The Critical Age and Dentocraniofacial Morphologic Deviation in Mouth Breathing patients

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Abstract

Obstruction of the upper respiratory structure at nose and pharynx may reduce air flow and will cause mouth breathing habit (MB). If this obstruction of upper respiratory tract (OURT) occurs for a long period of time during the development phase of a child will result morphologic deviation of the dentocraniofacial (DCF).Patients suffering from OURT usually have adenoid face and low self esteem.Purpose:To get the DCF morphology characteristic data of OURT patients and to determine the critical age when deviation of the DCF morphology occurs in patients of OURT. Methods:A cross sectional design study was done with189 case subjects, 96 control subjects, and 60 normal subjects. All subjects were divided into two groups, 9-12 years, and 12-15 years group. Data obtained from cephalometric analyzes and questionnaire. Result:DCF deviation of case group was shown at the angle of normal SNA, higher SNB (p 0.00), ANB (p 0.00), NA-APg (p 0.00), SN-SGn (p 0.00), and SN-GoGn (p 0.00),but lower Facial Ratio ($p<0.05$)and Bijugulare (p 0.045, only for age group 9-11 years). Age 8 was the critical point for the occurrence of dentocraniofacial deviation (DCF) in patients with OURT.

DCF morphology characteristics of OURT subjects with MB showed vertical growth pattern, Class II Angle skeletal relation with convex facial profile, narrow Bijugulare, and critical age was 8 years where DCF deviation occurs in patients suffering from OURT.

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Introduction

Malocclusion is one of the deviated manifestations in the development of dentocraniofacial structure. Malocclusion in Indonesia is relatively high with prevalence 80% and that most patients developed oral bad habit, one of them is mouth breathing. [1]

Obstruction of the upper respiratory tract (OURT) suffered by the patients during their development period has played an important part in the patophysiology of the **occurrence of mouth breathing (MB)**. In the long run, it may cause a deviation in the morphology of **dentocraniofacial (DCF).**Patients of OURT have a typical *adenoid face* with protruded anterior teeth and have difficult personality. Tanugraha *et al* proved that malocclusion patients with *adenoid face* have the lowest self esteem.[2]

OURT may cause someone to develop the habit of snoring and apnea during sleeping. If it happened to a growing child, any DCF morphology deviation might be occurred in the future. Early detection of OURT and MB is necessary to prevent. To determine whether a person suffered from OURT and developed MB and apnea when they sleep requires expensive equipments. However, questionnaire can be used to identify the symptoms quickly, easily and cheap.[3]

What is the morphology of the vertical, transversal, and lateral dentocraniofacial (DCF) of OURT patients with MB bad habit in Jakarta. At what age does nasal obstruction occur that may cause DCF morphology deviation?

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The objectives of this research are to get the DCF morphology characteristic data of OURT with MB patients and to determine the critical age when deviation of the DCF morphology occurs in patients of OURT with MB. The result of this research will open up ways to prevent the bad habit of mouth breathing on children through social education which will prevent any deviation on the DCF morphology. This information will encourage the community to find ways to improve children's health.

Repetitive disease such as infection and allergy in the respiratory tract in the nose may cause hypertrophy concha which make the narrowing nasal cavity. High frequency of infection and allergy on the pharynx may cause the adenoid and tonsil to swell which cause narrowing of the pharynx. The narrowing pharynx and nasal cavity will decrease breathing through the nose and will develop mouth breathing pattern. Someone with less volume of nasal breathing will choose the half sitting position or upright head position; it will lower the position of the tongue, which will further lower the position of the mandible. The uplifted head posture (HP) may affect the growth and development of dentocraniofacial. If this condition occurs during the development period of a person, it may cause changing direction of the dentocraniofacial growth and development.

Hypothesis. There is a vertical, transversal, and lateral deviation in the morphology of DCF in patients suffering from OURT that develop MB.

Materials and methods

Research has been conducted in the cross sectional design (a part of a case control study) to identify the vertical, lateral, and transversal deviation in the morphology of the patients' DCF.Those were lateral and vertical measurement (angle of SNA, SNB, ANB, NA-APg, SN-SGn, SN-GoGn, and Facial Ratio(Figure1) and transversal measurement (the distance of Bizygomatic, Bijugulare, Binasal-cavity, and Biantegonium (Figure 2).The age variable here was the critical age, meant to be the age when the symptom of DCF occurs and it was not the age of the respondent during data collection. The age variable was determined by subtracting the current age with the length of period of MB.A valid questionnaire was used to identify this variable.

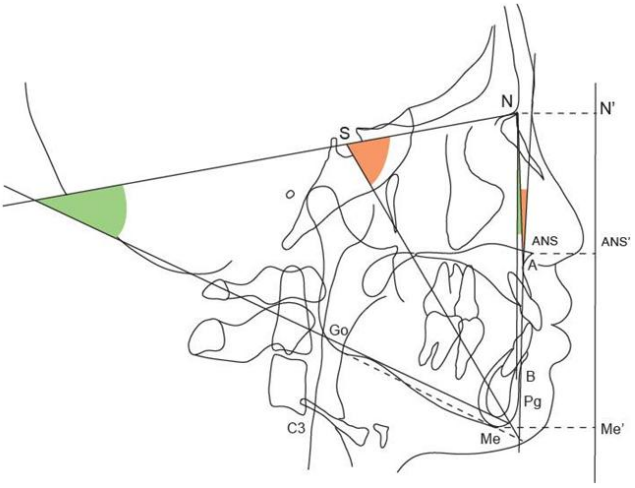

Figure 1. Sagital & Vertical measurement (ANB; NA-APg; SN-SGn, SN-GoGn Angle, and Facial Ratio) [4].

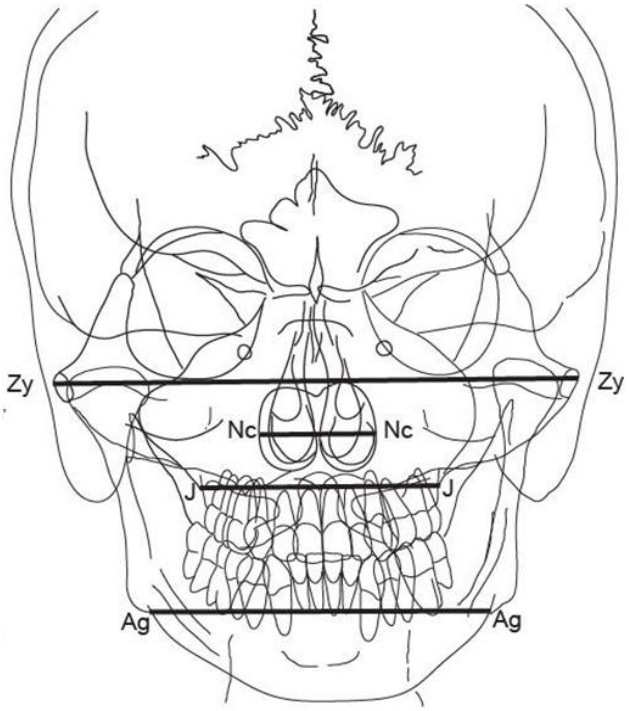

Figure 2. Transversal measurement (Bizygomatic; Bijugulare; Binasal-cavity, and Biantegonium)[5].

Inclusion criteria for the subject. Subjects were patients of Orthodontic and Pediatrict Dentistry Clinic Faculty of Dentistry Universitas Indonesia; Laryngopharynx Clinic of The ENT Department Faculty of Medicine, Universitas Indonesia. Patients to be chosen as samples were living in Jakarta and it's vicinity (Bogor, Depok, Tangerang, Bekasi) with race Deutro-Malay; age 9-15 years; male and female; well general health.

Exclusion criteria for the subject. Subject had bad oral habit except mouth breathing and mouth breathing followed tongue thrust (not truly tongue thrust). Diagnosis of mouth breathing habit obtained from the assessment of a questionnaire for subject and parent, and several physical examinations. Subject with tonsilectomy and adenoidectomy history, being suffer cough and common cold or influenza; ever suffer serious disease that interupting growth and development, asthma; and ever got orthodontic treatment. Subject had decay or missing or abnormality teeth and jaw may inhibit teeth and jaw growth and development.

Research subject. Research subject determined by the formula of the case control study based on the proportion of events obtained from the preliminary stages.[6]

$$N = \frac{(Z_\alpha \sqrt{2PQ} + Z_\beta \sqrt{P1Q1+P2Q2})^2}{(P_1 - P_2)^2}$$

$$P_1$$

$$P_2 = \frac{}{OR(1-P_1) + P_1}$$

Based on the results of the preliminary study, risk factors male gender, the proportion of the effect on the control of the DCF without deviation: P2=0.4, the number of subjects was 134.

Thus, the case N=134 and N= 134 in the control group.The total number of subjects was 268.

Selection of the subjects of Case Group. First, a cross section was conducted to identify OURT patients that developed the bad habit of MB. Medical records of OURT patients were studied to find new cases that had been diagnosed by the ENT specialists with hypertrophic tonsiloadenoid and or permanent nasal obstruction. Questionnaires were then distributed to identify patients with rhinitis, pharyngitis and MB history in order to detect whether they were exposed to OURT or not. After that, OURT patients that developed MB were identified.

Selection of the subjects of Control Group. Subjects were identified OURT patients without bad habit of MB.The procedure of visual observation on DCF appearance in the control group, the selection was conducted by 3 orthodontists. The candidates were visually observed to see that they had normal DCF and did not show any *adenoid face* both from the profile and frontal angles. The frontal examination was meant to see facial symmetry between the left and right facial by using the facial symmetrical analysis as shown in Figure 3. Another objective of the frontal examination was based on Simon analysis as shown in Figure 3. The profile examination was done from the right side of the face by using Schwarz' facial profile analysis evaluation as shown in Figure 3.[7] The aim was to see whether the subjects had straight facial profiles or had acceptable profiles according to the orthodontists. Then the orthodontists would conclude whether the subjects had normal DCF or not.

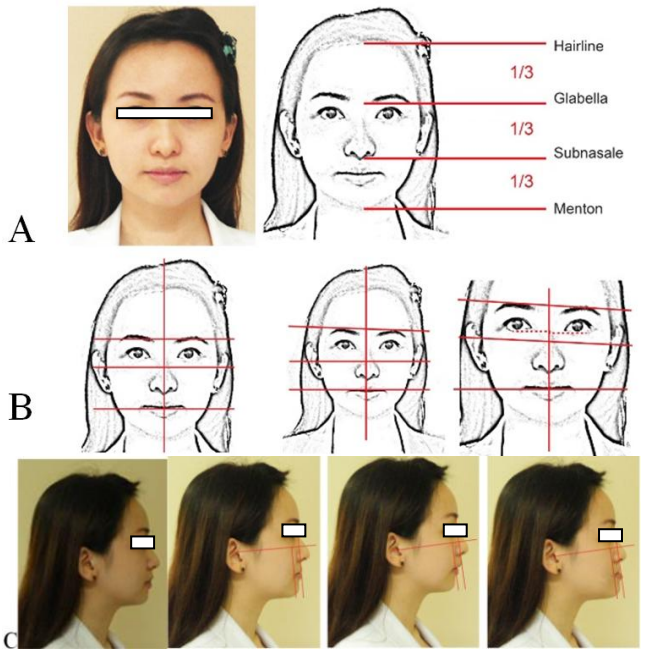

Figure 3. Facial and profile analyses. A. Normal DCF, Facial Balance/Ratio Analyzes (Simon); B. Facial Symmetrical Analyzes; C. Facial Profile Analyses (Schwarz).

Selection of normal subject. In the group consisting of normal subjects or subjects without any DCF deviation, the subjects were selected by using the criteria that they did not suffer from permanent OURT and with the characteristics of normal extra oral DCF. In the intra-oral examination, the normal subjects showed normal occlusion characteristics described by Cons *et al*'s Occlusion Normal Statistic.[8]

Population of case, control and normal subjects. The population was visitors of Orthodontic and PediatricDentistry Clinic Faculty of Dentistry Universitas Indonesia; Laryngopharynx Clinic of The ENT Department Faculty of Medicine, Universitas Indonesia.

Equipment and research materials. Tooth and mouth diagnostic tools;Tongue blade; A Yoshida Radiograph Panora 10C type made in Japan; frontal and lateral cephalogram of research subjects; Viewer; Matte acetate 003 paper from RMO; Cephalometric Protractor from Ortho Organizers, Inc.® to measure the angle; pencils 3 H and 5B; a Mitutoyo® Dial Caliper with 0.05mm precision; U Max Power Look 1120 scanner® made in Taiwan; Image Tool-3 Program[9]; Questionnaire.

The research proposal had carefully reviewed and approved by the Committee of The Medical Research Ethics of the Faculty of Medicine, Universitas Indonesia, with regards of the protection of human rights and welfare in medical research, with No:112/PTO2.FK/ETIK/2002.

Results

The total calculated number of subject was 268. In fact there were 345 subjects on the field, which were suitable for the next study, case control study. Those were 189 case and 96 control subjects, and 60 normal subjects. This number of subjects was calculated with *unequal sized groups* of *Lachin's adjustment*[10] for getting case and control ratio corectly.

$$N = ¼ (1/Q_1 + 1/Q_2) Ne$$

The subject selection was conducted by 3 orthodontists.The value of sensitivity and *positive predictive value* was above 90%. Kappa coefficient as a measure of reliability ranged from 0.789-0.819 and significant.[6]

In order to evaluate whether the questionnaire is reliable, a test was undertaken to assces reliability and validity. Test reliability using the test of internal consistency Cronbach alpha coefficient, with the test results showed Cronbach alpha values between 0.7-0.9. Conducted 12 tests of validity by looking at the correlation between items, with the result r was 0.51 to 0.75 and from 0.76 to 1.00.[11]Thus, it can be concluded as a whole questionnaire tool can be trusted.

Calibration test the intra-researchers and inter-researcher cephalometric measurements in this study using the calibration method of Bland-Altman, showing distribution of average value of data lies in the range of 2 standard deviation (x ± 2 SD), these 0.9955-1.000 the difference between measurements can accepted.[12]

1.Characteristic of DCF morphology of normal subjects, OURT patients without MB and those with MB

There was a significant difference in the characteristics of DCF morphology between OURT subjects that develop MB and normal subjects. **Hypothesis**: **"There is a difference in the DCF morphology of OURT patients with MB habit and OURT patients without MB habit, has been proven for the sagital and vertical direction, and the width of Bijugulare.** (Table1).

	Age Group (year)	OURT Without MB			OURT With MB			Normal			p	
		n	mean	SD	n	mean	SD	n	mean	SD		
Morphplogy Characteristic :												
SNA	12-15	48	83.792	3.888	117	83.530	3.655	30	82.275	3.049	0.169	
	9-11	8	80.213	4.006	112	82.471	3.598	26	81.567	2.789	0.131	
SNB	12-15	48	80.927	4.044	117	78.928	3.839	30	80.475	2.601	0.004	*
	9-11	8	77.600	4.135	112	77.937	3.786	26	80.212	3.672	0.021	*
ANB angle	12-15	48	3.010	1.945	117	4.573	2.409	29	1.853	1.472	0.000	*
	9-11	8	2.613	2.070	112	4.392	2.136	25	1.850	1.031	0.000	*
NA-Apg angle	12-15	48	3.724	4.755	117	8.075	5.420	29	2.310	2.788	0.000	*
	9-11	8	4.125	4.414	112	8.754	4.486	25	2.310	1.969	0.000	*
SN-SGn angle	12-15	48	67.365	4.087	117	69.974	4.035	29	66.628	2.842	0.000	*
	9-11	8	68.781	4.581	112	69.998	3.724	25	67.036	2.815	0.001	*
SN-GoGn angle	12-15	48	31.594	5.871	117	35.335	4.883	29	31.319	4.456	0.000	*
	9-11	8	32.750	5.041	112	35.482	5.316	25	31.760	4.369	0.003	*
Fasial balance	12-15	48	0.861	0.085	117	0.816	0.077	29	0.843	0.084	0.004	*
	9-11	8	0.855	0.064	112	0.807	0.074	25	0.844	0.056	0.018	*
Bizygomatic distance	12-15	48	139.686	5.669	117	137.563	6.366	29	139.359	4.283	0.072	
	9-11	8	129.481	12.430	112	126.940	7.315	25	129.251	7.521	0.300	
Bijugulare distance	12-15	48	73.661	3.467	117	72.779	3.929	29	73.091	3.032	0.381	
	9-11	8	69.005	5.988	112	67.531	4.159	25	69.768	3.584	0.045	*
Biantegonium distance	12-15	48	95.590	4.880	117	93.857	8.881	29	94.579	3.361	0.396	
	9-11	8	89.239	7.647	112	86.473	5.706	25	88.906	5.406	0.092	
Binasal-cavity	12-15	48	35.027	2.726	117	34.196	2.902	29	34.611	2.153	0.206	
	9-11	8	30.806	3.052	112	30.955	6.481	25	32.609	3.279	0.443	

*p<0.05

Tabel 1. Mean and Standar Deviation of Characteristic Risk Factors and Dentocraniofacial Morphology of Normal and OURT Subject devided by MB.

2. The critical age for DCF deviation

Prevalence (percentage) and number of patients of OURT according to the dependent variable subject with or without DCF morphologic deviation. (Table 2).

	DCF deviation (N= 190)		DCF no deviation (control) (N=95)		p
	n	%	n	%	
Age					
9-11 years	96	50.5	25	26.3	0.000 *
12-15 years	94	49.5	70	73.7	

*p<0.05

Table 2. Distribution of research subjects based on DCF in OURT patients.

To get the critical age of the occurence of DCF, an analysis was conducted. To analyze the critical age, the onset variable was divided into two or dichotomy. For example, lower than 6 (as the reference with code 0) and higher than and equivalent to 6. The analysis used ROC curve. (Table 3).

Cut of Point	OR	p	ROC	Sensitivity	Spesifisity
6 (<6 ref vs ≥6)	0.09	0.000 *	0.637	68.4	4.2
7 (<7 ref vs ≥7)	0.08	0.000 *	0.705	51.6	7.4
8 (<8 ref vs ≥8)	**0.11**	**0.000 ***	**0.747**	**29.5**	**21.0**
9 (<9 ref vs ≥9)	0.16	0.000 *	0.703	18.4	41.0
10 (<10 ref vs ≥10)	0.11	0.000 *	0.674	7.4	57.9

*p<0.05

Tabel 3. Receiver Operating Characteristic (ROC) Analysis The Critical Age.

It showed that there was no ideal median because both the value of sensitivity and specificity were less than 80%. OR showed the protective effect against DCF. Onset that was higher than or equivalent to 6 has more chance not to develop DCF or, in other words, onset that was lower than 6 has more risk for DCF. It meaned that the younger the age that onset happens, the higher the risk for DCF.

The 8 years onset, sensitivity and spesificity level were equal. OR at the median was 0.11 which means that at age more and equal than 8, it had less chance for DCF. Or, in other words, age younger than 8 had higher risk for DCF.It can be concluded that the critical age is 8 years old because the ROC is higher.

Discussion

In present study OURT with MB subjects had differed SNA (not significant); smaller SNB; greater ANB compared with normal subjects and control groups. This difference is highly significant, showing relationship between MB bad habit with large ANB angle (ANB> 4°). Contrary research showed morphological DCF characteristics in MB groups of growing child no statistically significant difference was seen for the variable SNA, SNB, ANB, and SN-PP.[13] The differencies may be because this study was composed of 100 children age of 6-12 years, while the present study was composed of 9-15 age children, and population difference.

Nasal breathing resistance pattern may cause a person to find a solution by opening his mouth to breathe more easily so lead the mandible to rotate to the inferior and posterior. If these conditions last long during growth, then the position of the mandible tends to settle so that the mandible position to the cranium and maxilla more posterior. As a result in this study a large ANB angle, this is a feature of the relationship Class II skeletal jaw.

The value of SN-SGn angle, the angle SN-GoGn and facial ratio value were significantly different than the normal subjects and the control group in present study. This angle also showed vertical dysplasia or vertical skeletal pattern. In patients OURT facial growth pattern more toward vertical, so that indicates a pattern of hyper divergent skeletal.

Similarly results shown in Malhotra *et al*'s study and evaluation of craniofacial morphology onsubjects with mouth breathing patternN-Me, ANS-Me, SN-GoGn was significantly higher than nasal breather group.[13]

The results of Harari*et all*'s study were people who breathe through their mouth show considerable backward and downward rotation of the mandible, higher overjet; higher mandible, and palatal plane angle, and make the upper and lower arches at the level of canines and first molars more narrow than the people who breathe through their nasals.[14]

Normally, growth and development of maxillary sinus is laterally and downward directions. In individuals with MB pattern this direction of growth should be blocked. In this study proved Bijugulare narrower. This condition lead narrow and deep palatine, while the size of teeth is normal, then the anterior teeth will be protrusion.

Research conclusion of Pirilä-Parkkinen*et al* were children with sleep disorder breathing (SDB) were characterized by an increased antero-posterior jaw relationship, increased mandibular inclination in relation to the palatal line, increased total and lower anterior face height. This present study showed DCF morphology characteristics of OURT subjects with MB show vertical growth pattern, Class II Angle skeletal relation with convex facial profile, and narrow Bijugulare.[15]

As the answer to the question: "**What is the critical age for the occurrence of dentocraniofacial deviation in patients with OURT?"** Age 8 is the critical point for the occurrence of dentocraniofacial deviation (DCF) in patients with OURT.

According to Govilot *et al*. that in childhood enlarged adenoid size and

pathological symptoms were most common among aged 2 - 12 years. In adolescence (12 - 13 years), adenoid will shrink, meaning nasopharynx cavity will grow, MB habits are greatly reduced.[16]The critical age in this present study is 8 years in the period of childhood, so at this time needs to be alert to the occurrence of respiratory infections and the impact on pharyngeal lumen narrowing that can lead to the emergence of MB bad habits which in turn raises morphological DCF deviation.

The conclusion of Harari *et al* was during critical growth periods in children, naso-respiratory obstruction with mouth breathing has a higher tendency for clockwise rotation of the growing mandible, with a higher and disproportionate anterior lower vertical face height and lower posterior facial height.[14] The most critical time was at the first 9 years old of human's life, according to Galella *et al*. In the early development stages of a child's life from age 4-9, the damage of craniofacial malformation is done, if the tonsils and adenoids are obstructing the airway.[17]

Jefferson recommended that children suffer OURT for orthodontic evaluation at age 5 years, because it would be easy to perform maintenance on jaw growth period. In this age of new facial growth 70%, in young growth over 100%.[16,18]

Given the adverse effect caused by MB; besides causing bad impacts on DCF morphology, also cause clinical and psychological disorders. In severe cases, children may experience a reversible syndrome and heart failure. In adult individuals, the disorder is not just a symptom of patognomonic sleep apnea, but can also be caused by other clinical disorders are narcolepsy, sleep deprivation, depression, and hypersomnolen idiopathic syndrome. There are symptoms that accompany OSA, called Obstruction Sleep Apnea Syndromes (OSAS) but rarely happen, namely hypertension, enuresis, night headache, and personality disorders in the afternoon. Further impact can occur is cardiopulmonary symptoms.[17,18,19]

Allergy is one of many causes of upper airway obstruction or mouth breathing which is often found in every family. Unfortunately it is sometimes undiagnosed with ADD (attention deficit disorder) and hyperactivity due to the tiredness and lack of concentration during the day. Mouth breathing can cause poor oxygen concentration in the bloodstream, which can cause high blood pressure, heart problems, sleep apnea and other medical issues also lack of sleep. Mouth breathing should be treated in order to prevent abnormal facial and dental development.[20]

By acknowledging the critical age of the occurence of DCF morphology deviation in OURT patients, preventive action can be taken to prevent any deviation in the DCF morphology, which is by preventing chronic infection in the upper respiratory tract in early childhood, so that it won't develop into the risk factors of OURT. By referring to the result of this research, people can be encouraged to make efforts in maintaining the health of their children, especially those below 8 years to gain a better health generally psychologic, and aestheticaly. If OURT had occured in early childhood, some actions can be taken to cure OURT before the child reaches the critical age of 8 years. Therefore, the knowledge and the health of the people can be improved which in the end will improve the quality of live of the people.

The study of Witzig and Spahl's said that between age 9-12 malocclusion become worse up to 25% or more severe. We don't have to wait to correct the problems. We have the choices and opportunity to improve the quality of life for the children now and the adults of tomorrow.[17]

Conclusions

The characteristics of DCF morphology of OURT subjects with M Bin Jakarta and its vicinitypopulation were vertical development (hyperdivergen) pattern, skeletal Class II Angle relation, with convex facial profile. Facial development toward mediolateral was only caused by an interference in the maxilla (Bijugalare is narrow in age group 9-11 years).

Age 8 years old was the critical point of the development of dentocraniofacial (DCF) deviation in OURT patients.The early diagnosis and prevention of OURT is the most important and need to be the focus attention for the team work.

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Declaration of Interest

The authors report no conflict of interest.

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