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A review of the eruption of primary teeth

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Abstract

Introduction

Eruption of deciduous teeth remains a rather sophisticated process. This paper gives a general overview of the process and explores on its implications.

Overview

Eruption of deciduous teeth may be divided into pre-eruptive tooth movement, eruptive tooth movement and post-occlusal tooth movement. Emergence of deciduous teeth is usually accompanied by teething symptoms. Mechanisms for eruption are still not entirely apparent. Proposed mechanisms included root elongation, hydrostatic pressure, periodontal ligament traction, bone remodeling and genetic pre-programming / cellular-molecular determinants.

Discussion and Conclusion

Understanding of the eruption of deciduous teeth made possible age estimation for children, shed light on management of teething issues and likely point towards a treatment philosophy of minimal intervention with definite building blocks of close observation and monitoring.

Introduction

'Deciduous teeth' from the Latin word meaning 'to fall off'. This is because they will be shed like leaves of the deciduous tree and be replaced by the adult permanent dentition. Other terms such as 'milk teeth', 'baby teeth', even 'temporary dentition' describe the nature of the deciduous dentition, namely, that they are found in children and are reasonably 'temporary' in their functional life.¹ These descriptive terms may give the misconception of the lack of importance of deciduous teeth. Yet, children rely on these deciduous teeth to chew and to obtain nutrients for their growth and development. They rely on these teeth to articulate speech in their tender years; prepare them for the next stage in life with the permanent dentition. Further, children and dentists alike may not be able to imagine how children would look and smile when they are devoid of teeth. How would the children find it? How would they really feel? What about their parents? How would they find their kids?² As for us, the dentists, we also have to be concerned with orthodontics: space maintenance and growth of the dental arches.¹ This relatively short-lived dentition should be awarded much more appreciation than one could imagine. For, it sheds light on the present situation and that which should guide

us to the focus of our management for the future. This paper gives a general overview of eruption of deciduous teeth and explores on some implications of the process.

Overview of Eruption

Eruption and emergence of teeth

Eruption of teeth may be defined as the natural physiological process by which a tooth moves from its site of development to its final functional position in the oral cavity.³ Emergence of teeth may be defined as the initial appearance of any part of the tooth crown penetrating through the gingiva into the oral cavity.^{1,4} Therefore, 'eruption' and 'emergence' of teeth denote slightly different things. With 'eruption', the developing tooth moves in the axial direction from its original location inside the jaw bone to its functional position in the oral cavity.^{1,5} Eruption of deciduous teeth appears to go through a rather standard sequence of happenings. The process of eruption commences way before the emergence of the concerning tooth.¹ And, the process of eruption continues until the erupting tooth is in functional position, normally.^{1,4}

The eruption process

Deciduous teeth develops within the developing jaws are too small to accommodate them initially and they are crowded within the jaws. To that end, each deciduous tooth germ started off rather small. The tooth germ grows in size as the jaw bone grows in length and girth with remodeling.³ Eventually, the deciduous tooth germ moves from its site of development into the oral cavity; in order that it comes into functional occlusion for the purpose of mastication. The process of deciduous tooth eruption may be arbitrarily divided into three descriptive phases, which are re-eruptive tooth movement, eruptive tooth movement and post-occlusal tooth movement. These phases are 'continuous' in the sense that demarcation between each of the stages may not always be clear.^{3,6,7}

Pre-eruptive tooth movement is made by a deciduous tooth germ within tissues of the jaw before it begins to erupt.^{3,7} Each deciduous tooth originally developed as a tiny offshoot from the oral epithelium. As the jaw bone grows in length and girth, it is then possible that individual deciduous tooth germ, together with its permanent tooth germ, become housed in their respective bone crypt. As this happens, the tooth germs appear to move in relation to the surrounding developing tissues in a three-dimensional manner.³

Eruptive tooth movement is the active phase of eruption.⁷ Root portion of the tooth has yet to be formed but the tooth germ would begin erupting from its bone crypt, in a three-dimensional manner.^{3,6,7} Bone remodeling during this

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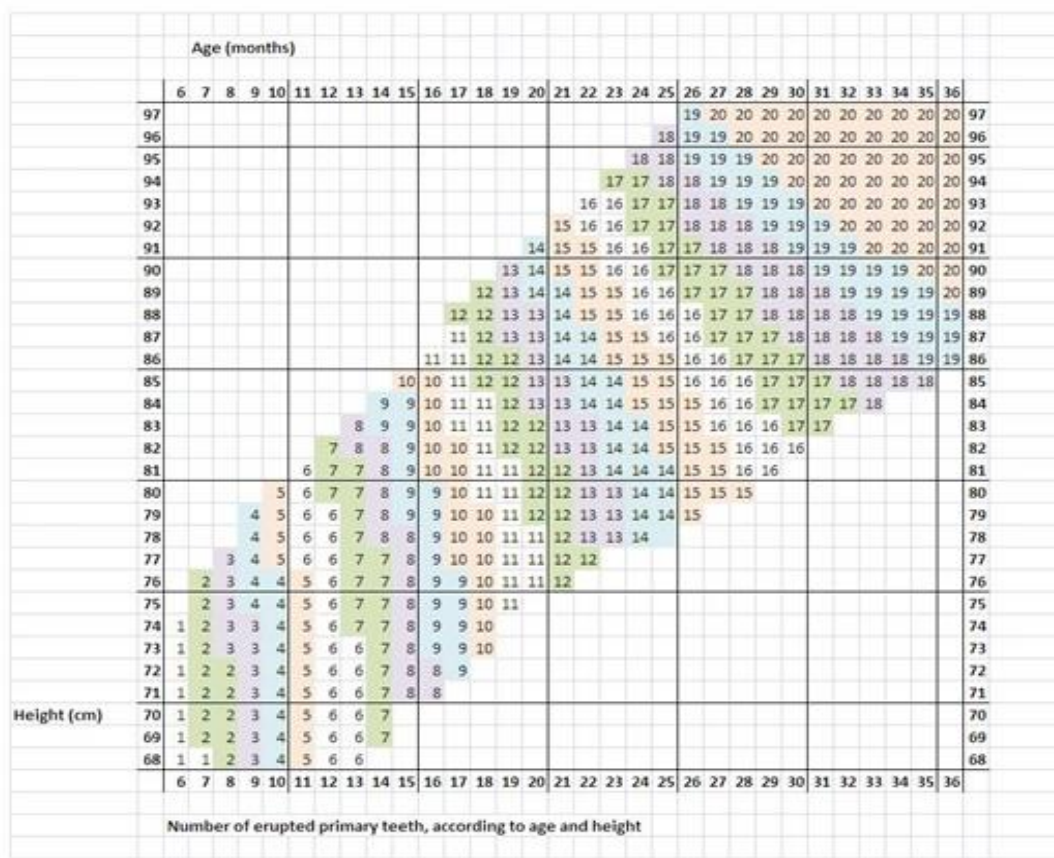


Figure 1: Age estimation according to height and the number of erupted primary teeth.

phase for the deciduous teeth, may not be too apparent because the tooth germ is usually not totally covered by dense alveolar bone and is already quite close to the oral mucosa.⁸ Yet, bone in the fundus of the crypt is continuously being remodeled to form a socket that house the erupting tooth, while its root is continuously taking shape.^{3,6,7} As the erupting tooth nears surface epithelium of the oral mucosa, there is a thickening and transformation of the enamel epithelium (giving rise to the reduced enamel epithelium) and fusion with the oral epithelium. Consequently there is no bleeding on penetration of the oral mucosa as the deciduous tooth germ emerges into the oral cavity. Around this time is when the infant experiences symptoms of teething.^{6,9} On emergence of the deciduous teeth, the speed of eruption begins to accelerate.⁶ This is when the tooth continues to erupt into occlusion, the phase of the pre-occlusal tooth movement. During this phase, bone forms at the base of the crypt and root of the tooth continues to take shape. Continual remodeling of connective tissues around the tooth shapes the periodontium, which, on maturation, maintains the erupted tooth in functional position.^{6,10} Post-occlusal tooth movement is the tooth movement that maintains the position of the erupted tooth in occlusion while the jaws continue to grow and compensate for occlusal and proximal tooth wear.^{3,8,11} There is a consolidation of the periodontal support of the tooth and completion of root formation.⁸ Minor tooth movement may

Table 1: Reported symptoms attributed to teething.	
Local Symptoms	General / Systemic Symptoms
<ul style="list-style-type: none"> Droling/sialorrhoea Ear rubbing or pulling on the same side as the erupting tooth Facial flushing/circumoral rash Gingival inflammation Gingival itching/rubbing/biting/sucking Pain 	<ul style="list-style-type: none"> Bowel upset (eg. Constipation, loose stools and diarrhea) Cough Ear infection Fever Irritability/malaise Loss of appetite/altered fluid intake Running nose Rashes eg. in diaper area Sleep disturbance Smelly urine Vomiting Wheezing/asthma exacerbation

be present to compensate for any tooth wear, attrition and growth of the jaw; in order that the deciduous tooth is kept functional in occlusion.^{3,6,7,8,11}

Emergence of deciduous teeth

The emergence of deciduous teeth at infancy is commonly referred to as 'teething'.⁹ Emergence of deciduous teeth usually begins at around six months after birth. Teething

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Table 2: Mean age of eruption (months) of primary teeth from various countries.

Tooth	Nigeria		Saudi		Iraq		Iceland		USA	
	Boys	Girls	Boys	Girls	Boys	Girls	Boys	Girls	Boys	Girls
51, 61	9.3	10.2	11.2	11.2	10.7	10.6	9.0	9.2	9.4	8.8
52, 62	12.0	13.0	13.1	13.3	10.1	11.4	10.4	10.2	12.0	11.8
53, 63	17.8	18.3	21.1	21.1	18.8	19.9	17.6	18.0	21.0	20.8
54, 64	16.0	16.9	16.9	16.9	16.3	16.4	15.1	15.0	17.5	16.3
55, 65	26.1	26.1	28.2	28.3	26.0	27.0	26.1	25.1	31.0	31.4
81, 71	7.6	7.9	8.4	8.5	9.2	8.4	8.0	6.9	7.2	7.7
82, 72	12.4	12.9	14.4	14.6	14.0	14.3	12.1	11.8	13.1	13.3
83, 73	18.2	18.8	21.0	21.1	19.0	20.3	19.2	18.2	20.9	20.5
84, 74	16.3	16.0	17.2	17.1	16.9	17.0	16.2	15.4	16.6	16.4
85, 75	24.1	24.2	27.9	28.0	26.0	25.1	25.6	23.7	30.0	29.5

*Adapted from Oziege et al, 2008.

for the twenty deciduous teeth completes at around thirty months after birth.^{12,13} The period of teething coincides with a diminution of circulating maternal antibodies and developmental changes. As such, this could be a period when the child is relatively prone to illness.^{14,15} Coincidentally as well, is that, over this period, it has been observed that teething is usually accompanied by 'teething symptoms'. Teething symptoms could be local symptoms, such as pain and gingival itching, and systemic symptoms, such as fever and irritability (Table 1). As can be seen, teething symptoms can appear rather 'general' or 'obscure' in nature. This could be especially cumbersome trying to arrive at the correct diagnosis.

Sequence and timing of eruption

The sequence of eruption of deciduous teeth is reasonably constant. The sequence follows in the order of central incisor, lateral incisor, first molar, canine and second molar. Usually, mandibular teeth emerges prior to the maxillary counterpart.^{1,9,12,13,16,17} Some minor ethnic variations exists^{18,19} as shown in Table 2.

Unlike the sequence of eruption, there could be considerable variation in the timing of eruption, as measured by the emergence of erupting teeth.^{1,19,20,21} As far as timing of the emergence of teeth is concerned, there appeared to be some amount of variation between the different genders and amongst different ethnic groups (Table 2). On the whole, it appears that deciduous teeth emerges earlier in boys; and that eruption completes earlier in boys.¹⁹ Hagg et al²² found that gender difference in the time of emergence of the various teeth was small and insignificant. Folyan et al¹⁸ found no observable effect of socio-economic status and breast feeding on the timing of the emergence of deciduous teeth.

Pattern of Eruption

Studies suggested that deciduous teeth emerge earlier in boys than in girls.^{18,19,22} The range of the length of time for all the deciduous teeth to emerge is about 20 to 30 months.^{18,19,21,22} Some ethnic, gender and temporal variations are observed. Further, it does not appear to be

any hard and fast rule on the right-left order of emergence.²¹ Mihailidis and co-workers²³ observed that the right-left emergence is kind of symmetrical and that each antimeric pair emerges within two weeks of each other.

Mechanisms of Eruption

Mechanisms for eruption are still not entirely apparent. Proposed Mechanisms of Eruption includes root elongation, hydrostatic pressure (tissue fluid pressure), periodontal ligament traction, bone remodeling and genetic pre-programming (cellular-molecular determinants).⁷

Root elongation is proposed as mechanisms for eruption because root of the erupting tooth is not yet fully formed upon eruption. Even after emergence, the root continues to develop and elongate into its final length. It is thus postulated that the elongation of the root could exert a force on the underlying bone and propels the erupting tooth occlusally into the oral cavity.¹⁰ Of course, for such a mechanism to work, there needs to be a concrete base apical to the developing root, capable of withstanding the force or pressure from the elongating mass of the root 'digging' into the alveolar bone.⁷ Yet, some researchers suggested that root elongation cannot be the mechanism because rootless teeth erupts.^{7,11} It is unlikely that the three-dimensional path of eruption could be possible through relying on root elongation alone.^{6,7}

Hydrostatic pressure (tissue fluid pressure) is proposed to be a mechanism for eruption because the vascular system inside or apical to the tooth germ could have a greater pressure than that outside of the tooth germ. Pressure from the interstitial fluids may push the bell-shaped tooth germ occlusally into the oral cavity.^{7,10,24,25} A pressure gradient appeared to be present within and outside of the erupting crown.¹¹ Yet, the hydrostatic pressure theory does not always explain eruption fully. A tooth would still erupt on excision of its growing roots, and hence, the periapical vasculature.⁷

Periodontal ligament traction is also a proposed mechanism of tooth eruption.⁷ It is postulated that fibroblasts, which developed from the dental follicle, in the connective tissues provided the force required for

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eruption. The obliquely inclined fibroblasts have been shown to contract and possibly pull the erupting tooth out during eruption.¹¹ It has been argued that the structural elements of frequent cell-to-cell contacts between periodontal ligament fibroblasts could permit summation of the contractile forces necessary for eruption.⁷ There are some, who would argue that the traction force is only present after the commencement of the process of eruption; hence, does not account for the initial phase of eruption.¹⁰ Furthermore, teeth with periodontal ligament may not always erupt, such as in the case of osteopetrotic mutations.⁶ Consequently, it has been concluded that this particular mechanism of periodontal ligament traction may not be the sole mechanism behind eruption.^{7,10,25}

Bone remodeling is also proposed as a mechanism for tooth eruption because alveolar bone forms during tooth development, and tends to be deficient where tooth fails to develop.⁷ It thus seems that alveolar bone growth, tooth development, and eruption are interdependent. Naturally, it has been proposed that formation of alveolar bone apical to developing tooth germs is conducive to eruption.⁶ The mechanism being that bone formation apical to the erupting tooth germ propels the tooth germ occlusally while osteoclastic activities present coronal to the erupting tooth germ opens up the path of eruption. Interesting is that base of the crypt of the permanent first and third molars continually resorbs on eruption of these teeth. However, for the second premolar and molar bone deposition was observed on the floor of the respective crypts.⁷ In addition, experiments done by various investigators have since demonstrated that dental follicle is actually the essential element in the process of eruption.^{6,7,11} Gorski et al²⁶ reported that teeth without dental follicles simply do not erupt. It appears that the dental follicle is central the element inducing formation of cells capable of bone remodeling observed over the process of eruption.^{6,7,26,27}

Genetic pre-programming / cellular-molecular determinants was suggested as a mechanism of tooth eruption because a study found a large number of genes involved in tooth development and eruption.⁸ Various molecular determinants, such as growth factors, colony stimulating factor, monocyte chemotactic protein-1 have been implicated in the process of tooth eruption. There has been suggestions of hormonal control of eruption, since that a circadian rhythm of eruption exists in human subjects, in the case of premolar eruption.¹¹ It is postulated that complex interactions between growth factor, transcription factors and hormones, etc. drives the eruption process.²⁷

To summaries, it is unlikely that any single one of the above postulated mechanisms explains the entire eruption process. Rather, given the available evidence, it is likely that there is some sort of complicated genetic pre-programming of the eruption process. It is also possible that the pre-programmed process response to certain environmental cues^{26,27,28} and employs various different mechanisms at various stage of the eruption process.

Discussion: Practical Implications of Eruption

Age estimation for children

Given the relative constant sequence and reasonably similar timing of the process of eruption, it is possible to derive an educated estimation of the age of a child up to 5 to 6 years of age.^{20,29,30} Bastos et al⁴ reported on a previous proposed formula by Bailey³¹. The formula produces a rough estimation of age for children aged 6 to 24 months of age when the date of birth is unavailable. The formula is simple and is as follows: Age (in months) = 6 + number of emerged deciduous teeth. Notwithstanding is that other information, such as socio-demographics (e.g. low birth weight) and medical history (e.g. chronic diseases and conditions), if available are also of bearing.⁴

Children's dental age may also be assessed radiographically or clinically. However, a young child may not be co-operative with radiographic examination. On the other hand, clinically counting the number of teeth present in the mouth appears to be a more appropriate quick simple alternative.^{29,30} Charts may be employed for estimating age of a child (Figure 1). Age estimation by the deciduous teeth could be quite informative in the sense that the teeth erupts in a reasonably linear fashion, at rather regular intervals of approximately 2 to 2.5 months.¹ One drawback of this method is that dental history of the child could be crucial. This is because the method relies on all emerged teeth being present and recognizable.³² Other information of the child, such as medical and social history, socio-demographics (e.g. height and weight, gender, ethnicity), should also be collected. For, the current literature suggests that such variables may have bearing on the growth of the child, and thus, masking the temporal age of the child.³²

Various investigators have found some minor differences in the emergence of deciduous teeth present between the different genders.^{30,32} In general, boys appear to have their first teeth erupted earlier than girls; and girls tend to have all their deciduous teeth present a bit earlier than boys.^{30,32} Studies suggested that the height and age of a child has significant correlation with the number of deciduous teeth present, and a taller child is likely to have more deciduous teeth present.^{4,29} The number of deciduous teeth present may be useful in estimating age of a child. However, other variables, such as dental history, height and socio-demographic data, should also be taken into account.²⁰

Teething Issues

Given the local and systemic symptoms (Table 1), it appears that teething could easily be the scapegoat for many common conditions. This could be potentially worrisome when the process of teething could spread over approximately 20 to 30 months.⁸ Yet, it is also true that sometimes genuine underlying medical and/or developmental condition, such as undiagnosed herpetic gingivostomatitis, could be present.^{9,14,33} Therefore, accurate diagnosis and careful observation of the concerning child is important. Some reported historic

management of teething included local measures such as lancing, applying leeches directly onto the gingiva; systemic medicaments like opiates, lead acetate; even non-pharmacological asinine therapies such as dietary changes, emetics and laxatives.^{16,33,34} Contemporary managements of teething can be non-pharmacological use of pacifiers, non-sweetened rusks, reassurance and pharmacological use of topical and systemic analgesics.³⁴ Alternative holistic medicine such as acupressure, aromatherapy, massage and homeopathy were suggested but practices of sugary food and drinks, topical application of alcohol are not recommended.³⁴

From both the historic and contemporary management modalities, it does appear that teething could be rather difficult for both the child and family. In fact, teething was seen as a life-threatening even until the late 19th century. Teething coincides with a particularly vulnerable period in life and had 'accounted for' rather high infant mortality rate in the past.³³ Indeed, teething accounted for 12% of the total deaths in children younger than four years old in the Registrar General's Report of 1842.^{33,34} Hence, the above rather interesting historic and contemporary accepted modes of 'treatment'. It should be interesting to find out on the local beliefs on teething. For instance, the Turks regard teething as a happy indicator for the developmental stage of a child.⁹ It is of interest whether some traditional remedies of teething exist that is safer and less invasive for the child; or that whether the social/family structure is conducive to simple uneventful management of the complaining child.⁵ The study by Sarrell et al¹⁴ highlighted some incongruent views and opinions on teething amongst the medical team and parents of the complaining child. Such a situation could potentially be a concern, not just for arriving at a correct diagnosis but also for dictating a safe and appropriate management for the affected child. This could be an area that warrants more research and investigation.

Conclusion

Eruption of the deciduous teeth may be the first step to the occlusal development. This complex and sophisticated process initiates at a time when the child is still at its infancy. Such is a time when communication between the child and us, the dentist, any adult, even its mother, could be difficult to comprehend.³⁵ During such a phase in time, the enigma in communication is only too easily coupled with personality traits and temperament;³⁶ and, consequently, too easily progresses to undiagnosed misunderstanding between the communicating parties. Usually the issue remains well into early childhood when the child is more amenable to weaning, made possible through the developing occlusion, and most euphorically may still be pacified by a dummy. Yet, just as the deciduous dentition is at its infantile stage, so is the systemic body system. Given the above phenomenal situation, as healthcare professionals, there should be clear implications in our treatment philosophy, aim or direction

in order to cater for these growing little darlings who got troubled by their deciduous dentition –This is most likely the time for minimal intervention and best to keep closing observation and monitoring, as in the case of teething.

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