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Remarkable factors related to preventing relapse of deciduous anterior crossbite

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Abstract In pedodontic practice, children with deciduous anterior crossbite are frequently encountered. In treating deciduous anterior crossbite, determining the optimal time to start treatment and predicting the prognosis of treatment are very important. We investigated the pre-treatment morphological characteristics of craniofacial complex and dentition of children with deciduous anterior crossbite who showed favorable prognoses and avoided relapse even after growth and development were completed. The subjects consisted of 7 boys and 12 girls with deciduous anterior crossbite before treatment. The subjects were divided into those without relapse (n = 13) and those with relapse (n = 6) and these two groups were compared using their lateral cephalometric radiographs and study models. The following characteristics were demonstrated in the children without relapse: (1) There was no family history of anterior crossbite. (2) There were no significant differences between two groups in the width or length of mandibular dental arch. (3) Anterior facial height was not longer than the standard value. (4) On angular analysis, the variable with the most conspicuous difference between the non-relapsed prognosis group and relapse group was the NSAr angle (Saddle angle). The value of this angle in the non-relapsed prognosis group was close to the standard value. This retrospective study indicates that early proactive treatment for deciduous anterior crossbite is considered suitable for children with the above characteristics.

Key words
Cephalometric analysis,
Deciduous anterior crossbite,
Saddle angle,
Study model analysis

Introduction

In pedodontic practice, children with deciduous anterior crossbite are frequently encountered[1–3].

During this period of primary dentition, oral function including pronunciation and mastication develops. It is thus considered that normal occlusion, but not anterior crossbite, is advantageous to children acquiring routine oral function during this period.

The rate of spontaneous healing of anterior crossbite during the period of primary dentition is said to be around 14.2%[4]. Moreover, the mandible is protrusive even in the late deciduous dentition and becomes more protrusive with time, making the discrepancy between the upper and lower jaws progressively more severe[5]. Therefore, it seems desirable to restore deciduous anterior crossbite as early as possible.

However, despite the correction of deciduous anterior crossbite, the patients may develop crossbite again and future orthodontic treatment may be required. For this reason, in treating deciduous anterior crossbite, determining the optimal time to start treatment and predicting the prognosis of treatment are very important.

In the present study, we investigated the pre-treatment morphological characteristics of craniofacial complex and dentition of children with deciduous anterior crossbite who showed favorable prognoses and avoided relapse even after growth and development were completed.

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Table 1 Subjects

	Boys		Girls	
	N group	R group	N group	R group
N	5	2	8	4
Mean age (years)	4.7	4.8	4.8	4.9

The subjects were divided into those without relapse (N group) and those with relapse (R group) and these two groups.

Materials and Methods

Subjects and materials

The subjects consisted of 19 Japanese children (7 boys and 12 girls) with deciduous anterior crossbite before treatment. The subjects were divided into those without relapse (N group) and those with relapse (R group) and these two groups were compared using their study models and lateral cephalometric radiographs taken at first examination (Table 1).

The construction bite could be taken by positioning the mandible posteriorly into centric relation from all subjects. All subjects were treated with lingual arch.

The presence or absence of a family history of anterior crossbite investigated by asking their parents or related guardians.

Study model analysis

Using a pair of electronic digital slide calipers, dental arch width, dental arch length, overbite and overjet were measured (Fig. 1). The following distances were measured as arch width: distances between the cusps of the bilateral deciduous canines in the maxilla and mandible, distances between the lowest lingual cervical points of the bilateral deciduous canines, deciduous first molars, and deciduous second molars in the maxilla and mandible, the distances between the lingual cusps of the bilateral deciduous first molars and deciduous second molars in the maxilla and mandible, distance between the buccal terminal sulci of the mandibular deciduous first molars, and the distance between the mesiobuccal terminal sulci of the deciduous second molars.

As arch length, the lengths of perpendiculars from the midpoint of inter labial surfaces of central deciduous incisors to the following lines were measured: to the cusp of deciduous canine in both side (1-3C), line connecting left and right buccal terminal sulci of second deciduous molars (1-5B), and the line connecting to left and right distal surfaces of second deciduous molar crown (1-5D).

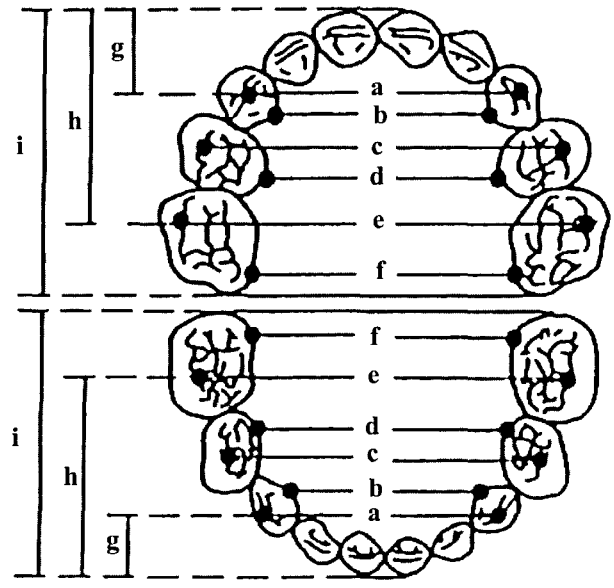

Fig. 1 Measurement items of dental arch size

a: The width of cusp of deciduous canine in both side (C-C)
b: The width of lingual cervical line of deciduous canine in both side (CL-CL)
c: The width of buccal cusp of maxillary first deciduous molars in both side (D-D)
The width of left and right buccal terminal sulci of mandibular first deciduous molars (D-D)
d: The width of lingual cervical line of first deciduous molars in both side (DL-DL)
e: The width of left and right buccal terminal sulci of second deciduous molars (E-E)
f: The width of lingual cervical line second deciduous molars in both side (EL-EL)
g: The length of inter labial surfaces of central deciduous incisors to the cusp of deciduous canine in both side (1-3C)
h: The length of inter labial surfaces of central deciduous incisors to left and right buccal terminal sulci of second deciduous molars (1-5B)
i: The length of inter labial surfaces of central deciduous incisors to left and right distal surfaces of second deciduous molar crown (1-5D)

Superimposed N group, R group, and standard profilograms of Japanese Society of Japanese Dentistry[19].

The results of measurements were compared with previously reported standard values[6,7].

Cephalometric analysis

Lateral cephalometric radiographs were analyzed using the method of the Japanese Society of Pediatric Dentistry[8]. On standard cephalometric radiographs, both linear and angular measurements were performed and the results were compared with previously

Table 2 Family history of anterior crossbite

Family history	Boys				Girls				Total			
	N group		R group		N group		R group		N group		R group	
	N	(%)	N	(%)	N	(%)	N	(%)	N	(%)	N	(%)
with familiar crossbite	0	(0.00)	2	(100.00)	1	(12.50)	2	(50.00)	1	(7.69)	4	(66.67)
without familiar crossbite	5	(100.00)	0	(0.00)	7	(87.50)	2	(50.00)	12	(92.31)	2	(33.33)
			*								**	

*: Significant difference at the 5% level, Yates 2×2 Chi-square test
**: Significant difference at the 1% level, Yates 2×2 Chi-square test

Table 3 Values of arch width

		Deciduous canine				First deciduous molar				Second deciduous molar			
		C-C		CL-CL		D-D		DL-DL		E-E		EL-EL	
		N group	R group	N group	R group	N group	R group	N group	R group	N group	R group	N group	R group
Maxillary arch													
Boys	N	5	2	5	2	5	2	5	2	5	2	5	2
	Mean	29.92	30.44	24.28	25.53	39.27	40.79	27.00	28.42	46.09	47.16	29.42	30.42
	S.D.	2.09	1.48	1.54	1.12	1.88	0.74	1.34	1.28	1.42	0.11	1.26	0.93
Girls	N	7	4	7	4	7	4	7	4	7	4	7	4
	Mean	29.55	30.58	24.69	25.60	38.72	39.62	27.02	28.25	45.59	46.85	29.91	30.98
	S.D.	0.71	0.99	1.24	0.42	1.22	0.22	1.37	0.46	2.62	1.77	2.37	1.68
Mandibular arch													
Boys	N	5	2	5	2	5	2	5	2	5	2	5	2
	Mean	23.72	24.51	19.34	20.10	33.73	34.24	24.61	25.90	40.16	39.45	29.02	29.47
	S.D.	1.03	0.74	1.19	1.41	1.61	0.42	1.05	0.74	1.76	0.40	0.97	1.82
Girls	N	7	4	7	4	7	4	7	4	7	4	7	4
	Mean	23.70	25.20	20.12	20.40	33.47	32.85	24.45	24.56	39.18	40.30	28.42	30.06
	S.D.	1.37	0.73	1.01	1.26	1.68	2.58	1.06	1.37	1.45	1.34	1.64	2.25

(mm)

C-C: The width of cusp of deciduous canine in both side. CL-CL: The width of lingual cervical line of deciduous canine in both side. D-D: The width of buccal cusp of maxillary first deciduous molars in both side. The width of left and right buccal terminal sulci of mandibular first deciduous molars. DL-DL: The width of lingual cervical line of first deciduous molars in both side. E-E: The width of left and right buccal terminal sulci of second deciduous molars. EL-EL: The width of lingual cervical line second deciduous molars in both side.

reported standard values[8-10].

Statistical methods

The findings of family history in each group were statistically analyzed using Yates 2×2 Chi-square test. The measurements of each group were statistically analyzed using the Student's *t*-test.

Results

Table 2 shows the presence or absence of family history of anterior crossbite. In the N group, only 1 girl had a family history of anterior crossbite. In the R group, however, 2 boys and 2 girls had a family history. Namely, the proportion of patient with its family history was significantly lower in the good occlusion group than in the poor occlusion group.

Table 3 shows the values of arch width. In both boys and girls, none of the determined values of arch width showed any significant difference between the two groups.

Table 4 shows the values of arch length. In both boys and girls, none of the determined values of arch length showed any significant difference between

Table 4 Values of arch length

		1-3C		1-5B		1-5D	
		N group	R group	N group	R group	N group	R group
Maxillary arch							
Boys	N	5	2	5	2	5	2
	Mean	6.25	7.45	21.01	23.95	25.02	27.91
	S.D.	1.53	1.03	2.42	1.05	0.77	0.53
Girls	N	7	4	7	4	7	4
	Mean	6.70	6.61	21.53	19.64	24.99	26.34
	S.D.	1.16	1.15	2.67	1.04	2.22	1.00
Mandibular arch							
Boys	N	5	2	5	2	5	2
	Mean	4.81	5.11	20.59	19.27	25.42	26.85
	S.D.	0.86	1.33	1.06	1.37	1.36	0.16
Girls	N	7	4	7	4	7	4
	Mean	4.89	5.63	20.24	18.87	24.44	25.68
	S.D.	0.88	0.47	3.49	1.06	2.39	1.13

(mm)

1-3C: The length of inter labial surface of central deciduous incisors to the cusp of deciduous canine in both side. 1-5B: The length of inter labial surfaces of central deciduous incisors to left and right buccal terminal sulci of second deciduous molars. 1-5D: The length of inter labial surfaces of central deciduous incisors to left and right distal surfaces of second deciduous molar crown.

Table 5 Values of overbite and overjet

		Overbite		Overjet	
		N group	R group	N group	R group
Boys					
	N	5	2	5	2
	Mean (mm)	2.08	1.56	−0.19	−0.87
	S.D.	0.70	2.21	1.60	0.12
Girls					
	N	7	4	7	4
	Mean (mm)	1.96	2.80	−1.22	−1.87
	S.D.	1.04	0.61	1.41	0.64

(mm)

the two groups.

Table 5 shows the values of overbite and overjet. In both boys and girls, none of the determined values of overbite and overjet showed any significant difference between the two groups.

Table 6 shows the results of linear measurement. In the linear measurement, neither boys or girls showed any significant difference between the two groups for any of the items examined. However, the front facial height in the N group showed a tendency to be not very large compared with the respective standard values in both boys and girls[8,9].

Table 7 shows the results of angular measurement. Concerning the angular measurements, a significant difference between the two groups was observed in the NSAr angle (Saddle angle). The saddle angle in the N group was not as large as the respective standard values, while the saddle angle of the R group was smaller than the standard values for both boys and girls[8,10].

Table 6 Values of linear measurements

Variable	Boys							Girls						
	N group			R group			*t*-test	N group			R group			*t*-test
	N	Mean (mm)	S.D.	N	Mean (mm)	S.D.		N	Mean (mm)	S.D.	N	Mean (mm)	S.D.	
N-S	5	65.44	3.32	2	65.10	0.57	NS	8	63.44	2.53	4	61.23	2.81	NS
N-Me	5	105.34	6.36	2	105.90	1.27	NS	8	103.43	4.21	4	103.15	3.37	NS
N-Ans	5	48.52	7.01	2	45.20	0.28	NS	8	43.37	9.76	4	45.48	3.24	NS
Ans-Me	5	58.72	0.93	2	62.65	2.62	*	8	59.27	1.88	4	59.03	1.33	NS
S'-Ptm'	5	20.18	3.19	2	22.25	6.86	NS	8	15.89	5.51	4	18.60	3.54	NS
A'-Ptm'	5	40.92	1.98	2	41.75	0.07	NS	8	43.86	3.78	4	41.13	3.63	NS
Ptm'-Ms	5	19.16	3.02	2	15.10	6.08	NS	8	19.35	2.79	4	16.48	4.13	NS
A'-Ms	5	21.72	2.66	2	26.60	6.22	NS	8	22.37	2.35	4	24.65	3.32	NS
Is-Is'	5	24.82	1.03	2	26.55	1.06	NS	8	25.44	0.83	4	23.93	1.17	*
Mo-Ms	5	18.80	0.73	2	23.95	5.44	NS	8	19.12	2.78	4	18.23	1.37	NS
Is-Mo	5	20.90	3.52	2	27.10	7.78	NS	8	22.93	0.90	4	25.38	5.07	NS
Gn-Cd	5	94.52	3.15	2	101.65	1.06	*	8	98.03	5.41	4	96.93	5.63	NS
Pog'-Go	5	62.52	1.48	2	61.80	0.71	NS	8	65.86	2.89	4	61.98	2.02	*
Cd-Go	5	46.00	1.36	2	50.70	3.54	*	8	46.99	3.49	4	47.38	3.86	NS
Ii-Ii'	5	33.82	1.79	2	34.90	1.27	NS	8	32.59	2.03	4	33.70	2.49	NS
Mo-Mi	5	28.48	3.94	2	23.70	7.35	NS	8	33.23	11.51	4	26.05	1.85	NS
Ii-Mo	5	21.18	2.09	2	29.15	8.98	NS	8	19.07	5.90	4	26.13	5.26	NS
S-S'	5	18.34	2.00	2	16.35	1.48	NS	8	19.39	2.06	4	17.00	2.77	NS

(mm)

*: Significant difference at the 5% level, Student's *t*-test

Table 7 Values of angular measurements

Variable	Boys							Girls						
	N group			R group			*t*-test	N group			R group			*t*-test
	N	Mean (mm)	S.D.	N	Mean (mm)	S.D.		N	Mean (mm)	S.D.	N	Mean (mm)	S.D.	
Facial Angle	5	82.80	2.56	2	85.45	3.61	NS	8	84.83	2.32	4	85.68	3.32	NS
Convexity	5	7.60	4.26	2	4.45	1.48	NS	8	4.96	2.75	4	5.90	2.57	NS
A-B plane	5	−5.82	2.48	2	0.95	0.64	*	8	−1.20	2.28	4	3.28	2.21	*
Mandibular p.	5	30.00	2.19	2	32.30	3.68	NS	8	29.13	4.15	4	30.38	2.43	NS
Y-Axis	5	62.24	1.81	2	61.25	3.89	NS	8	61.77	2.49	4	61.05	3.04	NS
Occlusal p.	5	14.12	1.59	2	20.25	7.00	NS	8	12.35	2.78	4	15.45	5.17	NS
Interincisal	5	158.38	11.82	2	165.35	5.30	NS	8	153.36	8.32	4	146.65	9.72	NS
L-1 to Mand.	5	81.88	4.91	2	68.70	2.40	*	8	83.83	7.57	4	82.43	7.34	NS
FH to SN	5	8.84	4.78	2	7.75	1.77	NS	8	7.44	5.31	4	9.78	0.48	NS
SNP	5	74.32	2.83	2	76.25	3.32	NS	8	77.43	4.86	4	77.90	1.19	NS
Y-axis (SN)	5	70.80	2.96	2	70.30	3.82	NS	8	69.13	4.07	4	70.73	3.32	NS
SNA	5	78.62	4.61	2	78.35	4.03	NS	8	79.73	4.85	4	78.93	2.58	NS
SNB	5	75.16	2.47	2	76.95	3.32	NS	8	78.36	5.13	4	77.28	3.96	NS
U-1 to FH	5	87.40	8.47	2	92.30	1.27	NS	8	93.76	3.70	4	91.98	9.08	NS
U-1 to SN	5	78.80	8.84	2	84.50	0.42	NS	8	86.41	4.83	4	82.38	9.03	NS
Gonial Angle	5	128.30	3.96	2	135.00	1.84	NS	8	127.96	4.93	4	128.33	3.46	NS
Ramus (SN)	5	90.26	3.55	2	86.70	4.95	NS	8	88.57	4.34	4	92.13	6.74	NS
Ramus (FH)	5	83.10	3.37	2	78.90	3.25	NS	8	81.69	5.81	4	83.03	5.91	NS
N-S-Ar	5	123.96	3.49	2	116.25	1.77	*	8	125.10	3.40	4	119.75	4.11	*

(mm)

*: Significant difference at the 5% level, Student's *t*-test

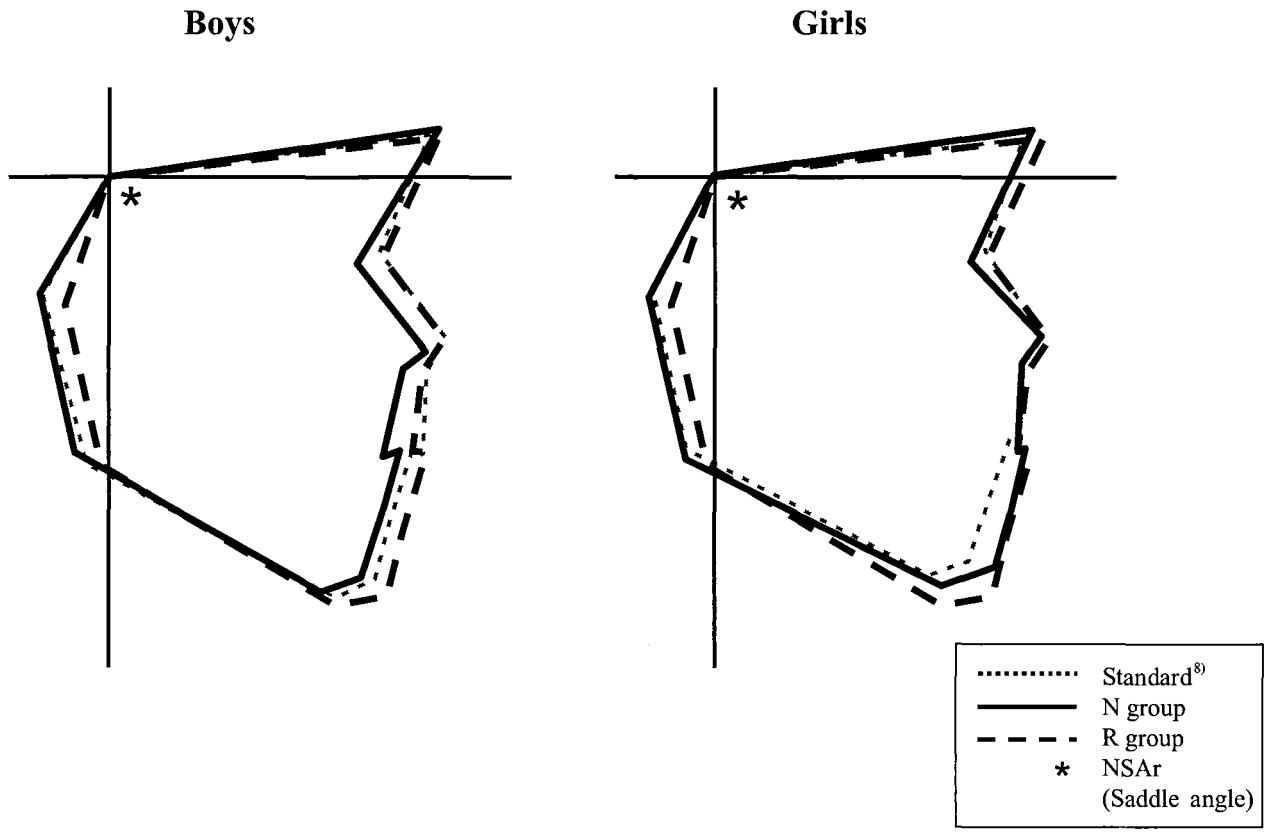

Fig. 2 Profilograms superimposed on standard value

Figure 2 shows N group profilograms and R group profilograms superimposed on standard value profilograms, respectively. Their profilograms also indicated that the saddle angle was smaller and the mandible protruded more anteriorly in the R group than in the N group.

Discussion

Family history of anterior crossbite is one of the important factor predicting the prognosis after treatment. In this study, the proportion of patients with a family history was lower in the N group than in the R group, which indicated agrees with the findings reported by Miyahara[11)].

Miyahara[11)] indicated that there was no distinct difference in the size of dental arch between pediatric patients with anterior deciduous crossbite that resolved spontaneously and those that did not. In the present study, there was no remarkable difference in the size of dental arch between the N and R groups. Based on the evidence presented above, it was suggested that the size of dental arch is hardly a determinant factor for predicting the prognosis of anterior crossbite.

When the size of the mandibular dental arch in the two groups was compared with the respective standard value in Japanese, the former values were found to successfully fall within the standard deviation derived from Japanese, implying that some cases had an episode of replacement even if the size of mandibular dental arch did not differ from the standard value. Therefore, it is supposed that a careful observation is required in such a case as those having a large mandibular dental arch exceeding the standard deviation.

In this study, there was no distinct difference between the two groups with regard to the distance measurements agreed with those reported by Miyahara[11)]. Sakamoto *et al.*[12)] and Mitani *et al.*[13)] concluded that the principal skeletal frame of those with mandibular prognathism is established before the pubertal growth period. As for growth and development in pediatric patients with anterior crossbite, Battagel[14)] and Miyajima *et al.*[5)] indicated that a retrograded mandible is often observed in younger

patients with anterior crossbite and the tendency is continued thereafter. Their studies indicated that the prognosis of anterior crossbite greatly depend on the pre-treatment maxillo-facial state.

Concerning the angular measurements of this study, a statistically significant difference between the two groups was observed in the saddle angle. Dissimilar to the angle of axial inclination, the saddle angle is hardly affected by orthodontic treatment. If the amount of mandibular growth is almost equal between a child with small saddle angle and another child with a large saddle angle, the mandible of the former must protrude more anteriorly than the latter[15].

Given the evidence presented above in a systematic manner, children with a relatively small saddle angle during the period of deciduous dentition are apt to have a characteristic skeleton thereafter with a potentially high risk of post-treatment retrogression. It was thus concluded that a saddle angle should be followed carefully when the prognosis of early treatment for anterior crossbite is predicted using standard cephalograms for analysis.

Several investigators have published articles indicating that anterior crossbite is exacerbated with advancing age[5,14,16–19]. In addition, it was also reported by some authors that deciduous anterior crossbite has a distinct influence on the paths of habitual opening movements[20]. Furthermore, Kaihara *et al.*[21] reported that the terminal plane became the vertical type, the curve of Spee was flattened, and the arch shape and maxillomandibular occlusal relationship approached normal after the early treatment for deciduous anterior crossbite. Namely, the early treatment is thus considered not only to prevent a potential exacerbation of anterior crossbite but also to promote a normal development of jaw function in children.

Individual differences distinctly exist in the therapeutic effect on anterior crossbite and relapse may occur. From the dentist's perspective, it is desirable to avoid prolonged treatment as far as possible and dentists are thus required to make a careful decision when they initiate treatment for anterior crossbite. However, the present study demonstrated the characteristics of maxillo-facial complex and dentition of children who did not show any sign of relapse after treatment of deciduous anterior crossbite. It can be concluded from this study that in a child with the characteristics demonstrated above, its early treatment is very effective and the treatment is allowed to initiate positively.

Conclusion

This retrospective study indicates that early proactive treatment for deciduous anterior crossbite is considered suitable for children with the following characteristics: (1) There was no family history of anterior crossbite. (2) There were no significant differences from the standard values in the width or length of mandibular dental arch. (3) On angular analysis, the variable with the most conspicuous difference between the non-relapsed prognosis group and relapse group was the NSAr angle (Saddle angle). The value of this angle in the non-relapsed prognosis group was close to the standard value.

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