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Original Article

Chronology of Deciduous Teeth Eruption: Agreement between Classic Authors

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Abstract

Objective: Assessing agreement between the eruption age of deciduous teeth eruption (DTE) in a children sample the City of Vitoria, Brazil, and the eruption age reported by classical authors. **Material and Methods:** The data derive from a cohort study with 86 newborns until their 36th month of age. Average DTE age of each child was calculated and testing was performed to comparing DTE age described by classic authors. Then, kappa test, McNemar and prevalence adjusted kappa were applied. **Results:** Average DTE ranged between 8 and 29 months of age in the lower arch, and 11 to 30 months in the upper arch. There was higher agreement proportion for DTE age of 71/81 (kappa= 0.82; IC95%= 0.72-0.93) and 52/62 (kappa= 0.88; IC95%= 0.78-0.99) between Minot (1873) and Shour and Massler (1941). Followed by deciduous teeth eruption age between the latter author and Logan and Kronfeld (1939) for 51/61 and 55/65 and between Lunt and Law (1974) for 53/63 and 73/83. High McNemar values were found for DTE age of 51/61 (McNemar= 54.0; p= 0.000), 72/82 and 75/85 between Logan and Kronfeld (1939) and Lunt and Law (1974) and for 51/61 between the latter author and Shour and Massler (1941). **Conclusion:** The sequence of DTE found here was similar to that reported in several studies, as well as average eruption age of deciduous upper and lower central incisors. However, average age was always later for the other teeth. Levels of agreement were higher for deciduous incisor and canine eruption than for deciduous molars.

Keywords: Deciduous tooth; Chronology; Tooth Eruption.

Introduction

A new baby's social, biological and behavioral life is a serious concern for parents, family members and friends. While growing up, attention to aspects of everyday life becomes a source of doubts and questioning to parents and/or caregivers. Therefore, one needs to know what is normal or pathological: two opposing [1] and qualitatively different phenomena, which in a child's life are reasons for anxiety and questions.

One of the most expected and feared moment is the children's first teeth, also known as deciduous tooth eruption (DTE). When this phenomenon does not follow a regular evolutionary pattern, there are changes in children's chewing pattern, and alterations in tooth and mouth growth [2]. However, this moment is less concerning to parents and healthcare professionals when they acquire knowledge about time, i.e. the average age in which each deciduous tooth (DT) appears in the oral cavity. This is an indicator to diagnose possible alterations in growth and general and mouth development of children [2-4].

Teeth emerging in the oral cavity follow a particular pattern. There are differences regarding gender, as well as interference of systemic and, mainly, environmental factors [5,6]. According to previous authors [7], there is the chance of association between occlusal dimensions and occlusal relations to alterations in masticatory demand, which leads to a comparative study of chronology and sequence of DTE in different populations, at different times.

Despite the different methods employed, the results of scientific studies differ in chronology and eruptive sequence, mainly regarding some groups of teeth [8]. This shows the concern about eruptive chronology from the scientific viewpoint and the need of further investigations.

Based on these facts, this study aims at assessing the agreement between the eruption age of deciduous teeth eruption (DTE) in a children sample the City of Vitoria-ES and the eruption age reported by classical authors.

Material and Methods

The data used in this paper derive from a longitudinal study (2003 to 2006) among 86 newborns observed until their 36th month. The sample was made up of resident children in low socioeconomic areas in Vitória, ES, Brazil. These areas had the worst indices of children mortality rates in the city, according to the Municipal Health Plan for 2001 [9].

It was used convenience sampling from a study conducted between 2003 and 2006 [9]. The sample was calculated using software BioEstat, version 5.3, in which alpha error was 5% and test power ranged between 55 and 98%.

All the children born in these areas and referred to by community healthcare agents were included in the study. They came from three healthcare units of two different areas, between November 2003 and May 2004. After selecting these children, four researchers, accompanied by community healthcare agents, periodically visited homes in which they gathered clinical data such as sucking habits, mouth breathing, breastfeeding patterns, and DT development by administering a

form to mothers and carrying out infant clinical examination. During these visits, mothers also receive guidance on infant care.

A tooth was considered erupted when any portion of the crown had passed through the gingiva and became visible in the oral cavity [2,4-6,10,11]. Information is declared by mothers or obtained through the clinical examination carried out by researchers at every visit.

Eight visits were made: seven at home and one at the healthcare office. Home visits occurred on average one every three months during the first two years of the study, and latter, six months in the last year, as the researchers found mothers and children in their homes. During each visit, a new form was filled out with structured interview and clinical exam data, and initial guidance was provided to mothers. After 36 study months, 67 children remained, the others could no longer be found, or moved or were no longer found in their homes after several attempts.

The research protocol was submitted to the Research Ethics Committee at the Biomedical Center at Federal University of Espírito Santo (UFES), Brazil. It was cleared in the 43rd meeting on June 25, 2003, under registration number 0020/2003. The Free and Informed Consent agreement was previously signed by parents. Also, access to this study's data base was granted by head researcher so the proposed objectives could be achieved.

Statistical Analysis

Data base was entered into SPSS for Windows v. 16.0 (SPSS Inc, Chicago, United States) selecting the interest variables: DTE. The average age DTE for each child was calculated per tooth group, in compliance with the two-digit system proposed by the American Dental Association (ADA) [12].

Then, tests to compare DTE time per group were carried out as per classic authors Minot [13], Logan and Kronfeld [14], Schour and Massler [15] and Lunt and Law [16]. In this construction, DTE time for each child was evaluated under the following categories: 1-followed partially, 2-followed totally, 3-early and 4-late. 1-followed partially: DTE time of one of the teeth, analyzed per group, was not in the DTE interval described by each author. 2-followed totally: DTE time of tooth group was in the DTE interval described. 3-early: DTE time in months was less than interval described by the author. 4-late: DTE time in months was greater than interval described by each author. When DTE time per group (pair) of teeth of sample individuals was not within the DTE time interval described by classic author, the average DTE time of both teeth was carried out for later comparison.

In order to measure the level of conformity between sample and the classic authors, we applied kappa test as per Landis and Koch [17]: almost perfect agreement (0.80-1.00), substantial (0.60-0.79), moderate (0.41-0.59), reasonable (0.21-0.40), poor (≤ 0.20). We applied McNemar's test to verify tendency to disagreement and prevalence-adjusted kappa using software PEPI version 4.0 (Computer Programs for Epidemiologists; http://www.sagebrushpress.com/pepi), adopting statistical significance level less than 5%.

Results

From the analysis in Table 1, the average DTE according to binary groups was from eight to 29 months of life in the lower arch; and eleven to 30 months of life for upper arch, both arches had the same DTE sequence: Lower central incisors (LCI), followed by the upper (UCI), upper lateral incisors (ULI), followed by the lower (LLI), upper first molars (UFM), followed by the lower, upper canine (UC), then lower canine (LC) and lower second molars (LSM), followed by the upper ones. There was a sample loss of 23%, concentrated mainly during eruption of late DT.

Table 1. Average age of DTE. Vitoria, ES, Brazil, 2003-2006.

Eruption	N of children	Average	Standard deviation	Minimum	Maximum
71/81	80	8.3	3.1	1.0	16.0
51/61	79	11.4	2.7	6.0	19.0
52/62	78	13.5	3.9	6.0	27.0
72/82	78	15.6	4.7	6.0	27.0
54/64	76	19.6	4.1	12.0	31.0
74/84	75	19.7	4.4	12.0	31.0
53/63	75	21.6	4.5	10.0	30.0
73/83	75	22.4	5.1	10.0	39.0
75/85	69	29.0	4.5	19.0	40.0
55/65	66	30.8	4.8	19.0	41.0

The results of agreement test of DTE time between sample and classic authors are presented in Table 2, 3 and 4. There was higher proportion of agreement (over 90%) for DTE time of 52/62 between Minot [13] and Shour and Massler [15], and almost perfect agreement (kappa = 0.88; p = 0.000) between them. These were followed by DTE of 74/84 and 54/64 between Minot [13] and Logan and Kronfeld [14], and DTE time of 51/61 and 55/65 between Logan and Kronfeld [14] and Shour and Massler [15]. Of these analyses, one showed almost perfect agreement; three, substantial agreement; and one, moderate agreement. Also, the highest levels of kappa were found for DTE time of 71/81, which presented almost perfect agreement (kappa = 0.82; p = 0.000) between Minot [13] and Shour and Massler [15]; for 73/83 with substantial agreement between Minot [13] and Lunt and Law [16], as well as for 53/63 and 73/83 between Schour and Massler [15] and Lunt and Law [16].

High levels of McNemar with tendency to significant disagreement were found for DTE time of 51/61 (McNemar = 54.0; p = 0.000), 72/82 and 75/85 (McNemar = 52.0; p = 0.000) between Logan and Kronfeld [14] and Lunt and Law [16]; and for DTE time of 51/61 (McNemar = 53.0; p = 0.000) between Shour and Massler [15] and Lunt and Law [16]. These analyses had disagreement percentage over 65%.

Table 2. Concordance of the eruption times between the sample classified according Minot (1873) versus Logan and Kronfeld (1939), and Schour Massler (1941), Lunt and Law (1974).

		Minot, 1873							
		N Sample	Agreement	Kappa	IC 95%	Adjusted Kappa	p-value	McNemar p-value	Reason for disagreement (%)
LCI	Logan and Kronfeld, 1939	80	83.8%	0.72	0.59-0.86	0.78	0.000	0.043	Late (15,0%)
	Schour and Massler, 1941	80	88.7%	0.82	0.72-0.93	0.85	0.000	0.174	-
	Lunt and Law, 1974	80	65.0%	0.50	0.37-0.64	0.53	0.000	0.000	Late (32,5%)
UCI	Logan and Kronfeld, 1939	79	64.5%	0.20	0.06-0.33	0.53	0.001	0.000	Late (27,8%)
	Schour and Massler, 1941	79	62.0%	0.19	0.08-0.29	0.49	0.005	0.000	Late (35,4%)
	Lunt and Law, 1974	79	63.3%	0.49	0.32-0.60	0.51	0.000	0.000	Late (32,9%)
LLI	Logan and Kronfeld, 1939	77	50.7%	0.08	-0.01-0.17	0.34	0.011	0.000	Late (46,7%)
	Schour and Massler, 1941	77	53.3%	0.17	0.06-0.29	0.38	0.001	0.000	Late (36,4%)
	Lunt and Law, 1974	77	66.3%	0.53	0.39-0.67	0.55	0.000	0.002	Late (19,5%)
ULI	Logan and Kronfeld, 1939	78	84.7%	0.55	0.34-0.76	0.79	0.062	0.062	-
	Schour and Massler, 1941	78	95.0%	0.88	0.78-0.99	0.93	0.000	0.677	-
	Lunt and Law, 1974	78	69.3%	0.49	0.33-0.64	0.59	0.000	0.001	Late (28,2%)
LC	Logan and Kronfeld, 1939	75	49.4%	0.11	0.01-0.21	0.32	0.006	0.000	Late (46,7%)
	Schour and Massler, 1941	75	76.0%	0.67	0.52-0.81	0.73	0.000	0.020	Early (9,3%)
	Lunt and Law, 1974	75	84.0%	0.74	0.61-0.87	0.79	0.000	0.062	-
UC	Logan and Kronfeld, 1939	75	69.4%	0.51	0.36-0.65	0.54	0.000	0.000	Late (30,6%)
	Schour and Massler, 1941	75	73.4%	0.57	0.43-0.72	0.64	0.000	0.083	-
	Lunt and Law, 1974	75	76.0%	0.63	0.50-0.76	0.68	0.000	0.006	Early (16,0%)
LFM	Logan and Kronfeld, 1939	75	94.0%	0.42	Indefinite	0.91	0.000	0.544	-
	Schour and Massler, 1941	75	80.0%	0.40	0.18-0.61	0.70	0.000	0.002	Late (18,6%)
	Lunt and Law, 1974	75	57.4%	0.11	0.00-0.22	0.43	0.034	0.000	Late (36,0%)
UFM	Logan and Kronfeld, 1939	75	92.0%	0.64	0.48-0.81	0.89	0.000	0.423	-
	Schour and Massler, 1941	75	81.4%	0.46	0.25-0.67	0.72	0.000	0.007	Late (16,0%)
	Lunt and Law, 1974	75	53.4%	0.17	0.04-0.30	0.38	0.001	0.000	Late (42,6%)
LSM	Logan and Kronfeld, 1939	68	33.8%	0.02	-0.03-0.07	0.12	0.180	0.000	Late (64,7%)
	Schour and Massler, 1941	68	33.8%	0.01	-0.07-0.09	0.12	0.438	0.000	Late (45,5%)
	Lunt and Law, 1974	68	76.5%	0.64	0.49-0.79	0.69	0.000	0.014	Early (11,7%)
USM	Logan and Kronfeld, 1939	66	53.0%	0.21	0.08-0.35	0.37	0.000	0.000	Late (43,9%)
	Schour and Massler, 1941	66	45.5%	0.06	-0.02-0.15	0.27	0.146	0.000	Late (42,4%)
	Lunt and Law, 1974	66	75.8%	0.63	0.48-0.79	0.68	0.000	0.038	Late (18,2%)

Table 3. Concordance of eruption time between the sample classified according Logan and Kronfeld (1939) versus Schour and Massler (1941) and Lunt and Law (1974).

		Logan and Kronfeld, 1939							
		N Sample	Agreement	Kappa	IC 95%	Adjusted Kappa	p-value	McNemar p-value	Reason for disagreement (%)
LCI	Schour and Massler, 1941	80	73.8%	0.59	0.45-0.73	0.65	0.000	0.002	Late (25,0%)
	Lunt and Law, 1974	80	51.3%	0.36	0.24-0.48	0.35	0.000	0.000	Late (47,5%)
UCI	Schour and Massler, 1941	79	92.0%	0.66	0.45-0.87	0.88	0.000	0.321	-
	Lunt and Law, 1974	79	31.7%	0.03	-0.05-0.11	0.09	0.215	0.000	Late (60,7%)
LLI	Schour and Massler, 1941	77	87.0%	0.34	0.09-0.59	0.83	0.000	0.125	-
	Lunt and Law, 1974	77	32.5%	0.06	-0.01-0.13	0.10	0.008	0.000	Late (66,2%)
ULI	Schour and Massler, 1941	78	80.8%	0.46	0.25-0.66	0.74	0.000	0.020	Late (16,6%)
	Lunt and Law, 1974	78	55.2%	0.23	0.09-0.36	0.40	0.000	0.000	Late (43,5%)
LC	Schour and Massler, 1941	75	61.4%	0.22	0.07-0.38	0.48	0.000	0.000	Late (38,6%)
	Lunt and Law, 1974	75	44.0%	0.11	0.00-0.21	0.25	0.001	0.000	Late (53,3%)
UC	Schour and Massler, 1941	75	61.4%	0.35	0.23-0.47	0.48	0.000	0.000	Late (22,6%)
	Lunt and Law, 1974	75	46.7%	0.24	0.14-0.34	0.29	0.000	0.000	Late (37,3%)
LFM	Schour and Massler, 1941	75	73.4%	0.09	Indefinite	0.64	0.040	0.003	Late (25,3%)
	Lunt and Law, 1974	75	54.7%	0.01	-0.01-0.03	0.40	0.387	0.000	Late (40,0%)
UFM	Schour and Massler, 1941	75	77.4%	0.37	0.19-0.54	0.70	0.000	0.009	Late (16,0%)
	Lunt and Law, 1974	75	52.0%	0.18	0.06-0.30	0.36	0.000	0.000	Late (42,6%)
LSM	Schour and Massler, 1941	68	80.8%	0.21	-0.04-0.45	0.75	0.000	0.043	Late (19,2%)
	Lunt and Law, 1974	68	23.6%	0.01	-0.03-0.06	-0.02	0.220	0.000	Late (75,0%)
USM	Schour and Massler, 1941	66	91.0%	0.62	0.43-0.80	0.88	0.000	0.423	-
	Lunt and Law, 1974	66	36.3%	0.16	0.05-0.26	0.15	0.000	0.000	Late (62,1%)

Table 4. Concordance of the eruption times between the sample and classified according Schour Massler (1941) versus Lunt and Law (1974).

		Schour and Massler, 1941							
		N Sample	Agreement	Kappa	IC 95%	Adjusted Kappa	p-value	McNemar p-value	Reason for disagreement (%)
LCI	Lunt and Law, 1974	80	75.0%	0.63	0.49-0.76	0.67	0.000	0.003	Late (22,5%)
UCI	Lunt and Law, 1974	79	33.0%	0.03	-0.05-0.1	0.11	0.310	0.000	Late (54,4%)
LLI	Lunt and Law, 1974	77	36.4%	0.11	0.01-0.20	0.15	0.009	0.000	Late (55,8%)
ULI	Lunt and Law, 1974	78	68.0%	0.47	0.31-0.62	0.57	0.000	0.001	Late (26,9%)
LC	Lunt and Law, 1974	75	82.7%	0.71	0.57-0.85	0.77	0.000	0.043	Late (14,6%)
UC	Lunt and Law, 1974	75	85.4%	0.76	0.62-0.88	0.80	0.000	0.088	-
LFM	Lunt and Law, 1974	75	77.4%	0.57	0.40-0.73	0.70	0.000	0.009	Late (17,3%)
UFM	Lunt and Law, 1974	75	69.4%	0.48	0.32-0.64	0.59	0.000	0.001	Late (26,6%)
LSM	Lunt and Law, 1974	68	33.9%	0.08	-0.03-0.18	0.12	0.079	0.000	Late (55,8%)
USM	Lunt and Law, 1974	66	30.4%	0.04	-0.06-0.13	0.07	0.217	0.000	Late (60,6%)

Discussion

The study adopted transversal and longitudinal methods for the chronology and sequence of DTE. Although some authors have adopted the transversal method [2,6,18], in this study the choice was for longitudinal, in compliance with other researchers [10,11,19,20]. Sectorial studies often use large samples of individuals examined at once, whereas longitudinal studies require extensive, constant and periodical exams throughout a long period of time (at least three years) when DT are studied [10].

Here, there were higher sample losses during eruption of posterior teeth, probably because of the nature of longitudinal studies, even though not enough to invalidate the results of our analyses, since the loss percentage was little (22.0%), with increased power for all statistical tests.

As far as DTE ages are concerned, they were obtained based on children's ages, according to eruption of each type of tooth [10]. From the results of this study, the first group of teeth to erupt in the oral cavity was the LCIs, on average at eight months of age, as reported by others [3,11,15,16]. The UCIs - the second group to erupt - came out on average at 11 months, compared to previous authors [10,16], the averages were similar.

Among the authors mentioned above, there is methodological conformity with previous study [10], which is a longitudinal study with 70 children from five days of age until eruption of every DT. The authors obtained DTE ages similar to the results of this present study for UCIs. Concerning the other DT, there was a difference of one to three months between results. The average age for these authors was always lower.

When comparing average age of DTE to Minot's results [13] - one of the first authors to be concerned about DT - upper canine (UC) and upper and lower second molars (USM and LSM) have similar results. However, there is a difference of one month for eruption of the other anterior teeth and five months for the UFM and LFM - always earlier for Minot's [13]. The teeth with most variability in DTE time reported by this author are the same of this present study: LC and USMs. Comparing to Lunt and Law [16], there are similarities in the average eruption age of all DT, with equal ages for both studies. However, the studies differ methodologically. Lunt and Law [16] were based on comparison of DTE tables obtained from literature review in 1848 and 1970.

There are further discrepancies when compared to Logan and Kronfeld [14], in which there is a difference of nine months between DTE ages, with their results being always earlier. The same occurs when compared to Schour and Massler [15], in which there is a six month difference in DTE age (also earlier for these authors), except for LCIs, which present average in the interval between six and eight months, similar to this present study.

The average DTE age for the study sample is overall later than for the reference authors, probably because of influence of hereditary, systemic and environmental factors in the chronology and sequence of DTE, as well as can be observed by others authors [5]. About the hypothesis that environmental factors are significant to human dental occlusion and craniofacial development, authors [21] concluded that differences in masticatory function can lead to morphological and occlusal alterations.

The DTE sequence for the sample was the following: 1) LCI (71/81); 2) UCI (51/61); 3) ULI (52/62); 4) LLI (73/83); 5) UFM (54/64); 6) LFM (74/84); 7); UC (53/63); 8) LC (73/83); 9) LSM (75/85); 10) USM (55/65), which can also be verified in other Brazilian [2,6,10] and international [11,13,16] studies. Central incisors and second molar erupt first in the lower arch, which is inverted for the other teeth. For other authors [14], DTE took place first in the mandible, then in the maxilla for all the teeth.

In the present study, Kappa statistics vary in terms of DTE time because of differences in results among authors. There is no consensus in DTE chronology [8] and chronological rate in erupt of some teeth groups have close relationship with their space and time [3,11].

It should be considered that the agreement analyses were carried out with authors called "classic", who are references in academic teaching in dentistry, highly quoted in books and articles, whose results are seen and used as standards, even if they are differing, based on particular methodologies and from different moments in history.

There was higher agreement proportion between Minot [13] and Logan and Kronfeld [14]; Minot [13] and Lunt and Law [16]; and between Lunt and Law [16] and Schour and Massler [15]. Note that Minot's [13] study was carried out based on observation of some other authors and on his own experience, with a sample of 400 children. The methodology employed and the type of analysis performed were not clearly described by this author. However, he achieved agreement for some groups of DT with the study by Logan and Kronfeld [14], in 25 human jaws dissected from

newborns to 15 year olds, in which the microscopic findings were compared to radiographic exams. Nevertheless, the sample was small and not standardized.

Studies by Lunt and Law [16] and Schour and Massler [15] are based on literature review. The former authors carried out a literature review at three moments between 1848 and 1970 so as to revise the DTE ages reported by Logan and Kronfeld [14], which would need to be changed, proposing a new table with more advanced ages for DTE. Schour and Massler [15], however, developed a simplified table of DTE chronology and sequence, also based on literature review and on data by Logan and Kronfeld [14].

The higher values found when tendency to disagreement is evaluated were between Logan and Kronfeld [14] and Lunt and Law [16]. Probably because the second author had carried out a review suggesting changes in the table of human DT chronology made by the first author.

Even with agreement about DTE time of some DT groups between authors, there is a paucity of data in these studies, mainly methodological. This can cause difficulty in comparing them. Another limitation of the present study concerns the representation and generalization of results, because the study individuals live in a particular region of Brazil, with lower socioeconomic level. Therefore, further studies involving more diverse population characteristics should be carried out in the future.

Conclusion

Despite the tables of DTE built by classic authors and used as standard in scientific research and clinical practice, continuing studies on chronology and sequence of DTE are justified by hereditary, environmental and systemic factors that can show differences in the eruptive process. Despite the differences in the DTE process, the sequence of DTE found for this study was the same as those in Brazilian and international studies, as well as the average age of deciduous UCI and LCI eruption compared to some of the study authors. However, the average DTE age of other teeth was shown to be always late. Also, there was higher level of agreement for deciduous incisor and canine eruption than for deciduous molars.

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