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Morphological Maxillary Inter-Incisor Width in Indonesian Sundanese Children with Beta Thalassemia Major

Eriska Riyanti[1*], Risti Saptarini Primarti[1], Naninda Berliana Pratidina[1], Prima Andisetyanto[1], Selvia Yunita[1], Iwan Ahmad Musnamirwan[1], Eka Chemiawan[1], Sri Ramadhany[2], Marhamah F. Singgih[3]
[1]Pediatric Dentistry Department, Faculty of Dentistry, Padjadjaran Pediatric Dentistry Department, Indonesia
[2]Department of Public Health, Faculty of Medicine, Hasanuddin University, Indonesia
[3]Pediatric Dentistry Department, Faculty of Dentistry, Hasanuddin University, Indonesia
E-mail Correspondence: eriska.riyanti@fkg.unpad.ac.id

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ABSTRACT
Introduction: Thalassemia is a hereditary blood disorder that leads to moderate or severe anemia. This anemia is associated with decreasing hemoglobin levels, thus reducing the erythrocyte count to a lower than normal level. Erythrocytes with less hemoglobin are more susceptible to hemolysis, which reduces their life.
Objectives: To analyze the maxillary inter-incisor width among patients with beta thalassemia major (BTM) in the Sundanese population of Indonesia.
Methods: This cross-sectional study included patients with BTM and normal children, and used a consecutive sampling method. The participants' maxillary impressions were molded and the inter-incisor width measured. Statistical analysis was performed using ANOVA and post hoc test, *with P* values <0.05 considered statistically significant.
Results: The average inter-incisor width was 2.90 cm in children with BTM aged 9-10 years; 2.84 cm in those aged 10-11 years; 2.87 cm in those aged 11-12 years; 2.85 cm in those aged 12-13 years; and 2.78 cm in those aged 13-14 years. The average inter-incisor width of boys was 2.90 cm, and that of girls was 2.74 cm.
Conclusion: The maxillary inter-incisor width in children with BTM was smaller than that in normal children. Among the former, the width was greater in boys than in girls.
Keywords: Maxillary Inter-incisor Width; Beta Thalassemia Major; Indonesian Sundanese Population
Correspondence:
Eriska Riyanti
Pediatric Dentistry Department, Faculty of Dentistry, Padjadjaran Pediatric Dentistry Department, Indonesia
E-mail: eriska.riyanti@fkg.unpad.ac.id
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INTRODUCTION
Thalassemia is a hereditary blood disorder that leads to moderate or severe anemia. This anemia is associated with decreasing hemoglobin levels, thus reducing the erythrocyte count to a lower than normal level. Erythrocytes with less hemoglobin are more susceptible to hemolysis, which reduces their life.[1-2] Thalassemia is classified according to the amino acid chain affected, as alpha thalassemia (production of α-globin chain affected) and beta thalassemia (production of β-globin chain affected).[3,4] Patients with thalassemia usually have severe chronic anemia with paleness, weakness, fatigue, and lethargy.[5-8]

Thalassemia is the most common genetic blood disorder found in many parts of the world. According to a WHO report, in 1993, approximately 300 million people worldwide were the carriers of this genetic trait, and no less than 300,000 babies are born with this disorder annually. Currently, based on data from some major hospitals and educational centers, Indonesia has a high frequency of the thalassemia gene: 3-8% nationwide.[5]

In the Department of Pediatrics of Faculty of Medicine of Padjadjaran University/Hasan Sadikin General Hospital Bandung, Indonesia, as many as 67 cases of thalassemia were reported during 1973-1977. In 1990, a study conducted by Haryono in the Department of Clinical Pathology of Faculty of Medicine of Padjadjaran University/Hasan Sadikin General Hospital, 30 cases of thalassemia major were reported. According to the data obtained from the Department of Pediatrics of Hasan Sadikin General Hospital, 23 new cases were found in 1990.[9]

There are variations in the growth and development of every individual, with a different manifestation of growth acceleration. In girls, the growth acceleration occurs between the age of 9-13 years, and in boys, it occurs between the age of 11-15 years. In dental arch growth, the distance between the canine and molar teeth increases with age.[10] There are three factors affecting the growth of organs inside the human body, which are the growth places, types, and affecting factors. Proffit and Fields in 2000 divided the craniofacial region into four growth areas according to the growth difference of each region, which are the cranial vault, cranial base, maxilla, and mandible.[11]

Many studies have suggested that the main facial change in patients with beta-thalassemia major (BTM) is maxillary enlargement.[12] Orofacial manifestations often found in beta-thalassemia patients are the cheekbones and maxillary protrusion caused by the enlargement of the bone marrow, known as the chipmunk facies.[13] The appearance of prominent frontal and parietal bones and also an enlarged maxilla leads to a typical facial characteristic called thalassemic facies.[14] In severe conditions, the thalassemic facies not only affects the facial aesthetics but also interferes with the mastication, ingestion, and speech function. The present study aimed to analyze the maxillary inter-incisor width among patients with BTM in the Sundanese population of Indonesia.

MATERIALS AND METHODS
The present study was approved by the Committee of Medical Research Ethics of Faculty of Medicine of Padjadjaran University with registration number 132/FKUP-RSHS/KEPK/Kep/EC/2007. This was a cross-sectional study. All samples were obtained from children with BTM and normal children using the consecutive sampling method. The study involved molding the children's maxilla and measuring the inter-incisor width.

Boys and girls as BTM patients aged 9-14 years, with left and right lateral incisors who were being treated at the

Thalassemia Clinic of the Department of Pediatrics of Hasan Sadikin Hospital, Bandung, Indonesia were included in this study. The patients had never received any orthodontic treatment previously, and willingly participated in this study after the study protocol was explained to their parents.

Dental Modelling

The dental modelling was performed by molding the maxilla using a dental impression spoon and alginate. The alginate powder was measured and sprinkled on the rubber bowl, and then poured with the water that was measured with a beaker and then stirred and placed on the dental impression spoon. After the mold was half hardened, it was inserted into the oral cavity and pressed on the maxillary teeth. After the mold was hardened, it was removed from the patient's oral cavity and immediately casted with a stone cast.

Measurement of Maxillary Inter-incisor Width

The measurement of the maxillary inter-incisor width was performed using a millimeter-scale compass and ruler by placing one tip of the compass at the distal contact point of the left incisor, and the other tip at the right incisor. The researcher directly read the measurement result on the ruler. The measurement was performed six times (three times by the researcher, and three times by other people), and then the average score was obtained.

RESULTS

The number of participants who were included in the present study was 56, and the participants were 34 boys and 22 girls aged 9-14 years. The average inter-incisor width in children with thalassemia aged 9-10 years was 2.90 cm; aged 10-11 years was 2.84 cm; aged 11-12 years was 2.87 cm; aged 12-13 years was 2.85 cm; and aged 13-14 years was 2.78 cm. The average inter-incisor width of the boys with BTM was 2.90 cm, whereas that of the girls was 2.74 cm.

The ANOVA test revealed that the inter-incisor width difference between the patients with thalassemia and normal children was significant difference *(P* 0.0028), as presented in Table 5. However, the ANOVA test showed an insignificant difference between the inter-incisor widths of girls and boys with thalassemia *(P* 0.1895), as presented in Table 6. The post-hoc analysis also showed an insignificant difference between the inter-incisor widths of boys and girls with thalassemia of every age range, except in the age range of 11-12 years (Table 7). The post-hoc analysis also showed an insignificant difference between the inter-incisor widths of boys with thalassemia and normal boys of all age ranges (Table 8). The inter-incisor widths of girls with thalassemia and normal girls of all age ranges also showed an insignificant difference (Table 9).

DISCUSSION

The selection of subjects aged 9-14 years in the present study was based on the hypothesis that this age range is when the period of acceleration occurs in child growth. In girls, growth acceleration ranges between the age of 9-13 years, whereas in boys it ranges between the age of 11-15 years.[11,15]

As presented in Table 1, the number of patients with BTM in the present study in whom the inter-incisor width could be measured was 56. The total number of patients with BTM aged 9-14 years who visited the thalassemia clinic during the study period in approximately one month was 76, with a boys-to-girls ratio of 44:32. In total, 20 patients were excluded from this study because of reasons such as the absence of the lateral incisor or conical lateral incisor, or lack of complete eruption of lateral incisors, which makes the determination of the largest contour infeasible; in the patients who refused to take the mold of their maxilla, measurements could be made directly inside their oral cavity. The sex ratio of boys (44 patients) and girls (32 patients) patients was close to 1:1 because thalassemia is not a sex-linked genetic disease, but an autosomal genetic disease.[16]

The indirect measurement method was chosen because direct measurement tended to result in an imprecise value owing to difficulties associated with direct measurement. The use of stone cast was chosen because stone casts have a faster hardening time compared to the plaster cast. Millimeter-scaled ruler and compass were chosen as the measuring devices because they are easy to use and results can be obtained fast, and the results will be accurate.

The results presented in Table 3 show an age-related decrease in the inter-incisor width. In thalassemic patients, one of the clinical symptoms is maxillary protrusion that leads to thalassemia facies.[17,18] With age, the maxillary protrusion in patients with BTM seemed to become more elongated and lead to further narrowing of the inter-incisor width. This was inferred from the study results presented in Table 1.

The results presented in Table 3 show that the inter-incisor width of BTM patients aged 9-14 years was found higher in boys than in girls. This result might be caused by the faster growth acceleration in boys compared to girls.[11]

The results presented in Table 3 also show that the average inter-incisor width of boys with BTM was higher than that of girls of every age range, except in the age group of 10-11 years, where girls presented with an average width of 2.86 cm, and boys presented with an average width of 2.83 cm. This result might be caused by the faster growth acceleration in girls aged 10-11 years than in age-matched boys.[11]

Based on the data obtained, the average thalassemia patient had stunted growth and development in aspects such as body height. Typically, a patient was diagnosed with BTM for the first time between the ages of 3-6 months. The anemia usually occurs in the period of 3-6 months after birth owing to a decreasing β-globin chain synthesis and causes the patient to appear pale, weak, and fatigue, and develop splenomegaly.[17,18]

Typically, BTM patients will need to undergo transfusion once every 1 to 4 weeks, depending on the severity of the disease; however, patients are often unable to undergo transfusion promptly because of cost issues. One of the apparent clinical symptoms of BTM patients is maxillary protrusion.[13,19,20,21,22]

The results presented in Table 5 show that there was a significant difference in the inter-incisor arch width between individuals with thalassemia and normal individuals. The maxillary growth and development in thalassemic patients appear to be bigger than those in the normal children. This is because the erythropoiesis process in thalassemic patients is faster than that in normal individuals, thereby resulting in

more rapid bone growth. The facial shape of thalassemic children, often referred to as chipmunk facies that affected the premaxillary width looks wider in the lateral direction.

The inter-incisor arch widths of boys and girls patients were not significantly different (Table 6). This may be because the growth spurt period is very different between boys and girls. The hormonal factor is very crucial to this condition. The growth hormone is one of the hormones affecting the growth acceleration in individuals of both sexes. The diet is also different between boys and girls. The amount of food intake of boys is more than that of girls.

The results reported in Tables 7, 8, and 9 show the analysis between individuals of different age ranges. The inter-incisor width of individuals of each age range showed no significant difference. Patients with thalassemia of each age range age-matched normal individuals showed a similar progression. The growth of the one-third mandible facial part greatly determines the occlusion distance between the maxilla and mandible. This condition also becomes the reference for the lateral and anterior facial growth and development.

Sundanese is one of the Deutero-Malays ethnic group. The body characteristics of this ethnic group are a medium body height and an oval-shaped face. These characteristics are likely to be one of the factors affecting the inter-incisor arch width of all of the study subjects. Sundanese children have a habit of eating rice as their main carbohydrate source and have a normal masticatory pattern. The three-times-daily dietary habit can also become a determining factor of the inter-incisor arch.

To our knowledge, this issue has never been investigated before. Our results can be used as a database for thalassemia patients in Indonesia and for clinical application to develop treatment planning in dentistry. However, a limitation of this study is the small number of samples analyzed.

CONCLUSION

The maxillary inter-incisor width of children with BTM is smaller than that of normal children, and that this width is greater in boys than in girls.

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TABLES

Table 1: Sample Distribution based on Age and Sex in Children with BTM

Age (y)	Boys (n)	Girls (n)	Number (n)	Percentage (%)
9 – 10	5	2	7	12.5
10 – 11	6	6	12	21.4
11 – 12	8	4	12	21.4
12 – 13	7	4	11	19.7
13 – 14	8	6	14	25.0
TOTAL	34	22	56	100

Table 2: Sample Distribution based on Age and Sex in Normal Children

Age (y)	Boys (n)	Girls (n)	Number (n)	Percentage (%)
9 – 10	6	6	7	21.4
10 – 11	5	2	12	12.5
11 – 12	8	4	12	21.4
12 – 13	8	6	11	25.0
13 – 14	7	4	14	19.7
TOTAL	34	22	56	100

Table 3: Average Inter-incisor Dental Arch based on Age and Sex in Children with BTM

Age (y)	Average (cm)	
	Boys	Girls
9 – 10	2.94	2.80
10 – 11	2.83	2.86
11 – 12	2.95	2.71
12 – 13	2.98	2.62
13 – 14	2.82	2.72

Table 4: Average Inter-incisor Width based on Age and Sex in Normal Children

Age (y)	Average (cm)	
	Boys	Girls
9 – 10	3.01	2.89
10 – 11	3.11	2.90
11 – 12	3.12	3.01
12 – 13	3.13	3.01
13 – 14	3.13	3.01

Table 5: Inter-incisor Width Difference between Patients with BTM and Normal Children

ANOVA table					
Source	SS	Df	MS	F	*P*-Value
Treatment	1.53	19	0.08	2.42	0.0028
Error	3.06	92	0.03		
Total	4.59	111			

Table 6: Inter-incisor Width Difference between Girls and Boys with BTM

ANOVA table					
Source	SS	Df	MS	F	*P*-Value
Treatment	0.6404	9	0.07116	1.47	0.1895
Error	2.2337	46	0.04856		
Total	2.8741	55			

Table 7: Post-hoc Test Results between Boys and Girls Patients with BTM

Group 1	Group 2	Post-hoc Test Result	*P*-Value
BTM Group Girls 9-10 y	BTM Group Boys 9-10 y	Insignificant	0.3361
BTM Group Girls10-11 y	BTM Group Boys 10-11 y	Insignificant	0.7408
BTM Group Girls11-12 y	BTM Group Boys11-12 y	Significant	0.0472
BTM Group Girls 12-13 y	BTM Group Boys 12-13 y	Insignificant	0.072
BTM Group Girls13-14 y	BTM Group Boys13-14 y	Insignificant	0.429

Table 8: Post-hoc Test Results between Boys with BTM and Normal Boys

Group 1	Group 2	Post-hoc Test Result	*P*-Value
BTM Group Boys 9-10 y	Normal Group Boys9-10 y	Insignificant	0.3501
BTM Group Boys 10-11 y	Normal Group Boys10-11 y	Insignificant	0.9743
BTM Group Boys 11-12 y	Normal Group Boys 11-12 y	Insignificant	0.9618
BTM Group Boys12-13 y	Normal Group Boys 12-13 y	Insignificant	0.9934
BTM Group Boys 13-14 y	Normal Group Boys 13-14 y	Insignificant	0.9082

Table 9: Post-hoc Test Results between Girls with BTM and Normal Girls

Group 1	Group 2	Post-hoc Test Result	*P*-Value
BTM Group Girls 9-10 y	Normal Group Girls 9-10 y	Insignificant	0.7575
BTM Group Girls 10-11 y	Normal Group Girls 10-11 y	Insignificant	0.9054
BTM Group Girls 11-12 y	Normal Group Girls 11-12 y	Insignificant	1.0000
BTM Group Girls 12-13 y	Normal Group Girls 12-13 y	Insignificant	0.9706
BTM Group Girls 13-14 y	Normal Group Girls 13-14 y	Insignificant	0.9592

FIGURE LEGENDS

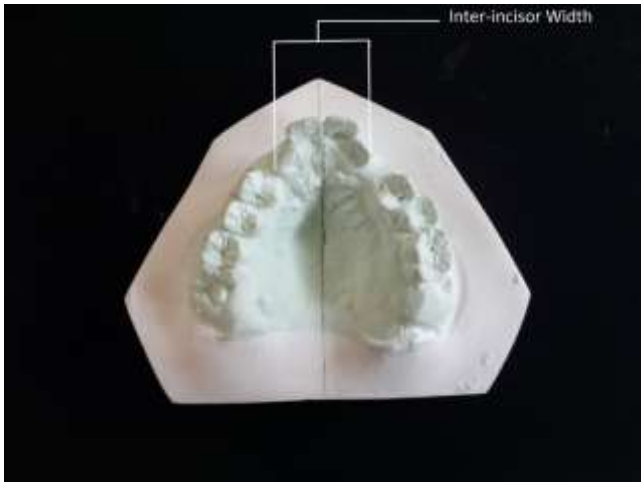

Figure 1: Inter-incisor width