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Original Article

Dentistry Section

Eruption Pattern of Deciduous Dentition in Children of Vadodara, Gujarat, India: A Cross-sectional Observational Study

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ABSTRACT

Introduction: The eruption pattern of deciduous dentition can be of significant importance in forensic investigations, especially for human remains identification, age estimation, and anthropological analysis. The eruption pattern of deciduous dentition depends on geographic patterns, genetic ancestry, socio-economic status, nutritional factors, etc. Currently, the authors follow an eruption pattern chart based on the population of Western countries.

Aim: To examine the eruption pattern of deciduous dentition in children from Vadodara city, Gujarat, India.

Materials and Methods: This was a cross-sectional study conducted in Vadodra city of Gujarat, between November 2022 and October 2023 on a total of 1025 children between the ages of 0-36 months who met the inclusion criteria on the respective days of the hospital visit after obtaining informed consent from a legal guardian, an oral examination was carried out to check the teeth present along with their chronological age. Probit analysis was performed to determine the mean age for the eruption of each deciduous tooth using StatsDirect software.

Results: The deciduous mandibular central incisor was the first tooth to erupt in the oral cavity at 6.05±1.12 months, followed by the maxillary central incisor and lateral incisors at 6.52±0.56 months and 7.92±0.62 months, respectively. The mandibular lateral incisor erupted at the age of 9.99±0.91 months. In the maxillary arch, the first molar erupted at the age of 13.51±1.12 months, the canine at 18.95±0.98 months, and the second molar at 28.05±0.94 months. In the mandibular arch, the first molar erupted at 14.12±0.82 months, the canine at 16.22±0.51 months, and the second molar at 24.75±0.99 months. Girls showed earlier eruption compared to boys; however, no inter-arch variation was observed in the mean age of tooth eruption. Additionally, there was no difference in the sequence of eruption of deciduous teeth, as reported in other studies.

Conclusion: From the present study, it can be concluded that the Gujarati population demonstrates slightly earlier eruptions when compared to the standard eruption chart given by Logan WHG and Kronfeld R. The sequence of the eruption remains consistent with that of other studies, which is A-B-D-C-E.

Keywords: Cross-sectional studies, Deciduous teeth, Probit analysis, Sequence of eruption

INTRODUCTION

The eruption and exfoliation of deciduous teeth, followed by the emergence of permanent teeth, occur in a systematic, sequential manner and are specific to age groups. Tooth eruption represents a significant developmental milestone in a child's life, raising concerns among parents about its timing [1,2]. Considerable efforts have been devoted to understanding the eruption of deciduous teeth, including the timing, sequence, and factors influencing this process. Deciduous teeth typically appear within the first 2.5 years of life, although the exact timing and sequence may vary across populations, geographic areas, and even within seemingly homogenous groups due to environmental influences [3].

Various methods are employed to determine age, and dental development offers a reliable indicator for determining age as it is less susceptible to factors such as malnutrition or endocrinopathies compared to skeletal development. Clinical assessment of dental age primarily relies on observing tooth eruption in the oral cavity, which follows a discernible pattern and can be easily assessed by counting teeth. This method is practical as it does not require specialised equipment or expertise [2].

The development of deciduous teeth commences at 14 weeks in utero and concludes around 11 months post-natally [4,5]. The eruption of the first deciduous teeth is eagerly anticipated by parents and signifies an important developmental milestone. Factors such as ethnic origin, nutritional status, consanguineous marriages, genetics, and socio-economic background may influence the timing of tooth eruption, highlighting the need for population-specific references [6,7].

This has led researchers all over the world to publish standard tooth eruptions specific to the population or ethnic group. India, known for its diversity, encompasses various ethnicities and different environmental conditions across different regions. The slightest variation in these factors can impact dental development and eruption. Despite this, much of the information regarding deciduous tooth eruption in India relies on standards derived from Western populations, underscoring the necessity for indigenous research.

Studies conducted in North India [8] and Mysore [9] have revealed significant differences in the timing of deciduous tooth eruption compared to reference tables based on US populations, such as the one provided by Logan WHG and Kronfield R in 1935 [10]. The impacting influence of cultural backgrounds on the eruption of teeth in the Indian population has been noted. However, research on this topic remains sparse in many parts of India, including the state of Gujarat.

Currently, dental academia in India commonly employs eruption age charts derived from Western populations, highlighting the need for region-specific comprehensive studies to determine the eruption patterns of deciduous dentition in various Indian populations. Therefore, the aim of the study was to evaluate the eruption pattern of deciduous dentition in children of Vadodara City, Gujarat, India. The objective of the study is to evaluate gender variation in the eruption sequence of deciduous dentition and to compare the age of eruption with the standard eruption timetable given by Logan WGH and Kronfield R in 1935 [10].

MATERIALS AND METHODS

This cross-sectional study was conducted in Vadodara City, Gujarat, India, from November 2022 to October 2023. Ethical clearance was obtained from the institutional review board and University Ethics Committee (SVIEC/ON/DENT/SRP/WCV/22/37).

Inclusion criteria: Clinically healthy children who visited the hospital during the study time period aged 0-36 months, born at full term (38-40 weeks) with an average birth weight (≥2500 g) were included in the study after taking informed consent parent/guardian.

Exclusion criteria: Those children whose parents were not willing to provide information and consent or those children with metabolic disorders and syndromes were excluded from the study.

Sample size: The sample size was estimated based on the proportion of the population, 50%, with a confidence interval of 95% having an error of 0.05, assuming a population size of 7,777,262 from the Census 2011 [11]. The required sample size was 385. A total of 1025 children visiting the Department of Paediatrics at Dhiraj Hospital and the Department of Paediatric and Preventive Dentistry at KM Shah Dental College and Hospital, Sumandeep Vidyapeeth, Deemed to be university, Vadodara, Gujarat, India, were screened and included in the study.

Procedure

The chronological age of the child was calculated in months from their birth certificate/hospital records. All the children were examined by a single examiner. The examination was done under natural daylight; teeth were categorised as "present" or "absent," with teeth considered present if any part of the crown penetrated the gingiva and was visible within the mouth [1]. Extracted teeth were considered as erupted teeth. Researchers concluded that there is no significant difference in the eruption timing of deciduous teeth on the right and left side [8,12,13]. Thus, only data from the right side of teeth were evaluated to compute findings. All the derived eruption ages of individual teeth were compared with the standard chart of Logan WGH and Kronfeld R [10].

Probit analysis was conducted for eruption age estimation. It is an effective method for examining tooth eruption in a cross-sectional study design, providing a normal sigmoid fit to the data. This analysis facilitates the estimation of the average age of tooth eruption based on the proportion of participants who had the tooth at that age [14]. This method has been employed in various cross-sectional studies to determine the eruption age and sequence of tooth eruption [1,3,15,16].

STATISTICAL ANALYSIS

Statistical analysis was conducted using Statistical Package for Social Sciences (SPSS) version 19.0 software (SPSS, Chicago, IL, USA). For calculating the mean age of emergence for each tooth, the probit model was adopted. The probit analysis was performed using StatsDirect (StatsDirect, Altrincham, Cheshire, UK). The mean age of tooth eruption was calculated from the model.

RESULTS

A total of 1025 children were included in the study. The final sample comprised 477 girls (46.53%) and 548 boys (53.47%). The mandibular central incisor erupted first at a mean age of 06.05±1.12 months, followed by the maxillary central incisor at a mean age of 06.52±0.56 months. In the maxillary arch, the lateral incisor erupted at 07.92±0.62 months, the first molar at 13.51±1.12 months, the canine at 18.95±0.98 months, and the second molar at 28.05±0.94 months. In the mandibular arch, the lateral incisor erupted at 09.99±0.91 months, the first molar at 14.12±0.82 months, the canine at 16.22±0.51 months, and the second molar at 24.75±0.99 months [Table/Fig-1].

Tooth	Age (in months) of eruption		
Gender	Overall N=1025 (100%)	Male N=548 (53.47%)	Female N=477 (46.53%)
51.	06.52±0.56	06.62±1.21	06.83±1.12
52.	07.92±0.62	07.93±1.22	07.97±1.14
53.	18.95±0.98	19.48±0.94	*18.50±0.79
54.	13.51±1.12	14.07±0.86	*12.85±1.16
55.	28.05±0.94	28.69±0.83	*27.56±1.22
81.	06.05±1.12	06.05±1.16	06.04±1.68
82.	09.99±0.91	10.59±0.41	*09.70±1.32
83.	16.25±0.51	17.15±0.72	*15.46±1.28
84.	14.12 ± 0.82	14.73±0.72	*13.51±1.61
85.	24.75 ± 0.99	25.26±1.19	*24.43±1.73

[Table/Fig-1]: Mean±Standard deviation age in months of eruption of deciduous teeth in total sample.
*Early eruption compared to males

Comparison with the standard eruption table of Logan WGH and Kronfeld R revealed early eruption of the maxillary central incisor, lateral incisor, and first molar, with delayed eruption observed in the mandibular lateral incisor, first molar, and maxillary and mandibular second molars. The maxillary canine, mandibular central incisor, and mandibular canine were consistent with the findings of Logan WGH and Kronfeld R (1933) [Table/Fig-2] [10].

Tooth	Overall	Age (In months) according to Logan WGH and Kronfeld R 1933 [10]
51.	*6.52	7.5
52.	*7.92	9
53.	18.95	18
54.	*13.51	14
55.	$28.05	24
81.	6.05	6
82.	$9.99	7
83.	16.25	16
84.	$14.12	12
85.	$24.75	20

[Table/Fig-2]: Comparison of mean eruption age (Months) of deciduous teeth with standard Logan WGH and Kronfeld R eruption chart.
*Earlier eruption when compared to Logan WGH and Kronfeld R 1933
$ late eruption when compared to Logan WGH and Kronfeld R 1933

The sequence of eruption for the maxillary arch: 51-52-54-53-55. The sequence of eruption for the mandibular arch: 81-82-84-83-85. Overall sequence of eruption: 81-51-52-82-54-84-83-53-85-55. The sequence of eruption according to Logan WGH and Kronfeld R 1933 [10]: 81-82-51-52-84-54-83-53-85-55.

Gender variations in the mean ages of eruption of deciduous teeth: On comparing the eruption age of males and females, females showed early eruption in the maxillary canine, first molar, second molar, and mandibular lateral incisor, canine, first molar, and second molar. Maxillary central incisor, lateral incisor, and mandibular central incisor showed a similar age of eruption.

DISCUSSION

The present study revealed variations in the eruption timing and sequence of primary teeth compared to the findings of Logan WGH and Kronfeld R [10]. These deviations can be attributed to factors influencing tooth eruption, like geographical and environmental differences, dietary habits, cultural practices, industrialisation, and the prevalence of inter-religious and consanguineous marriages [8,17]. These inconsistencies in the sequence and timing of eruption underscore the need for population-specific eruption age references, particularly in a culturally diverse country like India.

Consistent with existing literature, the present study demonstrated that deciduous teeth generally erupted in a typical order in both

arches, suggesting a coordinated underlying mechanism [8,12]. However, incongruent with the findings of Logan WGH and Kronfeld R, a difference in the sequence of eruption was observed in the present study. Maxillary lateral incisors emerged earlier than mandibular lateral incisors, irrespective of gender. The eruption sequence observed in the current study aligns with that reported in other studies [3,8,12,15,18-26]. However, Gupta A et al., Madiraju G and Basavaraja S; Gunashekhar M and Tenny J reported findings more consistent with Logan WGH and Kronfeld R's chart [6,10,26,27].

Variations in the mean eruption age of deciduous teeth have been identified in numerous population groups [8,12,15,17-30]. Studying the dynamic pattern of eruption, primarily controlled by the genetic make-up and environment of the populations under study, becomes crucial [8]. The role of genetics has been previously highlighted by a high concordance rate in monozygotic twins [29].

A cross-sectional study design was preferred over a longitudinal design because it allows for the incorporation of larger samples, resulting in findings that are typical of the general population [30]. Additionally, cross-sectional research has a reduced chance of bias compared to a longitudinal study. Heidmann compared Karber's method and Probit analysis to determine the average age and sequence of tooth eruption in a cross-sectional study design and concluded that Probit analysis is better than Karber's method [31]. Hence, Probit analysis was used in this study to derive the age and sequence of deciduous dentition.

According to Heikkinen T et al., the length of time it takes for each distinct category of teeth to grow is directly correlated with the symmetry of tooth eruption [13]. The controlled intrauterine environment and the quicker calcification and development of deciduous dentition might mean that it is less unbalanced than the secondary dentition [12]. Since no difference in eruption time of deciduous teeth on the left and right sides has been reported, by convention, right-side arches were examined for the eruption of teeth.

Females showed early eruption ages for most deciduous teeth as compared to boys. The gender differences in the eruption of deciduous teeth have not been firmly proven; however, there was a general trend for teeth to erupt earlier in girls in both jaws in the current study. Ethnic characteristics have been suggested as a potential mediator of sex differences in tooth eruption [24,32]. Magnusson TE claimed that in females, deciduous teeth erupted earlier than in boys [33]; however, other studies, including Al-Jasser NM and Bello LL, Tanguay R et al., and Holman DJ and Jones RE, have claimed that in boys, deciduous teeth erupted earlier [1,24,34]. According to research by Soliman NL et al., and Vejdani J et al., boys develop their deciduous teeth later than girls do, with the exception of the first molars [3,32]. The research has been inconclusive in establishing a definite pattern of eruption and sequence of deciduous teeth classified by gender. In contrast to the present study, results have been reported by GunaShekhar M and Tenny J, who discovered that deciduous teeth erupted sooner in boys than in girls [27].

There was a significant early eruption of deciduous teeth in the study population when compared to the findings of Logan WGH and Kronfeld R [10]. Since the eruption of teeth represents a developmental milestone, there is a need to amend the reference age of eruption for this group. India is home to roughly one-fifth of the world's population and has vast cultural and lifestyle differences relative to Western or developed nations. This difference can be attributed to diet, socio-economic status, climate, environment, and fluoride concentration in drinking water [35-37].

In Indian children, there is a discernible variation in the time of deciduous dentition eruption. Other studies conducted in India have reported a more delayed eruption time compared to the current study [Table/Fig-3] [8,17-19,26-28]. India's diverse population and ethos possibly explain this variation. Comparing to studies done in neighbouring countries of the region, delayed eruption of deciduous teeth has been reported in a study conducted in Nepal [6]. Between 1962-2022, several studies have been done across the globe [1,3,6,12,15,20,23-25,38,39]. Indian children in the current study have shown earlier eruption than that of other Western, Middle Eastern, European, and Asian countries, as shown in [Table/Fig-4].

The conclusion supports the necessity for a larger-scale study to be done, adjusting for the impact of diverse ethnic origins and socio-economic situations, especially for a multi-ethnic country like India. In light of this, careful generalisation of the study's findings to the Indian population is possible. When comparing studies that

City of study		Vadodara 2022		Banglore 2018 [26]		Lucknow 2018 [8]		Bhopal 2017 [17]		Jharkhand 2016 [18]		Manglore 2014 [28]		Hyderabad 2010 [27]		Patiala 2004 [19]	
	Author name	Aishwarya V Antala et al., (Current study)		Madiraju G and Basa-varaja S		Kariya P et al.,		Verma N et al.,		Vinod K et al.,		Rao A et al.,		Gunashekhar M and Tenny J		Singh K et al.,	
	Sample size	1025		954		1606		1601		60		565		135		126	
Arch	Teeth	Age of eruption (In months)															
Gender		M	F	M	F	M	F	M	F	M	F	M	F	M	F	M	F
Maxillary	Central incisor	06.62	06.83	12.1	12.3	09.67	09.81	08-13	08-13	10.4	09.91	12-17	12-15	11.88	12.00	09.84	09.0
	Lateral incisor	07.93	07.97	13.4	14.0	11.18	12.04	13-14	13-14	11.38	12.35	13-18	12-18	13.35	13.56	09.96	09.96
	Canine	19.48	18.50	21.5	21.8	18.11	19.21	18-24	19-23	19.14	20.27	24-28	24-29	21.04	21.17	19.32	18.96
	First molar	14.07	12.85	18.2	17.1	14.41	15.08	15-18	15-19	15.05	15.61	18-25	18-23	17.28	17.09	15.48	15.60
	Second molar	28.69	27.56	29.1	28.8	27.45	28.28	24-30	23-30	28.12	26.91	33-19	34-39	29.29	27.81	27.96	27.96
Mandibular	Central incisor	06.05	06.04	10.2	10.4	08.15	08.43	08-12	08-11	08.85	08.85	12-15	12-13	10.86	10.97	07.92	08.52
	Lateral incisor	10.59	09.70	13.3	13.0	13.80	14.37	13-14	14-15	13.25	13.25	14-21	14-21	12.55	12.55	10.20	11.04
	Canine	17.15	15.46	22.0	22.4	19.87	21.45	19-24	19-23	22.12	23.12	23-29	24-28	22.18	22.35	19.32	18.96
	First molar	14.73	13.51	19.2	18.5	15.92	16.60	15-18	16-19	17.03	16.54	21-23	22-25	19.00	18.94	15.12	14.28
	Second molar	25.26	24.43	27.6	27.1	26.31	27.35	24-30	24-30	25.79	26.48	34-36	34-36	26.82	27.53	27.72	27.60

[Table/Fig-3]: Comparison of mean age of eruption of current study with different studies done in India.
M: Male; F: Female

City of study		Vadodara India 2023	Romania 2022 [20]	Jordan 2015 [15]	Egypt 2011 [3]	Australia 2010 [12]	Nigeria 2008 [38]	Nepal 2007 [6]	Saudi Arabia 2003 [1]	Korea 2001 [22]	Spain 1994 [23]	Canada 1984 [24]	Iraq 1981 [39]	Sweden 1962 [25]
	Author	Aishwarya V Antala et al., (Current study)	Ogodescu E et al.,	Al-Batayeh OB and Shaweesh A	Soliman NL et al.,	Woodroffe S et al.,	Folayan M et al.,	Gupta A et al.,	Al-Jasser M and Bello LL	Choi NK and Yang KH	Ramirez O et al.,	Tanguay R and Temir-jian A	Baghdady VS and Ghose LJ	Lyell L et al.,
	Sample size	1025	70	1988	1132	207	1013	501	728	567	114	195	1017	171
Arch	Teeth	Age of eruption (In months)												
Maxillary	Central incisor	06.83	09.0	10.5	09.9	08.90	09.67	11.1	11.20	08.7	09.42	09.03	10.7	10.21
	Lateral incisor	07.97	10.6	13.0	12.6	10.30	12.46	13.2	13.20	09.7	10.66	10.19	10.1	11.35
	Canine	18.50	17.4	20.3	19.6	18.00	18.05	19.0	21.09	16.4	18.70	18.04	18.8	19.25
	First molar	12.85	15.7	15.5	17.1	15.10	16.01	15.3	16.89	15.4	15.28	15.13	16.3	16.01
	Second molar	27.56	24.7	27.5	27.2	27.60	26.12	25.7	28.21	25.5	26.77	27.48	26.0	29.09
Mandibular	Central incisor	06.04	07.7	08.2	08.0	07.00	07.72	10.0	08.47	06.3	07.20	07.18	09.2	08.02
	Lateral incisor	09.70	11.6	14.3	13.1	11.90	12.72	12.8	14.53	10.8	12.26	12.13	14.3	13.18
	Canine	15.46	17.8	20.4	20.0	18.40	18.49	21.4	21.07	16.9	19.03	18.34	19.0	19.72
	First molar	13.51	15.7	16.0	16.9	15.10	16.13	15.2	17.15	15.5	15.70	15.01	16.9	16.27
	Second molar	24.43	23.4	27.5	26.9	26.50	24.17	25.6	27.95	24.0	25.47	26.40	26.0	27.11

[Table/Fig-4]: Comparison of mean age of eruption of current study with different studies done Worldwide.

use different methods for data collection, analysis, and sample size, there are significant limitations. As a result, interpretations must also be made carefully.

Limitation(s)

The sample size was limited to a specific population, warranting larger cross-sectional or longitudinal studies across diverse population groups for more conclusive results. Additionally, other contributing factors such as socio-economic status, consanguinity of marriage, ethnicity, genetics, Body Mass Index (BMI), and birth weight were not considered in the present analysis, warranting further investigation.

CONCLUSION(S)

From the present study, the authors can conclude that the Gujarati population shows slightly earlier eruptions when compared to the standard eruption chart given by Logan WGH and Kronfeld R. Girls also showed earlier eruption than boys. Comparing the eruption age found in this study to those done in other parts of the country, the deciduous teeth showed early eruption age in the study population. The sequence of the eruption remains the same as that of other studies, which is A-B-D-C-E.

The results of the present study can be used to assess the dental age of the population of Gujarat state, and preventive protocols can be recommended based on the current results.

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