.*[49] suggested that exclusive breastfeeding had an overall role in child's growth and development. Sahin *et al.*[50] reported that feeding with cow or formula milk feeding in the 1st year of life has affected tooth eruption time negatively.

On the basis of our data, post-natal factors such as the use of pacifiers ($P = 0.782$) and the status of milestones of development ($P = 0.193$) were not found to have any significant association with the mean age of eruption of

the first tooth. This result is in accordance with the findings of Varma *et al.*[51] who reported no significant correlation between developmental milestones and tooth eruption. Our study, however, focused on healthy children who were medically fit, could have been the reason for this finding. History of oral intubation during the neonatal period was found to have a strong impact on the time of tooth eruption ($P = 0.000$). In a study, Viscardi *et al.*[32] reported that the duration of oral intubation is significantly related to tooth eruption time. In the present study, we did not record the duration of oral intubation which was a limitation of our study.

The mean age of first tooth eruption was found to be 10.28 ± 2.627 months. A similar finding is reported by Patil *et al.*[52] and Indira *et al.*[53] that there was a delay in eruption age in Indian children. In a longitudinal study, Gunashekhar *et al.*[39] also concluded the same result among Indian children. The first erupted tooth for a greater proportion of children was lower central incisors (80%) which were in accordance with findings of Gunashekhar *et al.*[39] but it in disagreement with the report of Patil *et al.*[52]

CONCLUSION

From the current study, it is evident that primary tooth eruption time is delayed in the Kerala population as compared to the standard eruption chart, which is commonly used in our clinical, academic, and research fields. This study also indicates that maternal age, gestational age, birth weight, and history of oral intubation are good predictors for the delayed eruption of a deciduous tooth. Medical, dental, and other paramedical professionals along with the general public should be made aware of the current evidence-based trend in eruption time of deciduous teeth. This study can be a useful basis for comparison with future studies. There is a need for further analytical studies using large sample size, including special children in order to enhance the evidence.

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