Education

Comparative study of first permanent molar emergence in children

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Abstract

Tooth eruption is a genetically regulated and dynamic component of odontogenesis, involving the transition of a tooth from its bony crypt to the occlusal plane, where it begins to function and contributes to the establishment of occlusion and caries risk assessment. This cross-sectional study investigated the eruption timing of the first permanent molars (FPM) in Benghazi children aged 5–7 years. A total of 381 children were included in this cross-sectional study. The mean age was 6.30 ± 0.69 years, with a nearly equal gender distribution of 197 (51.7%) males and 184 (48.3%) females were randomly selected from various primary schools, with parental informed consent. Clinical assessment classified the eruption status of FPM as partially erupted, fully erupted, or un-erupted. The Wilcoxon signed-rank test was applied to compare eruption timing between mandibular and maxillary teeth as well as right and left sides, while the Mann–Whitney test was used to examine gender differences. Results indicated that mandibular molars erupted significantly earlier than maxillary molars, with no notable difference between right and left sides. Additionally, females demonstrated earlier eruption compared to male. In summary, Libyan children exhibit a global eruption pattern of first permanent molars, characterized by earlier eruption of mandibular teeth relative to maxillary teeth and earlier eruption in females compared to males. These findings highlight the importance of early monitoring and preventive care, while also providing region-specific insights that enrich the global understanding of dental development.

Keywords: Permanent teeth, Tooth eruption, Key of occlusion, Time of eruption

Introduction

The timing of the first permanent molar emergence (FPM) implies significant aspect of dental development and denote critical phase in establishing the occlusion of permanent dentition. Its timing, sequence, and pattern profoundly impact on jaws growth and have substantial clinical significance in diagnosing occlusion, planning orthodontic treatment, physiologic age estimation and delivering preventive dental care [1]. The eruption of teeth is a complicated biological event that can be influenced by several factors, rendering it challenging to establish a precise, universal pattern [2]. These factors can be generally grouped into systemic and local influences, including climate, age, weight, socioeconomic status, ethnicity and genetic predisposition [3-5]. Numerous conditions may interrupt eruption of the first permanent molar one of them is ectopic eruption which is defined as deviation from the anticipated eruption route [6-9]. Other pathologies can affect FPM during the mixed dentition stage, causing delay of their eruption or mechanical failure of eruption which may lead to malocclusion or significantly impaction [10, 11]. The first permanent molars naturally erupt between ages 6 and 7 years, for this reason usually referred as “six-year molars”. According to several epidemiological studies, there is a consistent sequence of eruption placing the FPM as the first permanent tooth to erupt in the oral cavity. In the upper arch, the sequence is: first molar, central incisor, then lateral incisor, while in the lower arch, the first molar may erupt before or after the central incisor [12]. The average age for eruption of the lower first permanent molar is around 6.0 years, with an average range between 5.8 and 6.2 years [13]. However, it might be earlier than this age at about 4.09 in some population. This global analysis also reveals systematic differences based on heritage, where permanent teeth eruption generally found to be earliest in European populations, followed by African and Asian cohorts [14]. Multiple studies reported that the chronology of permanent teeth eruption exhibit notable sexual dimorphism as girls tend to experience earlier eruption timing, including the permanent first molars, compared to boys by an average of four to six months [15-18]. The overall eruption sequence is similar for both sexes, and there are no statistically significant differences existed when comparing the eruption time of contralateral teeth of each jaw [17-19]. However, several previous studies documented arch- specific differences, where mandibular teeth tend to erupt slightly earlier than their homologous maxillary counterparts [19-22].

The eruption of the FPM represents a critical milestone in dental development, serving as the cornerstone for establishing functional occlusion and acting as a reliable indicator in dental age assessment. This study underscores the significance of monitoring FPM eruption, contributing valuable region-specific evidence to the broader understanding of dental development and reinforcing the importance of early clinical attention in safeguarding oral health outcomes.

Methodology

Cross-sectional observational study design aimed at assessing the age of clinical emergence and examining sexual and arch-specific differences in the FPM. This design was chosen for its effectiveness in delivering a strong representation of eruption status throughout the sampled population. A convenient sample was selected from children who attending various kindergartens and primary schools (both government and private run schools). In this study, a total of 381 healthy Libyan children (184 girls and 197 boys) aged between 5 -7 years were randomly selected for examination. The current study approved by scientific research ethics committee of Faculty of Dentistry, University of Benghazi under approval number (093). Consent was acquired from the school director. Written informed consent was also secured from the children's parent. The clinical assessment of children was conducted by a single experienced examiner using disposable tongue depressors and a mouth mirror in sufficient natural lighting. A tooth was deemed ‘‘partially erupted’’ if any portion of it broke through the oral mucosa, and fully erupted if the entire crown was visible in the oral cavity.

Eligibility criteria

Children were eligible if they were Libyan, fell within the designated age range, had no documented history of systemic conditions that might notably impact dental development (e.g., endocrine disorders), and did not suffer from any severe congenital anomalies affecting the craniofacial structure. Children receiving active orthodontic treatment or those displaying uncooperative behavior during the clinical assessment were excluded from the study.

Statistical analysis

The data were collected and statistically analyzed using Statistical Package for the Social Sciences (SPSS) software computer program, and simple descriptive statistics. Wilcoxon signed-rank and the Mann-Whitney U tests were used in comparison. (p-value <0.05) was considered significant.

Results

A total of 381 children aged 5-7 years were included in this cross-sectional study. The mean age was 6.30 ± 0.69 years, with a nearly equal gender distribution of 197 males (51.7%) and 184 females (48.3%). Gender distribution was relatively balanced across all age groups, with males comprising 50.0%, 50.2%, 54.4%, of the 5, 6, and 7year-old groups, respectively (Table 1). The majority of participants were 6 years old (n=209, 54.9%), followed by 7 years old (n=136, 35.0%), 5 years old (n=36, 9.4%).

Table 1: Descriptive statistics of the sample

Subcategory	Number	Males n	Females n	Gender distribution percentage
Total Sample Size	381 patients	197	184	M: (51.7%),
				F: (48.3%)
Age 5 years	36 patients	18	18	M: (50.0%)
				F: (50.0%)
Age 6 years	209 patients	105	104	M: (50.2%)
				F: (49.8%)
Age 7 years	136 patients	74	62	M: (54.4%)
				F: (45.6%)

Analysis of individual teeth revealed varying eruption patterns across the four first molars. The lower arch demonstrated higher eruption rates compared to the upper arch. where the lower right first molar (LR6) and the lower left first molar (LL6) showed higher eruption rate of 59.1% and 59.8% compared with those of the upper arch upper right first molar (UR6) and upper left first molar (Ul6) with eruption rate of 50.9 % and 51.4% (Table 2).

Table 2: Eruption rate of each molar

Tooth Position	Fully Erupted n (%)	Partially Erupted n (%)	Not Erupted n (%)	Rate of eruption (%)
Upper Right 6	156 (40.9%)	38 (9.9 %)	187 (49.1%)	50.9 %
Upper Left 6	150 (39.4%)	46 (12.1%)	185 (48.6%)	51 %
Lower Right 6	172 (45.1%)	53 (13.9%)	156 (40.9%)	59.1 %
Lower Left 6	169 (44.4%)	59 (15.5%)	153 (40.1%)	59.84 %

Regarding the comparison between upper and lower arches, Wilcoxon signed-rank test was used for comparison, and the analysis revealed a statistically significant difference between upper and lower arch eruption rate (p = 0.01), indicating that the first molars in lower arch erupts significantly earlier than those in the upper arch even on each side separated (Table 3). The same test was used to compare the eruption status of contralateral molars, and the results shows no statistically significant difference between the right-side and left-side (p>0.05). The eruption of the first permanent molars shows remarkable symmetry across the right and left sides of the mouth (Fig 1 and Fig 2).

Table 3: Results of Wilcoxon Signed Rank Test for comparison between sides and arches

Side	Mean differences	*p*-value	Statistic	Interpretation
Upper vs Lower Arch	0.1287	0.01*	3150.5	Significant
UR6 vs UL6	0.0107	0.8	1509.0	No significant difference
LR6 vs LL6	0.0098	0.9	595.0	No significant difference
(UR6+LR6) vs (UL6+LL6)	0.0054	0.8	428.5	No significant difference

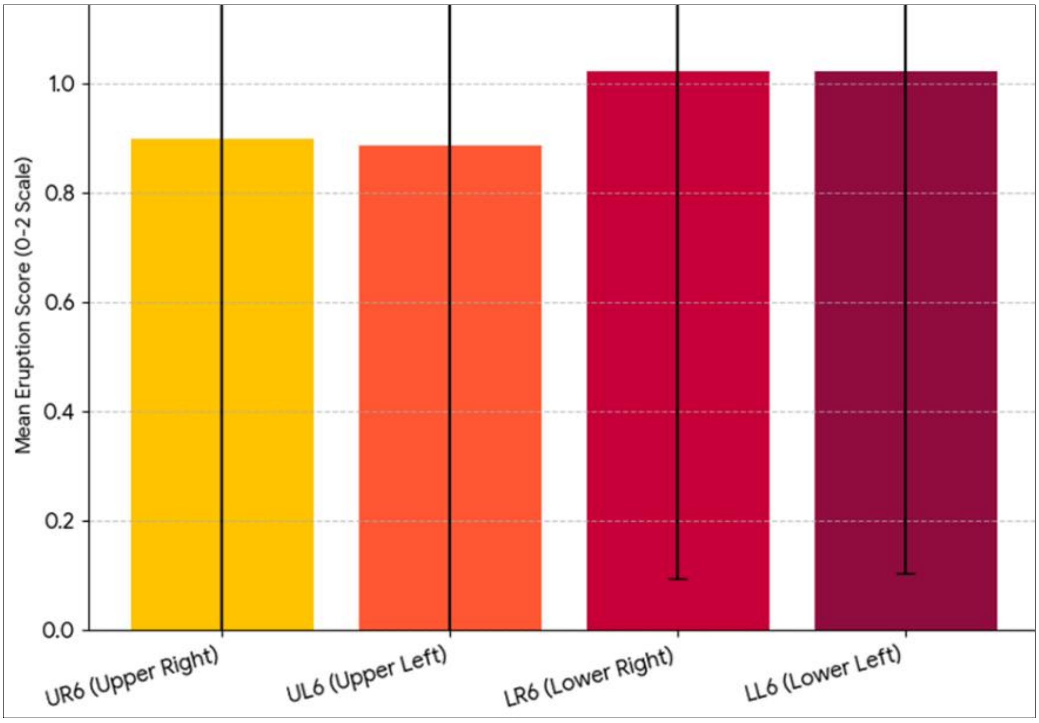

Fig 1: Shows comparison between upper and lower arches

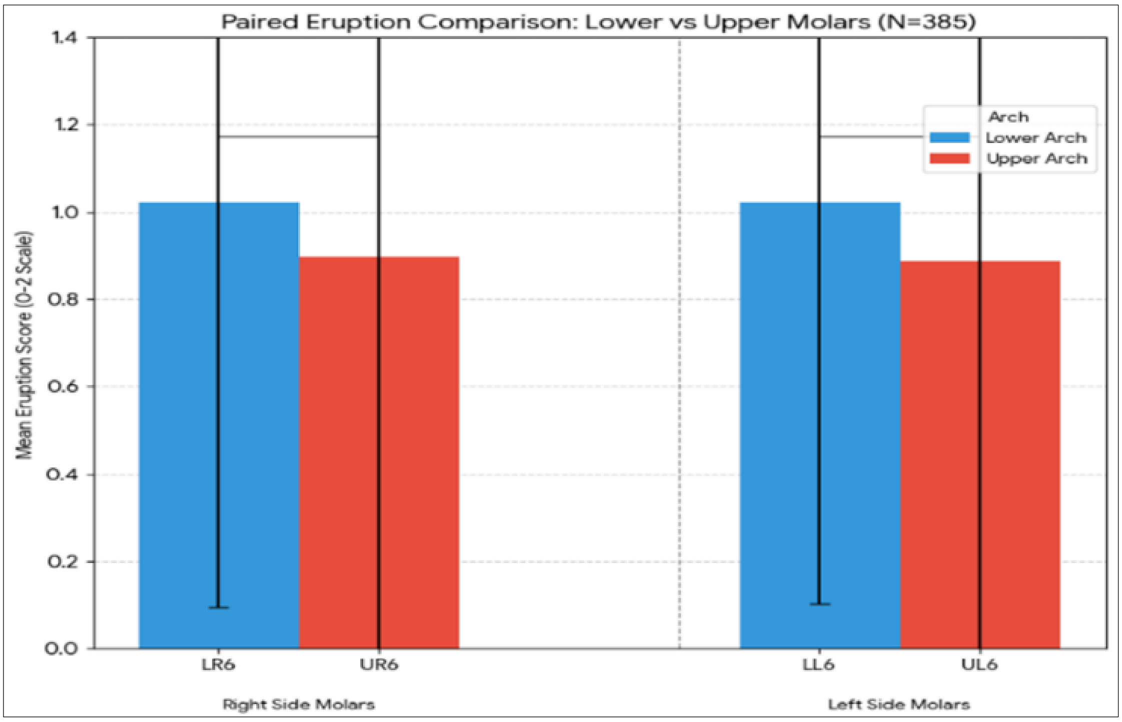

Fig 2: Shows comparison between right and left side

The Mann-Whitney U test was used for comparison sexual dimorphism in both arches and the results were statistically significant in upper and lower arches ($p = 0.02$) ($p = 0.01$) Respectively (Table 4). Females exhibit a significantly higher eruption rate in both the upper and lower arches compared to males, with the difference appearing slightly more pronounced in the lower arch ($p = 0.01$).

Table 4: Comparisons of eruption rate between male and female

Comparison	Test	Statistic	*p*- value	Significant	Effect size
Male vs Female (Upper)	Mann-Whitney U Test	15784	0.02	True	0.44
Male vs Female (Lower)	Mann-Whitney U Test	15458.5	0.01	True	0.43

Assessing gender differences in first molar eruption time, females demonstrated consistently higher eruption rates than males in both arches. For the upper arch, females showed a higher mean eruption score of (0.51 ± 0.45) compared to males (0.39 ± 0.45), with eruption rates of 45.4% and 35.3%, respectively. Similarly, in the lower arch, females achieved a mean eruption score of (0.56 ± 0.45) versus males (0.44 ± 0.46), with eruption rates of 51.4% and 38.6%, respectively (Table 5) Fig 3.

Table 5: Gender comparison statistic

Gender	Arch	N	Mean ± SD	Eruption rate (%)
Male	Upper	197	0.39 ± 0.45	35.3%
Male	Lower	197	0.44 ± 0.45	49.7%
Female	Upper	184	0.51 ± 0.45	45.4%
Female	Lower	184	0.57 ± 0.45	62.5%

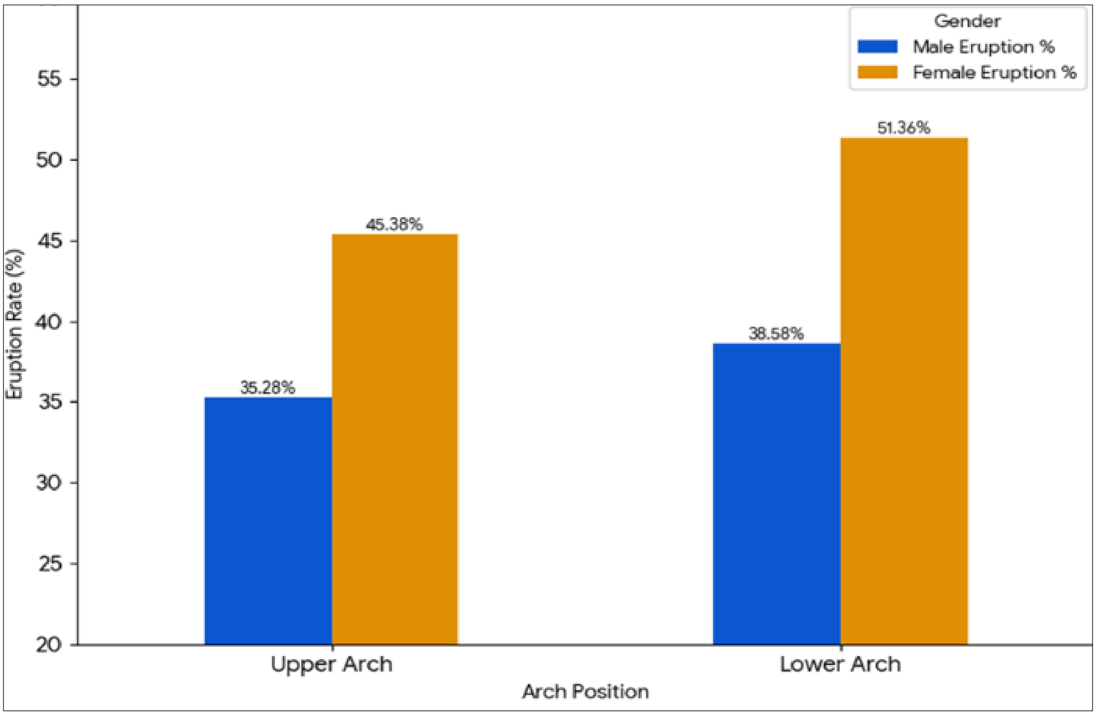

Fig 3: Shows eruption rate comparison by gender and arch

Regarding gender differences in each age group, female showed higher eruption rates in both upper and lower arch (66.9% &71.6%) than males (47.6% & 52.4%) at age 6, and this pattern continued at age 7, with females maintaining higher rates in both upper and lower arch (54% & 70.2%) compared to males (52% & 60.8%) Fig 4. Mann–Whitney tests was used for comparison within each age group and the finding indicate that male–female differences were not statistically significant at 5 and 7 years (more likely due to the small samples at those ages). However, at age 6 the results were statistically significant (p = 0.01) (Table 6). This parallels the overall finding that females tend to have slightly earlier eruption than males as they tended to have slightly higher mean counts than males in most age groups.

Table 6: Comparison of eruption status by gender within each age group

Age/Arch	Male mean score	Female mean score	U Statistic	*p*-value	Interpretation
5 years (Upper arch)	0.167	0.222	2661	0.7	No significant difference
5 years (Lower arch)	0.500	0.361	3572	0.7	Not significant difference
6 years (Upper arch)	0.852	1.197	70749	0.01*	Significant; females erupt earlier
6 years (Lower arch)	0.948	1.288	71890	0.01*	Significant; females erupt earlier
7 years (Upper arch)	0.912	0.960	33635	0.7	Not significant difference
7 years (Lower arch)	0.980	1.218	71405	0.1	Not significant difference

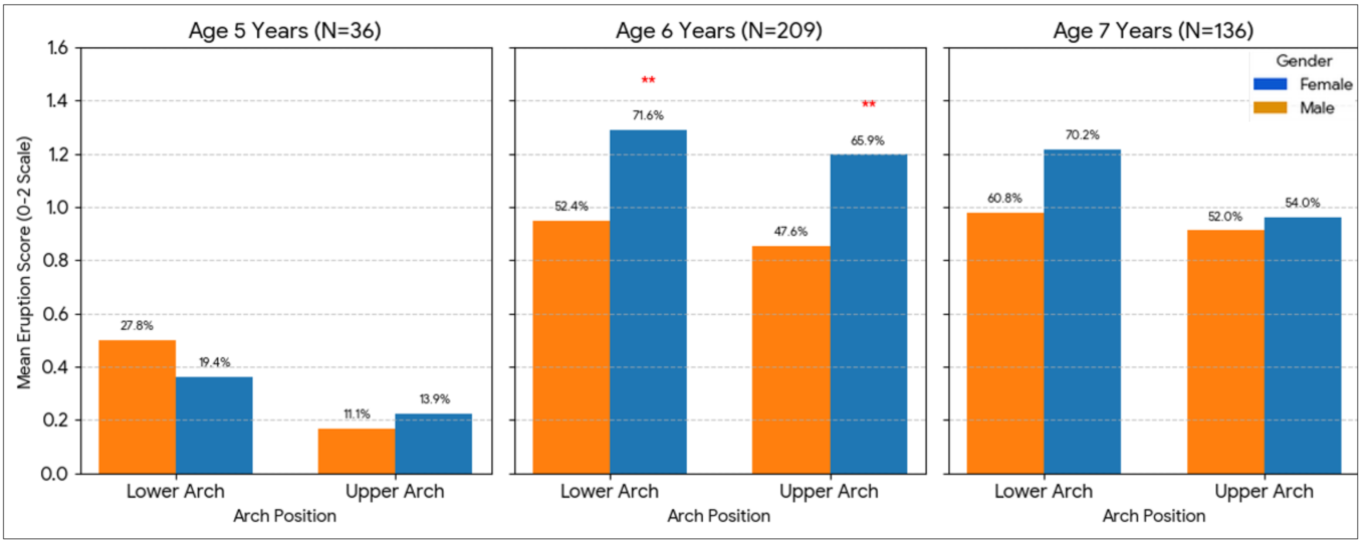

Fig 4: Shows eruption comparison between male and female (upper and lower arches) in each age group

Discussion

Tooth eruption is a multifactorial process influenced by genetics, nutrition, preterm birth, craniofacial morphology, and hormonal regulation [22]. The present study reported that the FPMs erupt at a mean age of 6.30 ± 0.69 years, with mandibular molars emerging earlier than maxillary molars, and females showing earlier eruption than males. In contrast, it was documented that the mandibular FPM erupt at 7.38 years in girls and 7.45 years in boys [23] which consistent with recent study findings [24]. More recent data indicated mandibular FPM eruption at 5.5 years, with earlier emergence in females, particularly in the lower jaw and on the right side (17). Conversely, earlier research observed no difference between jaws eruption time [25]. Several studies confirm that the first permanent lower molar is typically the earliest tooth to appear in the oral cavity [26-28].

Ethnic variation has also been documented: Caucasian children generally show delayed eruption compared with African and Caribbean populations [22, 29, 30]. Even within the same population, eruption timing can differ [31, 32] for example, Czech children differ significantly from Ghanaian children, whose teeth erupt earlier. It was reported that the mandibular FPM eruption just before age 5 in boys [22]. Such discrepancies may reflect biological, cultural, methodological, and sample-related differences that limit comparability.

Asymmetry in eruption patterns also varies. Gambian children showed no side preference [29], while Indian children exhibited earlier eruption of maxillary teeth on the right and mandibular teeth on the left, though differences were not statistically significant [27]. Similarly, the present study found no significant right–left differences in either sex. Nigerian data confirmed early mandibular FPM eruption, consistent with arch-specific variation in African populations [33], with mean ages slightly earlier than those reported by earlier investigator [34].

The consistent precedence of mandibular molars across populations suggests a stable biological pattern, likely linked to earlier mandibular development during embryogenesis. Sexual dimorphism has also been widely reported, with females erupting teeth earlier than males [35, 36]. Systematic reviews and multi-ethnic studies indicate that girls erupt permanent teeth 4-6 months earlier on average. Recent findings noted more erupted teeth in girls, though differences were not statistically significant [19], reinforcing the association between eruption timing and general somatic maturation. Regarding symmetry, previous studies found no significant differences between contralateral teeth [29, 37], though another study reported exceptions [38]. Understanding eruption chronology is critical for pediatric dentistry, orthodontic planning, and community health monitoring [30].

In Libyan children, mean eruption ages are comparable to European cohorts but slightly later than some Asian populations. Global analyses suggest European children erupt teeth earliest, followed by African and Asian groups. Early mandibular molar eruption may predispose to occlusal issues, underscoring the importance of preventive and interceptive orthodontics. Given the susceptibility of FPMs to caries soon after eruption, awareness of earlier emergence in females and mandibular arches is essential for targeted preventive care. Moreover, eruption timing remains a reliable marker for dental age estimation, with applications in forensic and pediatric contexts.

Conclusion

The study confirms that Libyan children follow the global eruption pattern of first permanent molars, with mandibular teeth erupting earlier than maxillary and females earlier than males. These findings reinforce the importance of early monitoring and preventive interventions, while also contributing region-specific data to the global literature on dental development.

Conflict of interest: Nil

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