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Comparative study of the craniofacial growth depending on the type of lactation received

ABSTRACT

Introduction *Several organizations consider mother's milk the optimal nutrition source for newborns [AAP, 1998; Gartner et al., 1997; Mohrbacher and Stock, 2002; WHO, 1989]. However, there is little scientific evidence supporting the idea that breastfeeding has a positive influence on the development of the orofacial structures.*

Study and methods *The study of cases and controls (observational, analytical and retrospective) and lateral teleradiographs of the cranium of 197 patients (106 breast-fed and 91 bottle-fed) were compared. Ricketts, Steiner and McNamara values were used for the cephalometric analysis. Differences between the two groups were analysed by applying the T-test and ANOVA. Statistical significance levels were set at $p<0.05$. Non-nutritive infantile sucking habits have been compared; differences between the two groups were analysed by applying the Chi-square test.*

Results *First, the upper incisors were found to be protruded in the bottle-fed group. Second, subjects belonging to the breast-fed group displayed a brachycephalic mandible arch, while those fed with bottle had a dolichocephalic Steiner mandibular plane. Third, both facial depth and distance of the pogonion to the perpendicular nasion presented a certain tendency to a retruded mandibular bone in the bottle-fed group. And fourth, the frequency of use of dummy and thumb suction were greater in the bottle feed group, without statistical significance.*

Conclusion *In addition to the multiple advantages that mother's milk offers to newborns, breastfeeding also helps correct orofacial development (not only for the incisors position, but also for the vertical and sagittal relations of the mandible with upper maxillary and cranial basis).*

Keywords: *breastfeeding, bottle feeding, orofacial growth.*

Introduction

In civilised countries, about 30% of children need orthodontic treatment to correct severe orthopaedic malocclusions. This percentage increases to 60% or 70% when considering dental malocclusions in general [Nobile et al, 2007]. As this percentage is very important, the maxillary orthopaedic problem ought to be treated in a preventive level beyond the dentists and the orthodontists circle to become a question on interest to obstetricians, paediatricians, gynaecologists and midwives. The biological and psychological benefits of breastfeeding are well-known [Mohrbacher and Stock, 2002]. Dentists also claim children that have been breastfed present a better longitudinal development of the mandible. During lactation, there are three important facts: first the newborn breathes through his/her nose; this reinforces the physiological nasal breathing while feeding and after it. Second he is obliged to bite, to advance and to retrude the mandible; thus the whole muscular system of masseters, temporals and pterygoids is involved and so it can develop properly and acquire muscular tone. Also, TMJ is stimulated, and, as a result, there is an anteroposterior growth of the mandibular body [Raymons, 2003a; Raymons, 2003b; Schmidt, 1983; Uwe Niekusch, 1998]. On the contrary, bottle-fed children present a relative atrophy for inactivity, since a muscle acquires its full shape when it functions properly [Labbok and Hendershot, 1987; Lescano and Varela, 2000; Raymons, 2003a; Saenz and Sánchez, 2000].

Bottle-fed babies use the tongue in a different way: its position is lower while the lips are more separated [Inoue et al., 1995; Molina and Maldonado, 1994]. This position will be modifiable depending on the material and size of hole of the teat used. As a consequence, the tongue-mandible propulsion is weaker, pterygoids and masseters will be less used, since the simple lingual depression can suffice to produce the alimentary flow. The baby learns how to "swallow" and it can be not synchronous with breathing, increasing the possibility of oral breathing [Inoue et al., 1995; Raymons, b2003; Schmidt, 1983; Turgeon-O'Brien et al., 1996].

We must bear in mind, that there are other factors, besides lactation, that influence growth level and dental occlusion. These are: oral habits, premature loss of primary teeth, general factors like sex, race, genetic and morphogenetic factors. All of these factors interact not only in a dental or maxillary level, but also at a muscular level, in the neuromuscular orofacial system and at the temporomandibular articulations level [Camps et al, 2001; Lescano and Varela, 2000; Vig and Fields, 2000; Warren and Bishara, 2002]. Therefore, malocclusions derive from a combination of genetic and environmental factors. One of the causes could be "industrialization", since progress also brought changes in feeding, such as a more extensive use of the bottle in the first stages of life and consumption of more refined food in more advanced stages of growth [Jeryl and Buschang, 2002]. However, there are few scientific evidences supporting that breastfeeding has a positive influence on the growth of the orofacial structures. For this reason, we believe there is a need to determine, by means of a complete radiographic and

exhaustive study, the dental and/or skeletal changes that occur depending on the type of lactation received.

Materials and methods

Sample

The sample consists of 197 patients of the University Dental Clinic "Fundació Josep Finestres", of the University of Barcelona.

The entire sample consisted in 105 males (53 %) and 92 females (47 %). Then subjects were divided into two main groups: breastfeeding (106) and artificial feeding (91). The breastfeeding group, included children that had been breastfed for over a month. The artificial feeding group, included children that were not breastfed or that were breastfed for less than a month. Moreover, the breastfeeding group was divided into two subgroups: from one to six months (83) and from seven to fifteen month of duration (23).

The age range was from six to eleven years old, with an average of eight years old and seven months, and with a standard deviation of almost one year.

Material

With the aim of comparing the craniofacial and dental features between the groups, we carried out a cephalometric study for each individual.

X-rays were taken at the University Dental Clinic "Fundació Josep Finestres", by a qualified operator and with the machine Orthoralix (SD Ceph; Philips).

Subsequently, they were scanned with the Scanner Epson 1600 a 100-150 ppi and analysed with the informatic system Nemoceph 4.0 (Nemotec Dental Systems).

Cephalometric method

For cephalometric analysis, we developed our own method based on values from different authors such as Ricketts, Steiner and McNamara. These values were then classified in three groups.

- Dental variables: they determine the sagittal relations between incisors, molars and canines, the vertical position of incisors and their axial inclinations.
- Skeletal variables: they allow to establish the sagittal and vertical relationships between maxilla and mandible and their relationships with the cranial bases.
- Aesthetic variables: they evaluate the anteroposterior position of the lower lip.

The points and the cephalometric planes used are represented in Figure 1. The cephalometric variables (dental, skeletal and aesthetic) are represented in Table 1.

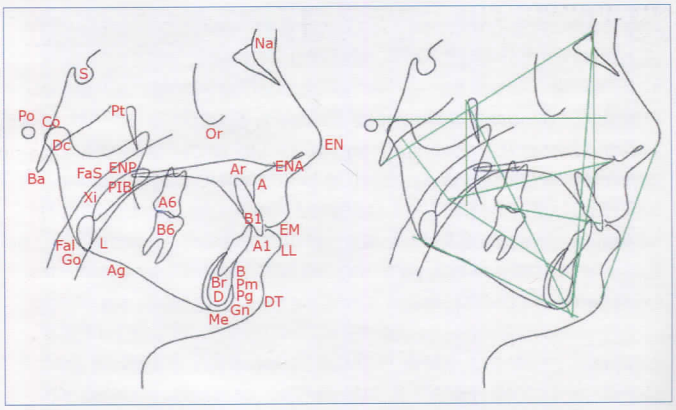

FIG. 1 - *Points and cephalometrric planes.*

Cephalometric error

The anatomic points of the teleradiography were recorded in the informatic programme by one person only. Two cephalometric tracings were obtained from each X-ray with an interval of at least one week and their coincidence was evaluated.

Dental variables	Skeletal variables	Aesthetic variables
Molar relationship (Ricketts)	Facial convexity (Ricketts)	Labial protrusion (Ricketts)
Canine relationship (Ricketts)	ANB angle (Steiner)	
Overjet (Ricketts)	Maxillary depth (Ricketts)	
Overbite (Ricketts)	SNA angle (Steiner)	
Interincisal angle (Ricketts)	A distance to perpendicular Nasion (McNamara)	
Extrusion of the lower incisor teeth (Ricketts)	Inclination of the palatine plane (Ricketts)	
Protrusion of the lower incisor teeth (Ricketts)	Facial depth (Ricketts)	
Protrusion of the upper incisor teeth (Ricketts)	SNB angle (Steiner)	
Inclination of the lower incisor teeth (Ricketts)	Pogonion distance to perpendicular Nasion (McNamara)	
Inclination of the upper incisor teeth (Ricketts)	Mandibular body length (Ricketts)	
	Posterior facial height (Ricketts)	
	Position ascendent mandibular ramus (Ricketts)	
	Localization of the Porion (Ricketts)	
	Inferior facial height (Ricketts)	
	Facial axis (Ricketts)	
	Angle of the mandibular plane (Ricketts)	
	Angle of the mandibular plane (Steiner)	
	Mandibular arch (Ricketts)	
	Angle of the occlusal plane (Ricketts)	

TABLE 1 - *Cephalometric variables.*

		N	mean	SD	T Student	U de Mann-Whitney
Protrusion inf inc	artificial	91	1.882	2.0953		
	breastfeeding	106	1.387	2.0228	P < 0.094	No sign.
Protrusion sup inc	artificial	91	6.348	2.6789		
	breastfeeding	106	5.784	2.7178	No sign.	P < 0.064
Inclination sup inc	artificial	91	28.276	7.0107		
	breastfeeding	106	26.946	7.6155	No sign.	P < 0.079
A distance / Na Fr	artificial	91	-.5956	2.7245		
	breastfeeding	106	.2009	2.7576	P < 0.045	No sign.
Facial depth	artificial	91	85.8495	2.5158		
	breastfeeding	106	86.7245	2.8239	P < 0.024	No sign.
Post facial height	artificial	91	53.937	3.3912		
	breastfeeding	106	54.938	3.9702	P < 0.059	P < 0.046
Po localization	artificial	91	-41.496	2.3632		
	breastfeeding	106	-42.225	2.6051	P < 0.042	No sign.
Pg distance / NaFr	artificial	91	-7.7811	4.7019		
	breastfeeding	106	-6.1632	5.3409	P < 0.025	No sign.
Inf facial height	artificial	91	45.9451	3.6758		
	breastfeeding	106	44.5321	3.4373	P < 0.007P	< 0.005
Ang mand planeRc	artificial	91	28.5824	4.4083		
	breastfeeding	106	26.5991	4.3017	P < 0.003	P < 0.006
Ang mand plane StP	artificial	91	35.992	4.5492		
	breastfeeding	106	34.829	4.3836	< 0.071	P < 0.014
Facial axis	artificial	91	87.516	3.5874		
	breastfeeding	106	88.018	3.5211	No sign.P	< 0.047
Mandibular arch	artificial	91	29.389	5.3050		
	breastfeeding	106	30.314	4.5814	No sign.	P < 0.009
Labial protrusion	artificial	91	.107	2.6368		
	breastfeeding	106	-.552	2.2114	P < 0.059	No sign.

TABLE 2 - *Significantly different variables between breastfeeding group and the artificial lactation group.*

The margin of error accepted was of 5%. If the cephalometric tracings presented more important differences, a third cephalometric tracing was performed and compared with the previous ones. The initial cephalometric tracing more similar to the last one, was considered valid.

Statistical analysis

The information obtained in the study was analysed with the statistic package SPSS 12.0 for Windows.

It establishes a statistic significance level, that is, the probability that the differences found should not be at random of 0.05.

Results

Comparative study between artificial plus breastfeeding groups (Table 2)

Observing the samples T of Student and U of Mann-Whitney, between the dental variables, three significantly different values were observed, with a confidence level of 90%: "Protrusion of the lower incisor", "Protrusion of the upper incisor" and "Inclination of the upper incisor". The nearer average to the norm in the three values is observed in the breastfeeding group.

Between the skeletal variables, with a confidence level of 95%, significant differences can be seen. In the majority of the variables, the nearest averages to the norm are those of the breastfeeding group. In this way, we observe that in the artificial feeding group, the mandible is more retrusive in the "Pogonion distance to perpendicular nasion" value, and growth is dolichocephalic (or long face) in the "Mandibular plane angle" of Steiner. However, in the breastfeeding group, the "Mandibular arch" variable determines a brachycephalic (or short face) and the "Inferior facial height", a tendency to brachycephalic.

With a confidence level of 90%, the aesthetic variable "Labial protrusion" has significant differences statistically, since in the artificial feeding group the lower lip is protuded.

Comparison between artificial plus breastfeeding for≤6 months group and breastfeeding for >6 month group (Tables 3 and 4)

Among the dental variables, with a confidence level of 95%, were observed two variables significantly different, following ANOVA: "Protrusion of the lower incisor" and "Inclination of the upper incisor". In individuals with a breastfeeding period of more than six months, the inferior incisors show a better inclination.

Among the skeletal variables, with a confidence level of 95%, two significantly different values can be observed: "Inferior facial height" and "Angle of the mandibular plane" of Ricketts. With a level of confidence of 90% two more values can be added: "facial depth" and "Pogonion distance to perpendicular nasion". However, when multiple comparisons are carried out between the groups, there is not a significant differences

		N	mean	SD	Anova
Protrusion inf inc	artificial	91	1.8824	2.0953	P < 0.023
	breastfeeding 6 m	83	1.1566	1.9512	
	breastfeeding > 6 m	23	2.2174	2.1017	
Inclinat inf inc	artificial	91	20.4473	4.3222	P < 0.047
	breastfeeding 6 m	83	19.5181	4.6231	
	breastfeeding > 6 m	23	22.0913	4.6763	
Facial depth	artificial	91	85.8495	2.5158	P < 0.054
	breastfeeding 6 m	83	86.6024	2.8800	
	breastfeeding > 6 m	23	87.1652	2.6236	
Pg distan / Na Fr	artificial	91	-7.781	4.7019	P < 0.062
	breastfeeding 6 m	83	-6.378	5.4282	
	breastfeeding > 6 m	23	-5.387	5.0510	
Inf facial height	artificial	91	45.9451	3.6758	P < 0.024
	breastfeeding 6 m	83	44.5530	3.4919	
	breastfeeding > 6 m	23	44.4565	3.3067	
Ang mand pl Rc	artificial	91	28.5824	4.4083	P < 0.008
	breastfeeding 6 m	83	26.5590	4.2109	
	breastfeeding > 6 m	23	26.7435	4.7116	

TABLE 3 - *Significantly different variables between the breastfeeding group that have received this type of lactation during a period of six months or less or more than six months.*

between the two last values.

"Inferior facial height" determines a tendency to a brachycephalic growth pattern in breastfeeding individuals. However, the average of the "Angle of the mandibular plane" of Ricketts is closer to the norm in breastfeeding groups than in artificially fed subjects.

Comparative study between artificial plus breastfeeding groups in males (Table 5)

Among the dental variables, when the T of Student analysis is applied one significantly different variable can be observed with 90% of confidence level: "Canine relationship".

Among the skeletal variables, with a level of confidence of 95%, the "Inclination of the palatine plane" can be observed. In the breastfeeding group, this value is smaller because of the anterior rotation of the palatine plane.

Comparative study between artificial plus breastfeeding groups in females (Table 6)

When the T test of Student was carried out, two statistically different values were observed, with a 95% confidence level: "Protrusion of the lower incisor" and "Inclination of the upper incisor". "With a level of confidence of 90%, we could add one more variable: the "Interincisal angle". Analysing these variables, it can be observed that in the artificial lactation group there is protrusion of the upper incisors, whereas the other values fall within the clinical deviation that we consider normal. When we compare the skeletal variables with a 95% level of confidence and three more variables with one of 90%, four significantly different values are observed. In the majority of these variables, the average closer to the norm are those of the breastfeeding group.

Whereas in the artificial lactation group, the "Angle of the mandibular plane" of Steiner determines a dolichocephalic pattern, in the maternal one, the

Multiple comparisons			
Protrusion	artificial	breastfeeding ≤ 6m	P < 0.067
		breastfeeding > 6m	No sign.
	breastfeeding ≤ 6m	artificial	P < 0.067
		breastfeeding > 6m	P < 0.091
	breastfeeding > 6m	Artificial	No sign.
		breastfeeding ≤ 6m	P < 0.091
Inclination inf inc	artificial	breastfeeding ≤ 6m	No sign.
		breastfeeding > 6m	No sign.
	breastfeeding ≤ 6m	artificial	No sign.
		breastfeeding > 6m	P < 0.055
	breastfeeding > 6m	artificial	No sign.
		breastfeeding ≤ 6m	P < 0.055
Facial depth	artificial	breastfeeding ≤ 6m	No sign.
		breastfeeding > 6m	No sign.
	breastfeeding ≤ 6m	artificial	No sign.
		breastfeeding > 6m	No sign.
	breastfeeding > 6m	Artificial	No sign
		breastfeeding ≤ 6m	No sign.
Pg distance / Na Fr	artificial	breastfeeding ≤ 6m	No sign.
		breastfeeding > 6m	No sign.
	breastfeeding ≤ 6m	artificial	No sign.
		breastfeeding > 6m	No sign.
	breastfeeding > 6m	artificial	No sign.
		breastfeeding ≤ 6m	No sign.
Inferior facial height	artificial	breastfeeding ≤ 6m	P < 0.039
		breastfeeding > 6m	No sign.
	breastfeeding ≤ 6m	artificial	P < 0.039
		breastfeeding > 6m	No sign.
	breastfeeding > 6m	artificial	No sign.
		breastfeeding ≤ 6m	No sign.
Ang mand plane Rc	artificial	breastfeeding ≤ 6m	P < 0.011
		breastfeeding > 6m	No sign
	breastfeeding ≤ 6m	artificial	P < 0.011
		breastfeeding > 6m	No sign.
	breastfeeding > 6m	artificial	No sign.
		breastfeeding ≤ 6m	No sign.

TABLE 4 - *Multiple comparisons of significantly different variables between breastfeeding groups that have received this lactation during six months or less or more than six months and artificial lactation groups.*

		N	mean	SD	T Student
Canine relationship	artificial	46	-.667	1.5772	
	breastfeeding	59	-.068	1.9205	P < 0.083
Inclination palatine plane	artificial	46	-2.2283	2.4909	
	breastfeeding	59	-3.3288	2.7816	P < 0.036

TABLE 5 - *Significantly different variables between breastfeeding groups and artificial lactation groups, in males.*

"mandibular arch" is brachycephalic. Moreover, the "Posterior facial height" is decreased in the artificial lactation group. For this reason, the ascendant branch is smaller.

With a level of confidence of 90%, we observe that the aesthetic variable "Labial protrusion" shows statistically significant differences. In the artificial lactation group there is a tendency to the protrusion of the lower lip.

		N	mean	SD	T Student
Protrusion	artificial	45	6.4511	2.5216	
superior incisor	breastfeeding	47	5.3851	2.4530	P < 0.044
Inclination	artificial	45	28.7844	6.8029	
superior incisor	breastfeeding	47	26.0106	6.4742	P < 0.049
Interincisal	artificial	45	130.633	9.2208	
Angle	breastfeeding	47	134.045	8.4044	P < 0.068
Posterior	artificial	45	52.4489	3.0942	
facial height	breastfeeding	47	53.8106	3.6890	P < 0.059
Pg distance /	artificial	45	-7.861	4.2823	
Na Fr	breastfeeding	47	-6.123	5.1212	P < 0.083
Inferior	artificial	45	46.5111	3.8304	
facial height	breastfeeding	47	44.0723	3.5199	P < 0.003
Facial axis	artificial	45	87.078	3.7664	
	breastfeeding	47	88.396	3.4117	P < 0.083
Angle mand	artificial	45	29.1778	4.1251	
plane Rc	breastfeeding	47	26.4085	4.3082	P < 0.003
Mandibular	artificial	45	28.7178	4.7411	
Arch	breastfeeding	47	31.3000	4.4079	P < 0.009
Angle mand	artificial	45	37.0200	4.8943	
plane St	breastfeeding	47	34.6936	4.4316	P < 0.02
Labial	artificial	45	-.484	2.2375	
protrusion	breastfeeding	47	-1.264	2.0691	P < 0.088

TABLE 6 - *Significantly different variables between breastfeeding groups and artificial feeding groups, in females.*

	Dummy	No dummy	Finger sucking	No finger sucking
Breastfeeding	79	27	13	93
	74.53%	25.47%	12.26%	87.74%
Artificial	68	23	12	79
	74.73%	25.27%	13.19%	86.81%
	147	50	25	172
	74.62%	25.38%	12.69%	87.31%
Chi-square Pearson		0.999		0.997

TABLE 7 - *Relation between type of lactation and non-nutritive sucking habits.*

Relationship between the type of lactation and non nutritive sucking habits (Table 7)

The differences between the two groups were analysed by applying the Chi-square test. Use of the dummy and digital suction were more frequent in the bottle-fed group, without statistical significance.

Discussion

After the cephalometric study of all the latero-lateral teleradiographs of the cranium, we conclude that breastfed individuals show a smaller tendency to malocclusion than the artificially fed subjects.

Thus, when we study the variables, it is possible to observe that, in the artificial lactation group, the upper incisor is protruded, whereas in the breastfeeding one it is in a correct position in an anteroposterior plane.

In the skeletal variables it is possible to observe that, in the artificial lactation group the "Facial deep" and the "Pogonion distance to perpendicular nasion" show a slight tendency to mandibular retrusion.

With regards to the values that determine the growth pattern, in the breastfeeding individuals, the "Mandibular arch" determines a brachycephalic mandibular growth pattern (or short face), and the "Inferior facial height" with brachycephalic tendency. However, individuals of the artificial lactation group show a dolichocephaplic (or long face) "Angle of the mandibular plane" of Steiner, and an "Angle of the mandibular plane" of Ricketts with a dolichocephalic tendency.

Finally, when studying the aesthetic variable "Labial protrusion", in individuals of artificial lactation, it is possible to observe that the inferior lip is protruded, whereas in breastfeeding individuals, the position is the correct one in an anteroposterior plane.

Nowadays, there are no studies that compare the values of the latero-lateral cephalometry of the cranium of breastfeeding individual and artificial lactation ones. However, some authors have observed there is a greater frequency of malocclusion associated to artificial lactation.

Lescano and Varela [2000] after carrying out a study in Cordoba (Argentina), found that breastfeeding children have a higher percentage of normal occlusion (69.1 %) than artificial fed children (53%).

Moreover, Labbok and collaborators [1981], in a study of 1981 conducted on a sample of 15.000 North American children, highlight that a prolonged breastfeeding (over six months) prevents orofacial malocclusions, which are 44% less frequent than in the other groups. However, others authors like Legovic and Ostric, Luz and collaborators claim that there are no statistically significant differences between the type of lactation, and the sagittal relationships of molars and incisors or mandibular deficiency. From these results, the authors concluded that there are many endogenous and exogenous factors able to influence malocclusion, such as oral habits (non-nutritive sucking) [Legovic and Ostric, 1991; Luz et al., 2006].

Warren and Bishara [2002] also found the same results, after carrying out a study in Iowa, USA. The authors observed that extended breastfed children with non-nutritional suction habits showed arch parameters and occlusal characteristics similar to those of subjects who had received artificial lactation or were breastfed for a short period of time. Therefore, the authors infer that in the development of malocclusion non-nutritional suction is more important than the type of lactation.

Other authors, such as Meyers and Hertzberg [1988], in a study carried out in Boston, report that there are statistically significant differences between malocclusions and type of lactation, type of teat, dummy use, type of dummy and finger suction. However, it seems that frequency of the malocclusions increases with the time of exposure to the bottle.

Conclusion

After the study of all the latero-lateral teleradigraphies of the cranium, it can be said that there are dental, skeletal

and aesthetic changes depending on the type of lactation received by the patient.

Therefore, we can conclude that, apart from multiple advantages of breastfeeding both for the newborn and the mother, breastfeeding also helps a correct orofacial development (position of the incisors, vertical or sagittal relationship of the mandible regarding the maxilla or the cranial base). Besides, it not only has a positive influence on the development of the orofacial structures, but it can also limit the onset of bad oral habits.

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