Chronological Age Versus Corrected Age of First Tooth Eruption in Jordanian Premature Infants

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ABSTRACT

Objective: To evaluate the chronological and corrected age and the impact of neonatal factors on first tooth eruption of Jordanian premature infants.

Methods: A prospective study of 110 Jordanian preterm infants (gestational age < 37 weeks and birth weight < 2500g) who were born and attended the neonatal follow up clinic at Prince Hashim Ben Al-Hussein Military Hospital, Zarqa / East of Jordan. A first tooth eruption record including factors that might have an influence on teething were completed by the principal neonatologist and the parents of the enrolled infants, during the annual clinic visits.

Results: The study population consisted of 110 premature infants (50 males and 60 females) who were born at mean gestational age of 32.21 weeks + SD of 2.38 (Range was 28 to 37 weeks), mean chronological age 37.20 weeks + SD of 6.446 (Range was 24 to 48 weeks) and mean corrected age 29.45 weeks + SD of 5.55 (Range was 19 to 39 weeks) and mean birth weight 1551.82 grams + SD of 422.74 (Range was 850 to 2450 grams).
More normal eruption has been seen in subjects with birth weight (>1500 grams) than (<1500 gram) and gestational age (>32 weeks) than (< 32 weeks). There were great significant differences in birth weight and gestational age between normal and delayed groups when the chronological age rather than corrected age used (P< 0.05, Fisher's exact test). Introduction of total parenteral nutrition, breast milk, and full term formula to premature infants associated with early first tooth eruption (P< 0.05, Fisher's exact test).

Conclusion: Introduction of total parenteral nutrition, breast milk, and preterm formula to premature infants associated with early first tooth eruption. The significant difference between groups was mainly with chronological age rather than corrected age.

Key words: premature, infant, tooth eruption, chronologic age and corrected age.

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Introduction

World Health Organization (WHO) defines preterm birth as birth occurring before the 37th completed week of gestation and the prematurity had been defined by birth weight under 2500 grams.[1-2] Prematurely born infants have a short

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prenatal development period and predisposed to different neonatal and developmental problems. Main aetiological factors for premature birth remains unknown but the maternal and foetal diseases are the main predisposing factors. There are several systemic derangements that can interfere with the developing teeth, especially teeth that are at a critical stage of development at the time of the insult and not calcified or dimensionally complete at the time of birth.[3] Influence of preterm birth on teeth development and eruption has been investigated. Most of the studies reported that preterm babies' children have delayed primary and permanent teeth eruption.[3] The exact tooth eruption mechanism is still unknown. Many theories have been suggested to explain the eruption process. Root growth, dentine formation, proliferation of the dental pulp, the periodontal ligament, the connection between the enamel organ and the oral epithelium and the role of the dental follicle, including its innervations and blood supply, are considered to be crucial.[4-5]

Preterm Birth and Developing Dentition

Studies of preterm children have shown that the developing dentition may be affected at a time of an exceptionally early delivery. The prevalence of enamel defects in the deciduous[6-7] and permanent dentition[8] has been reported to be higher in premature infants. Different studies found that hypomineralization of the teeth have been thought to be associated with the systemic derangements of preterm birth such as nutritional problems,[9] neonatal infections[10] and metabolic disorders.[11] While dental defects arising from local causes tend to affect only single teeth or groups of teeth. Local traumatic factors associated with endotracheal intubation and laryngoscope during a critical period of tooth amelogenesis may also contribute to dental defects in the deciduous dentition. A close correlation exists between birth weight, dental defects and the intubation period, the prevalence of dental defects generally increasing with a longer period of orotracheal intubation.[8,12-13]

Importance of Deciduous Dentition

Healthy deciduous dentition is necessary for proper alignment, placing and occlusion of permanent dentition. The deciduous incisor teeth are functional in the mouth for approximately five years, while deciduous molars are functional for approximately nine years.[14-15] Calcification of deciduous teeth begins during the fourth month of fetal life, and by the end of sixth month all deciduous teeth have begun calcification. Like every other biological process, the time of calcification and eruption of the deciduous teeth is subject to several individual variants. This process may be affected in infants by their birth weight, however all deciduous teeth usually erupt between 24 and 40 months of age.

Timing of Deciduous Tooth Eruption

There is no agreement on the time of first tooth eruption in prematurely born infants. The timing of deciduous and permanent tooth eruption has sometimes been found to be delayed in prematurely born children.[12,16-20] It has also been reported that the maturation of both dentitions does not differ appreciably between preterm and full-term children.[21]

Factors related to delayed tooth eruption are thought to include the general delay in the growth development of preterm babies,[20] short gestation,[12-14,18] low birthweight,[17] and neonatal factors, including complications of prematurity, systemic disorders, duration of oral intubation, average weight gain / day,[19] Nutritional factors, postnatal weight gain and growth of the child may also affect the eruption of the deciduous teeth. Seow *et al*, 1988 showed that very low birth weight infants had significant retardation of dental eruption compared with low birth weight and normal birth weight infants.[14]

Corrected and Chronologic Ages

What is chronological age?

The baby's chronological age is the number of days, weeks, months or years today from his or her actual date of delivery, or birthday. This is the same method most of us use to calculate our own age. The chronological age is sometimes referred to as the "actual age".

What is corrected age?

Corrected age "corrects" for the baby's prematurity. Sometimes, you hear it referred to as "adjusted age" or "post conceptual age". It is calculated by starting with the chronological age and subtracting the number of weeks of

prematurity from that age. The formula is: (Chronological Age) - (Weeks or Months of Prematurity) = Corrected Age (Actual Age) (Corrected Age) (Adjusted or Post Conceptual Age) for example, if the baby was born at a gestational age of 28 weeks, you probably know that she was 12 weeks premature (a term pregnancy is 40 weeks; simply subtract your baby's gestational age from 40 weeks to find the number of weeks of prematurity). If the actual age is 6 months, then the corrected age would be: 6 months - 3 months = 3 months

Lunt 1974, Tanguay *et al*, 1984, and Rose et al, 1994 proposed that the first tooth erupts at the usual chronologic age in healthy premature infants,[22-23,24] where Seow *et al*, 1988, in their cross – sectional study, and Golden *et al*. 1981, in their prospective study.[14-18], showed that delayed teeth eruption in premature infants was no longer apparent when corrected rather chronologic ages were used to evaluate the time of first tooth eruption in premature infants The chronological teething age may be delayed in prematurely born children, but when corrected ages are used, tooth eruption is not delayed.[12-14,18-25] Individual differences may exist, however, and gestational age should be taken into account when estimating the eruption of the dentition in premature infants. In a study done by Viscardi and co-workers, the delay of eruption of deciduous teeth was shown in low birth weight (LBW) and premature infants.[19] Lowoyin *et al*. (1996) showed the number of erupted teeth was related to age of the infant and to some extent to their weight.[26] Fadavi and co-workers' (1992) study on LBW and very Low birth weight (VLBW) infant showed that premature infants had low numbers of erupted teeth in comparison with controls.[12]

Our Proposed Study

With increase in the survival of prematurely borne infants in the past decade, most researches devoted for studying the neurodevelopmental outcomes of prematurity and minimal attention was given to the impact of prematurity on oral cavity in general and teething specifically. It is uncertain whether premature birth by itself, its complications or both or whether there is other neonatal factors that can affect the teething process in this category of infants. One of the few studies that addressed the impact of different neonatal factors (e.g., oral intubation, nutrition, infections, and medications) on first tooth eruption of premature infants was a prospective, longitudinal study by Rose *et al* in 1994.[24] This is a prospective longitudinal study to investigate if first tooth eruption in Jordanian preterm infants chronological age, corrected age and neonatal factors.

Methods

A prospective longitudinal study of 110 Jordanian preterm infants who were born and attended the neonatal follow up clinic at prince Hashem Ben Al-Hussein Military Hospital, Zarqa / East of Jordan until the age of 18 months. A first tooth eruption record which was approved by the Jordanian Royal Medical Services ethical committee including the factors that might have an influence on teething such as: (sex, gestational age, birth weight and weight on the time of the first tooth eruption, neonatal sepsis, history of oral intubation, use of total parenteral nutrition, feeding history, use of multivitamins, history of rickets, presence of chronic medical illnesses, recurrent diarrheal episodes and history of recurrent admissions to the hospital) were completed by neonatologist using the medical records and the parents of the enrolled infants, during the annual clinic visits after full explanation of the benefits, risks , procedures and possible discomforts that the infant might face to the infant's parents, and their consent was obtained prior to inclusion in the study. Infants with congenital orofacial abnormalities (e.g. cleft palate or cleft lip), chronic medical illnesses (such as chronic lung disease, failure to thrive, congenital hypothyroidism, bone defects and malabsorption states) and infants with documented rickets were excluded.

Tooth eruption was considered if any part of its crown had penetrated the mucous membrane and confirmed by the dentist who was not aware of the medical history of the infant during the oral examination that was carried out using an artificial light, in the dental clinic at prince Hashem Ben Al-Hussein Military Hospital.

Delayed tooth eruption was considered if the first tooth erupted after the chronological age of 40 weeks.[21]

Table I: Study population according to gestational age, Birthweight, chronological age, corrected age and gender.

	N	Minimum	Maximum	Mean	Std. Deviation
Gestational age (weeks)	110	28.00	37.00	32.21	2.38
Chronological age(weeks)		24	48	37.20	6.446
Birth weight (grams)		850.00	2450.00	1551.82	422.74
Corrected age(weeks)		19	39	29.45	5.55
Gender		Male: Female	50:60	%:45.5:54.5	

Statistical Analysis

The premature infant was the unit of analysis in this study. A descriptive statistical study (mean, standard deviation and cross tabulation) was carried out on the measurements of variables collected. Some data collected in this prospective study were parametric and other data were nonparametric. The Chi-squire distribution or Fisher's exact test where appropriate were used when concerning proportions. Simple Pearson's correlation was used for the study of the possible association and interrelationships between first tooth eruption and factors that might have an influence on teething (sex, gestational age, birth weight neonatal sepsis, history of oral intubation, use of total parenteral nutrition). The level of significance was set at $P<0.05$.

Results

As shown in Table I the study population consisted of 110 premature infants (50 males and 60 females) who were born at mean gestational age of 32.21 weeks + SD of 2.38 (Range was 28 to 37 weeks), mean chronological age 37.20 weeks + SD of 6.446 (Range was 24 to 48 weeks) and mean corrected age 29.45 weeks + SD of 5.55 (Range was 19 to 39 weeks) and mean birth weight 1551.82 grams + SD of 422.74 (Range was 850 to 2450 grams). Subjects were arranged into two groups according to gestational age and birth weight as follows: one group more than or equal to 1500 grams and less than 1500 grams, the other group less than or equal =32 weeks and more than 32 weeks. Subjects were divided into two groups according to chronological age as follows: more than 40 weeks and equal or less than 40 weeks and corrected age as following: more than 24 weeks and equal or less than 24 weeks.

The subjects were examined episodically until eruption of the first tooth or longer. Since the first tooth erupts between 24 and 48 weeks of age in the normal population. Subjects were considered to be delayed if their first tooth erupted after 40 weeks of chronologic age or after 24 weeks of corrected age. There were 59 subjects (53.6%) whose first tooth erupted between the 24th and 48th week chronologic age (normal group) and 51 subjects (46.4%) whose first tooth erupted after the 40th week (delayed group). (No tooth erupted in any child before the 24th week.). For the corrected age, the range of tooth eruption was 19-39 weeks Subjects were considered to be delayed if their first tooth erupted after 24 weeks of chronologic age. There were 83 subjects (75.5%) whose first tooth erupted more than 24th week corrected age (delayed group) and 27 subjects (24.5%) whose first tooth erupted before 24th week.

Fifty patients were males (12 with upper incisors and 38 with lower incisors) compared to 60 female patients who had 11 with upper incisors and 49 with lower incisors. However, the difference in proportions between intergroup of males and females was not statistically significant $P>0.05$. The difference between upper and lower incisors in each group was statistically significant $P<0.05$.

Comparison between Normal and Delayed Groups

More normal eruption has been seen in subjects with birth weight (>1500 grams) than (<1500 gram) and gestational age (>32 weeks) than (< 32 weeks). There were significant differences in birth weight and gestational age between normal and delayed groups when the chronological age rather than corrected age was used (Table II-III). As far as gender is concerned, there were statistically more females with early eruption than males (33 females versus 18 males) $P< 0.05$. The significance was only with chronological age rather than corrected age (Table IV).

Table II: Birth weight and eruption at chronological and corrected age

		Eruption at chronological age		Total
		>40	**<40**	
Birth weight/ grams	< 1500	31	19	50
	> 1500	20	40	60
Total		51	59	110
		Corrected eruption age		**Total**
		>24	**<24**	
Birth weight / grams	< 1500	37	25	62
	> 1500	14	34	48
Total		51	59	110

Table III: Gestational age and eruption at chronological and corrected age

		Eruption at chronological age		Total
		>40	**<40**	
Gest. Age weeks	<32	37	25	62
	>32	14	34	48
Total		51	59	110
		Eruption at corrected age		**Total**
		>24	**<24**	
Gest. Age weeks	<32	49	13	62
	>32	34	14	48
Total		83	27	110

There was no statistical significance in intubation between delayed and normal groups (Table V). Neonatal sepses were significantly increased when the oral intubation was for more than 5 days (Table VIII). Fifteen subjects had intubated and sepses versus 14 subjects had no intubation and sepses, the difference was not statistically significant P>0.05 (Table VIII). Oral intubation in this study did not seem to affect number of sepses cases. At the same time the number of sepses cases did not seem to be affected by patients age (Table VIII). Oral intubation and admission in this study did not seem to affect either mean corrected age or mean chronological age of eruption (Table VIII).

According to the gestational age premature infants spend long time (several weeks to months) in neonatal intensive care unit (NICU) and are subject to various complications relating to their prematurity. This period of time is critical for development and is considered one of most rapid growth. If the infant was in the uterus, he would take essential nutrients carbohydrates amino-acids and fatty acids) for its growth and development However, outside the uterus meeting the nutritional demands of these infants presents challenges.

In this study, premature infants were divided into 5 groups, groups were given Total Parenteral Nutrition (TPN), breast milk, formula, solid food and vitamins and iron.

When both groups were compared for TPN, there was statistically significant difference (more delayed eruption without TPN) especially when the corrected eruption age was considered (Tables VI). There were no statistical differences between groups for vitamins and iron (Table VIII). Early eruption was more seen in subjects on breast milk feeding than others without breast milk (Table VII). Early eruption was seen more in subjects under preterm formula than full term formula (Tables VIII). When solid food was considered, there was no difference at both chronological and corrected ages (Tables VIII). Table VIII shows summary of the results comparing chronological, corrected age groups and type of test used.

Table IV. Gender and eruption at chronological and corrected age

		Eruption at chronological age		Total
		>40	**<40**	
Gender	Female	33	27	60
	Male	18	32	50
Total		51	59	110

		Corrected eruption age		Total
		>24	**< 24**	
Gender	Female	47	13	60
	Male	36	14	50
Total		83	27	110

Table V: Oral intubation (days) and eruption at chronological and corrected age

		Eruption at chronological age		
		>40	**<40**	**Total**
Oral intubation (days)	No intubation	30	38	68
	Intubation	21	21	42
Total		51	59	110

		Corrected eruption age		Total
		>24	**<24**	
Oral intubation (days)	No intubation	52	16	68
	Intubation	31	11	42
Total		83	27	110

Table VI: Eruption at chronological and corrected age and total parenteral nutrition

		Total parenteral nutrition		
		no TPN	**TPN**	**Total**
Eruption at chronological age	>40	40	11	51
	<40	46	13	59
Total		86	24	110

		Total parenteral nutrition		
		no TPN	**TPN**	**Total**
Corrected eruption age	>24	69	14	83
	<24	17	10	27
Total		86	24	110

Table VII: Eruption at chronological and corrected age and breast milk

		Breast milk		
		No breast milk	**Breast milk**	**Total**
Eruption at chronological age	40 or >	38	13	51
	< than 40	33	26	59
Total		71	39	110
		Breast milk		
		No breast milk	**Breast milk**	**Total**
Corrected eruption age	> than 24	55	28	83
	< than 24	16	11	27
Total		71	39	110

Table VIII: Summary of results

Neonatal factors	**Compared groups**	**Test**	**P value**	**Type of age**	**Significance**
Birth weight (grams)	>1500, <1500	X^2	P=0.004	Chronological	Yes
Birth weight (grams)	>1500, <1500	X^2	P=0.075	Corrected	No
Gestational age (weeks)	>32, < 33	X^2	P=0.002	Chronological	Yes
Gestational age (weeks)	>32, < 33	X^2	P=0.375	Corrected	No
Gender	Male/Female	X^2	P=0.047	Chronological	Yes
Gender	Male/Female	FE	P=0.50	Corrected	No
Oral intubation(days)	<40, >40	X^2	P=0.54	Chronological	No
Oral intubation(days)	<24, >24	FE	P=0.83	Corrected	No
Sepses	<40, >40	FE	P=0.52	Chronological	No
Sepses	<24, >24	FE	P=1.0	Corrected	No
Admission	<40, >40	FE	P=0.68	Chronological	No
Admission	<24, >24	FE	P=0.64	Corrected	No
Total parenteral nutrition	<40, >40	FE	P=1.0	Chronological	No
Total parenteral nutrition	<24, >24	FE	P=0.037	Corrected	Yes
Vitamins and iron	<40, >40	FE	P=1.0	Chronological	No
Vitamins and iron	<24, >24	FE	P=1.0	Corrected	No
Breast milk	<40, >40	FE	P=0.048	Chronological	Yes
Breast milk	<24, >24	FE	P=0.64	Corrected	No
Type of formula	<40, >40	FE	P=0.01	Chronological	Yes
Type of formula	<24, >24	FE	P=0.02	Corrected	Yes
Solid food	<40, >40	FE	P=0.54	Chronological	No
Solid food	<24, >24	FE	P=0.51	Corrected	No
Sepses	Intubated, Not intubated	FE	P=0.062 R=92	----------	No
Sepses	Intubated > 5 days, less than 5 days, Not intubated	X^2	P=0.082		No
(X^2) Pearson Chi-Square	(FE) Fisher's exact test				

Discussion

The present study is a comparative prospective longitudinal study of first tooth eruption in Jordanian preterm infants. The present study focuses on the chronological and corrected age of first tooth eruption of premature infants. The findings confirmed that more normal eruption has been seen in subjects with birth weight (>1500 grams) than (<1500 gram) and gestational age (>32 weeks) than (< 32 weeks). There are significant differences in birth weight and gestational than between normal and delayed groups when the chronological age rather than corrected age was used. These findings support earlier studies.[14,17-20] In a study done by Viscardi and co-workers, the delay of eruption of deciduous teeth was shown in low birth weight infants (LBW) and premature infants.[19] Lowoyin *et al*. (1996) showed the number of erupted teeth was related to age of the infant and

to some extent to their weight.[26] Fadavi and co-workers' (1992) study on LBW and very Low birth weight (VLBW) infant showed that premature infants had low numbers of erupted teeth in comparison with controls.[12]

The present study confirms that the introduction of total parenteral nutrition to premature infants is associated with clinically and statistically earlier first tooth eruption with the corrected age compared to chronological age. This finding supports the evidence that lipids influence bone modeling[27] and the proposal of Petros *et al*. 1993,[28] that the tooth movement in polyunsaturated fatty acids(n-6 and n-3) fed rats is faster than saturated fatty acids fed rats, which could be explained by the anabolic effect of PGE2 which in low concentration stimulates bone formation.[29] Further evaluation of the effect of intralipids on preterm infants in general and teething especially is warranted. In our study the introduction of vitamins and iron to preterm infants had no effect on both chronological and corrected age for compared groups. These results support the results of Backström *et al* 2000, who found that different intakes of vitamin D and mineral in the neonatal period does not affect maturation of the deciduous teeth in children born preterm.[21] It is well known that calcium and phosphorus supplementation in preterm infants in the neonatal period increases bone mineral accretion during the first few years.[21] These results are in agreement with the results of the cross- sectional study of Seow *et al*. 1988[14] and the prospective study of Golden *et al*. 1981.[18] Delayed primary teeth eruption in preterm infants was no longer apparent when corrected rather than chronologic ages is used.

Breast milk fed premature infants showed significant difference with both chronological and corrected age for compared groups. Premature infants who were taking preterm formula showed more normal eruption at chronological age than those who were taking full term formula. Breast milk and preterm formula are considered good nutrition for premature infants and this explains the significant association between good nutrition and healthy tooth eruption of preterm infants. On the contrary, poor nutritional status is associated with delayed tooth eruption.[30-31] various studies in India also reported a significant association between poor nutritional statuses and delayed tooth eruption. Therefore, it can be concluded that malnutrition caused delayed tooth development. It is well known that breast milk contains too little calcium and phosphorus to enable intrauterine mineral accretion in preterm infants. Thus the main cause of metabolic bone disease of prematurity is an inadequate supply of calcium and phosphorus.[32-37]

Premature infants who were taking solid food showed no more normal eruption at chronological age than who were taking full term formula. Even if it was not the aim of our study to evaluate the prevalence of neonatal sepsis in endotracheally intubated preterm infants yet the study showed that there was no significant increase when the oral intubation was more than 5 days. Our study showed also that neonatal sepsis has no significant impact on the time of first tooth eruption in premature infants in all groups.

Previous studies (Seow 1984, Pimlott 1985, Johnson 1984, Seow 1987 and Moylan 1980)[9,38-40] showed that local trauma caused by laryngoscope blades or direct pressure from endotracheal tubes disrupted normal dentition development. This study like a study conducted by Fadavi *et al*.[12] showed that timing of first tooth eruption was not affected by oral intubation or its duration in any study group as the difference was not significant when the delayed group compared to the normal group.

The difference between the present results and previous studies may be explained by the increase of neonatal complications that associated with prolonged intubation such as bronchopulmonary dysplasia, pneumothorax and PDA that affect the general condition of preterm infant and might have influence on teething process.[26] Our study showed that eruption of the first tooth occurred significantly later in preterm girls than in preterm boys and the lower incisors erupted earlier than the upper ones in all groups which were not previously reported.

In summary, our study showed that the time of first tooth eruption of preterm infants did not have a delayed corrected teething age. This is in accordance with the findings of Seow and coworkers and Golden and coworkers, who showed that the chronological teething age in children born preterm was delayed, but not the corrected teething age.[14,18]

Conclusion

Early first tooth eruption is associated with the introduction of total parenteral nutrition, breast milk, and preterm formula to premature infants. The significant difference between the groups was mainly associated with chronological age and not with the corrected age.

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