

Eruption Pattern of Permanentcanine and Premolar Teeth among School Children aged 10 to 12 Years in a Rural Area: A Cross-Sectional Study

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Abstract

Background: Forensic dentistry is a specialized field that evaluates dental evidence to identify unidentified individuals and missing persons in legal proceedings. Dental charts are compared with known records to establish identity. Accurate age determination is crucial, and dental age assessment is reliable up to 17 years. The study aims to analyze permanent teeth eruption patterns of canines and premolars in school children aged 10 to 12, contributing valuable insights for accurate age determination and identification in legal cases. The research seeks to aid the interest of justice in criminal, civil, and employment-related scenarios by understanding dental eruption patterns in this age group.

Methods: This was across-sectional study conducted among the school children of south Kerala belonging to age group of 10-12 years. Eruption pattern of permanent canines and premolars of 562 subjects were recorded and analyzed using SPSS software.

Conclusion: Sequence of eruption pattern of permanent canines and premolars were compared and it was observed with statistical significance that eruption of canine precedes the eruption of second premolars. All the teeth erupted earlier in females compared to males. There was a significant relation with reduced body mass index and delayed eruption of teeth.

KeyWords: Eruption pattern; Canines; Premolars; school children, Body Mass Index (BMI)

Introduction

Forensic dentistry is a specialized area within dentistry and forensic science that plays a critical role in legal proceedings by utilizing dental evidence to aid in identifying unidentified individuals, missing persons, and victims of mass fatality incidents¹. This

involves comparing the dental structures of the victim with dental records of known individuals, obtained from sources such as private dental offices, prison, military dental databases, investigating agencies etc. Dental identification is considered reliable due to the durability of teeth, even in decomposed or mutilated bodies, making them lasting remains that can be used

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for accurate age determination and identification. Dental charts, containing details of dental eruption, growth, diseases, and restorations, can establish identity with a high degree of certainty, similar to comparing fingerprints. Teeth, both deciduous and permanent, are relatively indestructible due to their mineralization, making dental age assessment possible even in challenging cases.²

Age determination is a pivotal factor in determining the severity of crimes and appropriate punishments. In Indian Penal Code (IPC), certain sections consider the age of the accused and the victim, such as Section 82, which exempts children under 7 years from criminal responsibility, and Section 83, which acknowledges that children aged 7 to 12 years may lack the maturity to understand the consequences of their actions. The age range of 10-12 years is significant as offenses against individuals in this group are frequently reported. Accurate age determination is essential in various legal scenarios, including criminal cases, civil procedures like marriage and organ donation, and employment-related matters. Dental age assessment is a convenient and reliable method, particularly up to 17 years of age³.

The study aims to contribute valuable information to the field of forensic dentistry by analyzing the dental eruption patterns of premolars and canines, as well as their relationship to gender, age, and nutritional status in school children aged 10 to 12 years. By understanding these patterns, it can provide insights that help determine age and identity, thereby serving the interest of justice in legal proceedings.

Materials and Methods

A cross-sectional study was conducted at SDV Government Upper Primary School, Neerkunnam, Alappuzha district, Kerala during the year 2015. The study included school children aged 10-12 years who met specific inclusion criteria, such as ascertained birth certificates, no history of major dental interventions, and no documented or apparent nutritional deficiencies or illnesses. All children from class v to vii standard, about 562 (280 boys and 282 girls), were included in the study. Approvals were obtained from the Institutional Research Committee and Institutional Ethical Committee. Data collection

started after obtaining, informed written consent from the school's head, and assent from the students.

Children who had completed 10 years but not 11 years were taken as **Group I** and those who had completed 11 years but not 12 years were taken as **Group II**. The groups were subdivided as follows: **Group I B** (Boys 10-11 years), **Group I G** (Girls 10-11 years), **Group II B** (Boys 11-12 years), and **Group II G** (Girls 11-12 years). The study involved examinations of each participant for developmental defects, nutritional deficiencies, and a history of surgical intervention or trauma. Height and weight were measured using standard methods, followed by dental examinations using a dental mirror and torchlight. Teeth eruption was recorded when the crown's tip penetrated the gum margin. Additional dental characteristics, like Carabelli's cusps, incisor shape, and ectopias (Buccal/Palatal), were also documented.

Data were entered into Microsoft Excel and analyzed using SPSS version 16.0 software. Mean and standard deviation summarized quantitative variables, while frequency and proportion summarized qualitative variables. Eruption patterns of premolars and canines were compared with age, gender, and BMI, and Chi-square test used to assess statistical significance.

Results and Discussion

A total of 562 school children aged 10-12 years were assessed for eruption pattern of individual teeth, this included 274 children who completed 10 years and 288 children who completed 11 years. The eruption pattern was analyzed under six headings: Upper First Premolar(UFPM), Lower First Premolar (LFPM), Upper Second Premolar (USPM), Lower Second Premolar (LSPM), Upper Canine(UC), Lower Canine(LC). It was observed that out of all subjects studied 92.9% (n=522) had erupted Lower first premolar, 92.0% (n=517) had erupted Upper first premolar, 90.7% (n=510) had erupted Lower canine, 69.0% (n=388) had erupted Upper canine, 59.1% (n=332) had erupted Lower second premolar and 52.8% (n=297) had erupted Upper second premolar.

Dental eruption patterns:

The assessment of the dental eruption showed following findings. (Table 1)

- (i) **First premolars:** In Group I (10-11years), over 80% of children had erupted Upper first premolars (84.7%, n=232) and Lower first premolars (88.4%, n=242). In Group II (11-12 years), more than 90% had erupted Upper first premolars (95.6%, n=285) and Lower first premolars (97.2%, n=280).
- (ii) **Second premolars:** In Group I (10-11 years), only a small proportion of children had erupted upper second premolars (29.2%,

n=80) and lower second premolars (35.8%, n=98). In contrast, a significantly larger number of children in Group II (11-12 years) had erupted upper second premolars (75.4%, n=217) and lower second premolars (81.3%, n=234).

- (iii) **Canines:** In Group I (10-11 years), only 52.6% (n=144) had erupted upper canines, while 83.3% (n=228) had erupted lower canines. In contrast, the proportion of children in Group II (11-12 years) with erupted canines was significantly higher, with 84.7% (n=244) having erupted upper canines and 97.9% (n=282) having erupted lower canines.

Table 1: The eruption pattern of individual teeth according to age and gender-wise categories.

Age and gender group	UFPM	LFPM	USPM	LSPM	UC	LC
	Erupted	Erupted	Erupted	Erupted	Erupted	Erupted
	n (%)	n (%)	n (%)	n (%)	n (%)	n (%)
Group I G (n=135)	116 (85.90)	124 (91.90)	40 (29.60)	48 (35.60)	79 (58.50)	117 (86.70)
Group I B (n=139)	116 (83.50)	118 (84.90)	40 (28.80)	50 (36.00)	65 (46.80)	111 (79.90)
Group II G (n=147)	146 (99.30)	143 (97.30)	111 (75.50)	119 (81.00)	128 (87.10)	144 (98.00)
Group II B (n=141)	139 (98.60)	137 (97.20)	106 (75.20)	115 (81.60)	116 (82.30)	138 (97.90)
Total (n=562)	517 (92.00)	522 (92.90)	297 (52.80)	332 (59.10)	388 (69.00)	510 (90.70)

The gender distribution in Group I (10-11years) showed a higher proportion of dental eruption in girls compared to boys except for Lower Second Premolars. In Group II (11-12 years), girls had a higher proportion of erupted teeth in the case of upper first premolar, lower first premolars, upper second premolar, and upper canine; while boys had a higher proportion in lower second premolar and lower canine (Table 1).

Comparison of dental eruption with different factors.

In children aged 10-12 years, comparing teeth

eruption by gender revealed a higher proportion of females with erupted teeth (first premolars, second premolars, and canines) compared to males. However, this gender difference was statistically significant only for Upper Canine. Specifically, 73.4% of females had erupted Upper Canine, while 64.6% of males did, with a statistically significant difference ($p < 0.025$). Bivariate analysis showed that children in Group II (11-12 years) had a higher proportion of erupted teeth (first premolars, second premolars, and canines) compared to those in Group I (10-11 years), and this difference was statistically significant ($p < 0.001$). (Table 2).

Table 2: Comparison of dental eruption status with sex and age categories

Name of the teeth	Variable category		Dental Eruption status		P value
			Unerupted	Erupted	
UFPM	Sex	Female (n=282)	20 (7.1)	262 (92.9)	0.423
		Male (n=280)	25 (8.9)	255 (91.1)	
	Age	Group I (n=274)	42 (15.3)	232 (84.7)	<0.001
		Group II (n=288)	3 (1.0)	285 (99.0)	

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LFPM	Sex	Female (n=282)	15 (5.3)	267 (94.7)	0.096
		Male (n=280)	25 (8.9)	255 (91.1)	
	Age	Group I (n=274)	32 (11.7)	242 (88.3)	<0.001
		Group II (n=288)	8 (2.8)	280 (97.2)	
USPM	Sex	Female (n=282)	131 (46.5)	151 (53.5)	0.739
		Male (n=280)	134 (47.9)	146 (52.1)	
	Age	Group I (n=274)	194 (70.8)	80 (29.2)	<0.001
		Group II (n=288)	71 (24.7)	217 (75.3)	
LSPM	Sex	Female (n=282)	115 (40.8)	167 (59.2)	0.944
		Male (n=280)	115 (41.1)	165 (58.9)	
	Age	Group I (n=274)	176 (64.2)	98 (35.8)	<0.001
		Group II (n=288)	54 (18.8)	234 (81.2)	
UC	Sex	Female (n=282)	75 (26.6)	207 (73.4)	0.025
		Male (n=280)	99 (35.4)	181 (64.6)	
	Age	Group I (n=274)	130 (47.4)	144 (52.6)	<0.001
		Group II (n=288)	44 (15.3)	244 (84.7)	
LC	Sex	Female (n=282)	21 (7.4)	261 (92.6)	0.138
		Male (n=280)	31 (11.1)	249 (88.9)	
	Age	Group I (n=274)	46 (16.8)	228 (83.2)	<0.001
		Group II (n=288)	6 (2.1)	282 (97.9)	

*Chi-Square test

Comparing BMI with teeth eruption revealed significant differences. Erupted teeth were associated with higher BMI compared to unerupted teeth

($p < 0.001$). The most notable difference was observed for lower first premolars, with a mean BMI difference of -2.37 kg/m^2 . (Table 3).

Table 3 : Comparison of eruption status of teeth with BMI categories

Name of the teeth	Eruption status	N	BMI (kg/m^2)			P value
			Mean	Std. Deviation	Mean difference	
UFPM	Unerupted	45	16.46	1.74	-2.06	< 0.001
	Erupted	517	18.52	2.18		
LFPM	Unerupted	40	16.16	1.30	-2.37	< 0.001
	Erupted	522	18.53	2.18		
USPM	Unerupted	265	17.40	1.73	-1.82	< 0.001
	Erupted	297	19.22	2.25		
LSPM	Unerupted	230	17.16	1.71	-2.03	< 0.001
	Erupted	332	19.19	2.14		
UC	Unerupted	174	17.05	1.72	-1.89	< 0.001
	Erupted	388	18.94	2.16		
LC	Unerupted	52	16.47	1.61	-2.08	< 0.001
	Erupted	510	18.55	2.18		

*student's t-test

Comparison between eruption of premolars and canines

Among 324 subjects, erupted canines and premolars were observed, while both remained unerupted in 44 subjects. Notably, 186 individuals had

erupted canines without premolar eruption, while only 8 subjects displayed erupted premolars without canines. The predominance of canine eruption was found to be statistically significant (p-value <0.001). (Table 4).

Table 4: Comparison between eruption of premolars and canines

		Canines		P-value*
		Unerupted n (%)	Erupted n(%)	
Premolar	Unerupted (n=230)	44 (19.1)	186 (80.9)	< 0.001
	Erupted (n=332)	8 (2.4)	324 (97.6)	
Total		52	510	

*McNemar Test

Comparison of eruption of Canines between the upper and lower jaws

Both upper and lower permanent canines had erupted in 381 subjects, while both were unerupted in 45 subjects. Additionally, 129 subjects exhibited erupted lower canines with unerupted upper canines,

and only 7 subjects had erupted upper canines with unerupted lower canines. These findings indicate that the eruption of lower canines precedes that of upper canines, which was statistically significant (p-value <0.001). (Table 5)

Table 5: Eruption pattern of Upper Canine (UC) compared to Lower Canine (LC).

		LC		P-value*
		Unerupted n (%)	Erupted n(%)	
UC	Unerupted (n=174)	45 (25.9)	129 (74.1)	<0.001
	Erupted (n=388)	7 (1.8)	381 (98.2)	
Total		52	510	

*McNemarTest

Prevalence of Caries among the study group.

In the 10-12-year age group, 15.8% (n=89) of children exhibited dental caries. Dental caries prevalence was higher in Group I (10-11 years) at 23% (n=63) compared to Group II (11-12 years) at 9.0% (n=26). Males had a higher prevalence of dental caries (17.1%, n=48) than females (14.5%, n=41). A significant association was observed between dental caries presence and BMI, with children having dental caries having a lower mean BMI (mean=17.38 kg/m², sd=1.82 kg/m²) compared to those without dental caries (mean BMI=18.54 kg/m², sd=2.24 kg/m²), with a p-value of <0.001.

Other morphological features- Carabelliscus p was observed in 21 out of 562 subjects. Ectopias present only in four subjects.

Discussion

The present study aims at providing latest information regarding the eruption pattern of teeth as the overall socioeconomic and nutritional status of the people is improving from time to time. Hence latest studies and collection of new sets of data are very important as some changes may occur in the eruption pattern from time to time. The eruption pattern of permanent set of teeth in humans provides information regarding the age of the individual.

The mandibular (Lower) permanent teeth tend to erupt before maxillary (upper) teeth. The conventional teaching is that, age of eruption of permanent canines is 11-12 years and second premolars 10-12 years. The **first premolars** follow the **Upper** laterals incisors in sequence when the child is about 10 year old; the **Lower canines** (cuspids) often appear at the same time. The **second premolars** follow during the next year, and then the **Upper canines** follow. Usually, the second molars come in when the individual is about 12 years of age; they are posterior to the first molars and are commonly called **12-year molars**. The **Upper** canines occasionally erupt along with the second molars, but in most instances of normal eruption, the canines precede them¹⁴.

Dental age assessment based on eruption pattern is very useful in assessing the age below 14 years and it will not do any harm to the subjects as it is a noninvasive procedure⁵. Forensic age estimations in the living are requested in relation to age thresholds in criminal investigations, during immigration procedures and for civil purposes. Previous studies on eruption sequence and timings of permanent teeth were conducted in different countries in different time periods and in different ethnic groups. The results from those studies showed variations in eruption pattern of premolars and permanent canines.

In the present study 562 school children of age group 10 to 12 years belonging to almost same socioeconomic group and geographical strata were taken as study samples and data collected was analyzed with statistical software. Their exact age is known as they from birth certificates. Hence the eruption timings of teeth can be correlated with actual age. Lower first premolar is the most prevalent tooth in the study subjects, 522 out of 562 subjects (92.9%) had erupted Lower first premolar, 517 (92.0%) had erupted Upper first premolar, 510 (90.7%) had erupted Lower canine, 388 (69.1%) had erupted Upper canine, 332 (59.1%) had erupted Lower second premolar and 297 (52.8%) had erupted Upper second premolar which is the least prevalent tooth in the age group often to twelve years.

In the comparison of permanent canine and premolar eruption sequences, 186 subjects exhibited erupted canines before premolars, while only 8 subjects had erupted premolars with unerupted

canines. This indicates a higher occurrence of canines erupting before premolars. This pattern was observed in both jaws and was statistically significant. These findings align with similar studies.⁶⁻⁸ An Australian study revealed a sequence where, in the upper jaw, the first molar emerged first, followed by the central incisor, lateral incisor, first premolar, canine, second premolar, and second molar. In the lower jaw, the first molar was followed by the central and lateral incisors, canine, first premolar, second premolar, and second molar.⁹ This order differed from studies in other countries and recent research, suggesting potential racial and ethnic variations in eruption patterns. Another European study in 2004 noted a change in the sequence, with the canine erupting before the second premolar.⁶ A study among Delhi boys in 2002-03 confirmed a change in eruption patterns. They observed median eruption ages of maxillary canines at 9.9 years, mandibular canines at 9.7 years, maxillary first premolar at 9.7 years, mandibular first premolar at 10.1 years, maxillary second premolar at 10.6 years, and mandibular second premolar at 10.8 years.⁷ These findings contradicted the conventional belief that permanent canines only erupt after both premolars. A study in Kerala examined school children aged 10-12 years from seven randomly selected schools, found that canines precede the eruption of second premolars.⁸ Another study conducted in Karnataka, involving of 5007 school children concluded that permanent canines precede the eruption of second premolar in lower jaw.¹⁰ The study revealed that all permanent teeth generally erupt earlier in females, and the presence of dental caries accelerates permanent tooth eruption. These findings highlight variations in eruption patterns and timings.

Eruption pattern in sexes

All permanent canines and premolars were observed to erupt earlier in females, in accordance with the eruption pattern described in various literatures. However, significant difference in eruption pattern was observed in the case of the upper canine.

Eruption pattern in relation to Body Mass Index

It has been observed that a delayed eruption of permanent canines and premolars is associated with a reduced Body Mass Index (BMI), which is consistent

with the findings of similar study conducted in Kerala.⁸

Conclusion

Forensic dentistry, forensic odontology and forensic odontostomatology are terms used for that branch of forensic medicine, which in the interests of justice deals with the proper handling and examination of dental evidence by its proper evaluation and presentation.² Simple tooth counts and eruption pattern aid in the determination of biological age of living persons along with radiological examination, especially for the young individuals for legal purposes.

This study led to the following observations:

1. The eruption pattern of the first premolars in both jaws corresponds with earlier studies.
2. Permanent canines erupted before second premolars, a statistically significant and contrary finding to conventional beliefs.
3. Mandibular canines erupted earlier than maxillary canines, (this difference was statistically significant).
4. Eruption timings of all the studied teeth were earlier in females, however, statistical significance was observed in the case of maxillary canines.
5. A significant association was found between delayed tooth-eruption, presence of caries, and reduced body mass index.

The median age of eruption for permanent canines and premolars could not be determined due to the cross-sectional nature of the study, wherein observations were conducted at a single point in time. Additionally, the study did not incorporate radiological assessment of tooth eruption, which could result in a tooth on the verge of erupting being categorized as unerupted. Conducting a longitudinal study in conjunction with radiological assessments of tooth eruption would provide more precise eruption timings and mean ages for the permanent canines and premolars.

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