

## Mandibular Size and Position in 8-13 Year Old Iranian Children with Class II Division 1 Malocclusion

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### Abstract:

**Statement of Problem:** Assessment of mandibular size and position is essential when planning a treatment strategy for patients with Class II malocclusion.

**Purpose:** This study was carried out to evaluate the mandibular size and position of 8-13 year-old children with Class II Division 1 malocclusion whom were referred to the Faculty of Dentistry, Shiraz University of Medical Sciences, Iran.

**Materials and Methods:** 935 lateral cephalograms of children with normal occlusion (425 films) and Class II Division 1 patients (510 films) referred to the Department of Orthodontics, School of Dentistry, Shiraz University of Medical Sciences, during 2002 to 2004 were evaluated. The control and Class II Division 1 subjects were each divided into three groups according to age (8-9, 10-11 and 12-13 years), and were further divided into two subgroups according to gender. The radiographs were converted to computer-readable X and Y coordinate and data obtained from 29 linear and angular measurements in the cranial base, mandible and dentition, were compared.

**Results:** The cranial base angle was significantly larger in Class II Division 1 patients as compared to the control subjects. A smaller mandible along with a protrusive dentition was observed in the test group. The form and position of the mandible was also different in comparison to normal cases. All class II patients showed a vertical growth pattern and an increased facial height.

**Conclusion:** The main factors responsible for class II Division 1 malocclusion in 8-13 year-old children in present study were retropositioning of the lower jaw and a short mandibular length.

**Key Words:** Class II Division 1; Malocclusion; Mandible position and size

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### INTRODUCTION

In dentofacial orthopedics a thorough knowledge of the skeletal and dental components that cause a specific malocclusion may be considered a prerequisite for planning orthodontic treatment and orthognathic surgery. Therefore, determination of the size, form and position of the mandible and also the location of the mandibular first permanent molar is essential for choosing the appropriate appliances and evaluation of the treatment

results in class II division I patients. In addition, it is important to know whether a skeletal discrepancy is associated with, or is the cause of, a dental malocclusion [1]. The mandible can be normal or deficient in Class II division 1 individuals and mandibular deficiency might be due to its small size or retroposition. An understanding of the broad characteristics of normal and deviant gnathic growth (mandibular deficiency, maxillary protrusion or both) in Class II Division 1

patients can sometimes enable the clinician to control the outcome of treatment and prevent failure [2].

A number of studies investigated the relationship between mandibular deficiency and Class II malocclusion [3-5]. While some of the published reports suggested that a combination of mandibular size and position were responsible for Class II Division 1 mal-occlusion [6,7], others attributed the malocclusion to either the size [8-10] or the position of the lower jaw [11-13].

Previous studies were influenced by a number of factors including insufficient sample size, a wide range of the subjects' ages, lack of controls, and unreliability of some angular measurements used to determine the jaw position. Considering variations in prior investigations and the importance of age, mandibular size and position in orthodontic treatment planning, the present study was designed to evaluate the mandibular size and position in subjects with Class II Division 1 malocclusion in 8 to 13 year-old Iranian schoolchildren who were referred to the Faculty of Dentistry, Shiraz University of Medical Sciences, Iran.

## MATERIALS AND METHODS

510 subjects with Class II division 1 malocclusion were selected from those referred to the Faculty of Dentistry, Shiraz University of Medical Sciences, during 2002-2004. The inclusion criteria were: Class II Division 1 malocclusion diagnosed by clinical examination and dental casts (convex profile, Class II molar and canine relationships, overjet > 4 mm); an age range of 8-13 years; a normal FH-SN angle ( $7-8^{\circ}$ ); presence of all permanent teeth (except for third molars); and access to high quality cephalograms, all radiographs were taken using a PM (Planmeca o-y), CC Proline-cephalostat (KV=85 2002 CA and CM) by the same technician. The exclusion criteria were prior orthodontic treatment and history of severe medical illnesses.

The control group (n=425) was chosen from 573 skeletal Class 1 patients. The inclusion criteria for the control group were a straight or mild convex profile (angle of convexity = 0-5 degrees); class 1 occlusal relationship (2-4 mm overjet and overbite, normal incisal inclination); less than 5 mm crowding; and a lateral cephalometric assessment of ANB (1-4 degrees) and Wit's ( $1 \pm 1$  mm). These subjects had received short term non-extraction orthodontic treatment to correct dental crowding.

The case and control groups were divided into three subgroups according to age (8-9, 10-11, and 12-13) in order to assess the growth changes. Each of these subgroups was subsequently divided into two groups according to gender.

The lateral cephalograms of all patients were converted into a mathematical model, and then into a composite drawing by tracing and digitizing anatomical landmarks. The tracing was orientated on a scanner so that sella would represent the origin of a Cartesian coordinate system. The X-axis was defined as a line parallel to the Krogman-Walker horizontal plane (marked by two highly reproducible endpoints: occipitale and maxillon) through sella [1]. Maxillon was the point just below the Key ridge, midway between the upper and lower border of the palate. Occipitale was the lowest point on the occipital bone. The Y-axis was perpendicular to the X-axis through the sella (Fig. 1 B).

On cephalograms, 22 points were selected and digitized to measure 10 angles (Tables I, II and III) and 19 lines (Fig. 1) on the cranial base, mandible, alveolar processes and the lower teeth. All points were determined and verified three times by the authors. A computer software program (Photoshop 7) was used to calculate the mean X and Y coordinated values for each of the landmarks for each subgroup (3 female and 3 male) within the control and Class II Division 1 groups. The reliability was estimated to be 0.89.

**Table I:** Descriptive statistics obtained from 8-9 year-old male and female children participated in the present study.

Definition	P-Value (gender)	Males (8-9 y/o)			Females (8-9 y/o)		
		Control	Class II Division 1	P-Value	Control	Class II Division 1	P-Value
		69	75		70	81	
<b>Cranial base:</b>							
Ba-S-N	0.85	130.6 (4.8)	132.9 (4.5)	0.01	130 (4.3)	132.7 (4.9)	0.009
Ba-N	0.002	100 (3.8)	105.7 (4.6)	0.001	101.4 (5)	103.2 (5.1)	0.08
S-N	0.02	69.4 (3.3)	71.4 (3.4)	0.004	68.3 (2.6)	69.9 (3.4)	0.01
N-S-Ar	0.02	121.6 (4.4)	123.4 (4.3)	0.04	120.3 (4.7)	122.4 (4.9)	0.03
Ar-S	0.09	14.6 (3.8)	15.2 (3.4)	0.01	14.4 (3.3)	14.9 (3.4)	0.46
S-Go	0.001	70.3 (3.8)	68.4 (3.5)	0.01	66.3 (4.3)	65.5 (4.3)	0.35
<b>Mandible:</b>							
Ar-Gn	0.05	98.4 (5.2)	96.6 (5.1)	0.05	97.1 (5.4)	95.2 (4.6)	0.047
Ar-Go	0.01	40.3 (3.5)	38.8 (3.6)	0.039	37.7 (3.5)	35.0 (3.4)	0.062
18-Pog	0.05	77.2 (4.4)	76.3 (4.3)	0.05	75.2 (5.3)	74.1 (4.8)	0.37
S-N-D	0.09	70.4 (3.4)	69.1 (2.3)	0.02	71.3 (3.3)	70.2 (2.7)	0.06
ANB	0.0001	4.3 (2.7)	6.2 (2.3)	0.001	4.2 (2.1)	5.7 (8.1)	0.001
[Or-Po]-[MeGo]	0.02	25.3 (3.4)	26.7 (2.5)	0.01	25.8 (2.3)	25.9 (2.1)	0.81
<b>Facial depth:</b>							
Ar-N	0.01	89.7 (4.3)	91.1 (4.2)	0.11	88.3 (4.4)	90.2 (3.7)	0.01
18-Pog	0.0001	79.4 (4.7)	77.2 (4.4)	0.01	75.8 (3.9)	75.2 (5.3)	0.84
<b>Facial height</b>							
N-Me	0.0001	112.8 (5.7)	113.2 (5.1)	0.052	109.8 (5.6)	111.1 (5.3)	0.064
Pr-Me	0.0001	49.3 (4.2)	52.3 (3.9)	0.001	46.8 (3.8)	48.6 (4.3)	0.03

According to the scale on each radiographic film, a magnification coefficient was calculated. After data collection, the descriptive statistics, including mean and standard deviation were determined for each subgroup within the control and Class II Division 1 groups. Student *t*-test was used to compare the matching control and test groups for gender and age.

## RESULTS

The most important variables that showed statistical significance are listed below:

### Cranial base

In all age ranges, the total cranial base length (Fig. 1A, line 8) was significantly larger in Class II Division 1 subjects as compared to those in the control groups. Moreover, cranial base flexure (Ba-S-Na) and saddle angle (Ar-S-Na) were larger in Class II Division 1 patients in all age ranges, reaching statistical significance in most cases (Tables I, II, and III).

### Mandible

In all age ranges, the overall length of the mandible (Fig. 1A, line 2), ramal height (Fig. 1A, line 1) and body length (Fig. 1A, line 7) were shorter in subjects with Class II Division 1 than those in the control groups, demonstrating statistical significance in most instances (Tables I, II, and III). Pogonion, B and D points, were retruded in Class II Division 1 subjects in comparison to the matching controls in all age ranges, showing statistical significance in most parameters, especially in the 10-11 year and 12-13 year age ranges. Although the mean value of FMA and GoGn-SN angles were higher in Class II Division 1 subjects as compared to the matching controls, statistical significance was observed only in male subjects. The mean value of S-Pog (Fig. 1B, line 1), S-Go (Fig. 1B, line 5) and S-Gn (Fig. 1B, line 3) distances in Class II Division 1 subjects were significantly less than the matching controls, only in the 12-13 year age range.

**Table II:** Descriptive statistics obtained from 10-11 year-old children participated in the present study.

Definition	P. Value (gender)	Males (10-11 y/o)		Females (10-11 y/o)		P. Value	P. Value
		Control	Class II Division 1	Control	Class II Division 1		
		71	83	68	87		
<b>Cranial base:</b>							
Ba-S-N	0.3	130.8 (5.1)	133.5 (5.1)	0.005	130.9 (5.1)	132.7 (4.9)	0.06
Ba-N	0.0001	104.6 (3.3)	109.3 (4.5)	0.001	101.9 (4.8)	104.6 (4.9)	0.005
S-N	0.0001	71 (2.9)	72.4 (3.6)	0.02	68.9 (2.9)	69.5 (3.8)	0.39
N-S-Ar	0.4	121.4 (6.6)	123.6 (4.6)	0.04	121 (4.3)	122.9 (6.1)	0.09
<b>Mandible:</b>							
Ar- Gn	0.0001	104.9 (4.6)	101.4 (4.9)	0.001	99.8 (5.2)	97.3 (4.8)	0.01
Ar-GO	0.002	41.4 (3.8)	39.1 (3.4)	0.001	38.4 (4.2)	37.3 (4)	0.17
18-Pog	0.0008	79.3 (5.3)	77.1 (4.8)	0.01	76.8 (4.8)	75.3 (3.9)	0.07
S-Ar	0.2	15.2 (4.5)	16.7 (4.1)	0.05	14.8 (3.5)	15.3 (3.7)	0.88
S-Go	0.0001	72.4 (4.5)	71.8 (3.9)	0.42	67.7 (3.9)	66.7 (3.8)	0.009
S-N-Pog	0.85	78.9 (3.3)	77.2 (3.5)	0.007	79.8 (2.8)	77.3 (3.2)	0.002
S-N-B	0.5	77.8 (3.8)	75.1 (2.5)	0.001	78.6 (3.3)	76.1 (3.9)	0.03
S-N-D	0.09	71.2 (3.6)	70.1 (2.5)	0.001	71.5 (3.4)	69.4 (2.8)	0.02
[S-N]-[Go-Gn]	1	33.2 (3.6)	34.5 (2.8)	0.03	33.4 (2.7)	34.5 (2.6)	0.31
[Or-Po]-[Me-Go]	0.1	25.6 (3.9)	26.9 (2.9)	0.03	25.3 (2.5)	26.2 (2.7)	0.17
<b>Dentition:</b>							
S-DL6	0.0001	32.7 (3.6)	32.3 (4.7)	0.61	30.3 (4.8)	29.4 (3.5)	0.009
Mid RmPt-DL6	0.0001	42.8 (3.3)	42.8 (3.3)	0.28	39.9 (4.4)	29.3 (4.3)	0.02
[L1-16]-[Go-Me]	0.001	94.7 (2.9)	95.2 (3.1)	0.36	94.3 (3.8)	96.6 (3.8)	0.01
<b>Facial Height and Depth</b>							
Ar-N	0.0001	92.4 (4.9)	94.8 (4.7)	0.006	89.2 (4.8)	90.8 (3.9)	0.21
Mid RmPt-A	0.0001	80.7 (3.9)	82.3 (4.0)	0.001	74.6 (4.5)	75.6 (4.9)	0.12
18-Pog	0.0002	82.3 (4.7)	79.3 (5.3)	0.001	78.7 (4.2)	76.8 (4.8)	0.005
N-Pr	0.0001	69.1 (3.9)	70.3 (4.5)	0.12	66.6 (4.7)	67.3 (4.7)	0.003
Pr-Me	0.004	50.6 (3.6)	53.4 (4.6)	0.001	48.7 (3.5)	51.3 (4.7)	0.9

### Mandibular Dentition

An increased molar-incisor distance (Fig. 1A, line 4) was observed in all cases with the Class II Division 1, however, only 12-13 year-old males showed significant difference. The lower incisor inclination (IMPA) was greater in Class II Division 1 subjects than the matching controls, showing statistical significance in 12-13 year-old males and females and 10-11 year-old females (Tables I, II, and III).

### Facial height

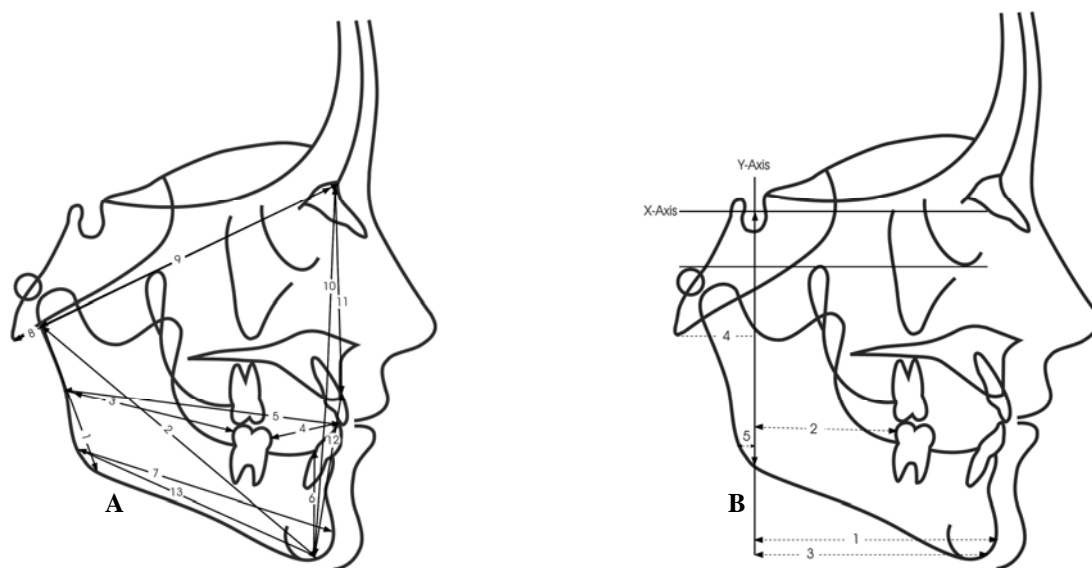
Total anterior facial height (N-Me, Fig. 1A, line 10) was significantly larger in the 12-13 year-old age group of Class II Division 1 subjects. The upper anterior facial height (N-Pr, Fig. 1A, line 11) showed significance increase in 10-11 year-old females and the 12-13 year-old of test group. Lower anterior facial

height (Pr-Me, Fig. 1A, line 12) was significantly larger in subjects with Class II Division 1 than the matching controls, except for the 10-11 year-old female subgroups.

Posterior facial height (S-GO, Fig. 1B, line 5) was significantly smaller in Class II Division 1 subjects compared to the matching controls in all subgroups except for the 8-9 year-old female and 10-11 male subgroups (Tables I, II, and III).

### DISCUSSION

Determination of factors contributing to Class II Division 1 malocclusion is important in preparatory measures, approach to treatment and treatment outcome. Therefore, this study tried to determine the factors contributing to this malocclusion among Iranian school-



**Fig. 1:** Schematic images of the linear measurements used in the study.

children residing in Shiraz. According to the present investigation, mandibular retroposition and small size were the main aspects of Class II Division 1 malocclusion in the studied patients, especially those in the age range of 12-13 years. A vertical growth pattern of the face with increased facial height and protrusion of the lower anterior teeth were also observed in the older age groups. The cranial base length increased in all the studied Class II Division 1 subgroups and most of these subjects also showed an increase in the cranial base flexure and the saddle angle. This implies a posterior position of the mandible in relation to the cranial base, a situation which can directly affect the approach to treatment. The results of the present study were comparable with those of Maj et al in 1960 [14], James in 1963 [11], Houston in 1967 [12], Buschang et al in 1986 [7] and Kerr et al in 1994 [13]. However, our findings differed from those reported by Rosenblum [15] and Rothstein and Yoon-Tarlie [1], who described a similar mandibular position in Class II Division 1 and normal individuals. In a study conducted by Rothstein and Yoon-Tarlie, the anterior position of point N, rather than the posterior

position of point B, was attributed to the smaller SNB angle in Class II Division 1 subjects [1].

The findings of the current investigation revealed smaller mandibular length and ramal height in Class II Division 1 subjects compared to their normal controls, especially in the 12-13 year-old subgroups. Small size and retropositioning of the mandible are the most important factors which should be considered during treatment planning. However, there is no agreement as to whether a small size of mandible can always be considered as a component of Class II malocclusion. Gilmore [8], Blair [9], Menezes [10] and Buschang et al [7] considered small mandibular size as a contributing factor for Class II malocclusion, but Kerr et al [13] proposed the larger gonial angle and the short mandibular body length to be responsible, at least in part, for the problem. Moreover, Bishara [16] suggested that smaller mandibular body length was a contributing factor only in the earlier (primary and mixed dentition periods), and not in the later stages of development (after third molar eruption).

However, Maj et al [14] and Rothstein and

**Table III:** Descriptive statistics obtained from 12-13 year-old children participated in the present study.

Definition	P-Value (gender)	Males (12-13) y/o			Females (12-13) y/o		
		Control	Class II Division 1	P-Value	Control	Class II Division 1	P-Value
		73	94		74	90	
<b>Cranial base:</b>							
Ba-S-N	0.24	130.3 (4.7)	132.6 (2.3)	0.001	133.3 (5.3)	133.3 (5.2)	0.03
Ba-N	0.0001	107.6 (4.1)	110.7 (4.7)	0.002	103.2 (4.3)	106.6 (5.3)	0.003
S-N	0.0001	72.6 (3.6)	73.8 (2.5)	0.06	69.3 (3.2)	71.5 (3.6)	0.007
Ba-S	0.0001	25.9 (2.7)	27.1 (2.5)	0.04	24.9 (3.3)	25.4 (3.6)	0.43
N-S-Ar	0.9	122.3 (6.1)	124.6 (5.4)	0.21	122.5 (4.8)	124.7 (5.2)	0.01
<b>Mandible:</b>							
Ar- Gn	0.0001	108.5 (5.4)	104.5 (5.5)	0.001	101.9 (4.8)	98.1 (4.3)	0.001
Ar-GO	0.0001	44.8 (4.7)	41.3 (4.2)	0.001	40.6 (3.9)	38.4 (3.8)	0.001
18-Pog	0.0001	84.7 (4.6)	80.2 (4.5)	0.001	80.4 (4.5)	77.1 (4.3)	0.001
Me-29	0.0001	33.7 (4.7)	36.4 (4.3)	0.001	31.5 (4.1)	32.4 (3.9)	0.21
S-Pog	0.0001	63.8 (4.7)	60.2 (4.2)	0.001	59.6 (4.8)	56.7 (4.3)	0.005
S-Go	0.0001	77.3 (3.8)	75.4 (3.4)	0.004	69.9 (4.4)	68.2 (3.5)	0.016
S- Gn	0.0001	110.3 (5.5)	112.6 (5.3)	0.02	103.3 (5.5)	105.2 (5.1)	0.05
S-N-Pog	0.048	81.3 (3.2)	78.4 (3.6)	0.001	80.3 (2.6)	77.4 (3.2)	0.001
S-N-B	0.77	80.4 (3.5)	77.3 (2.3)	0.001	79.1 (3.4)	77.2 (2.3)	0.001
S-N-D	0.79	72.9 (3.7)	70.3 (2.4)	0.001	72.5 (3.67)	70.2 (2.7)	0.001
ANB	0.009	3.2 (2.2)	6.5 (2.7)	0.001	3.2 (2.3)	5.5 (2.4)	0.001
[S-N]-[Go-Gn]	0.05	33.5 (2.8)	35.1 (2.6)	0.001	33.8 (3.1)	34.3 (2.9)	0.36
[Or-Po]-[Me-Go]	0.0001	26.7 (3.1)	28.9 (2.4)	0.001	24.4 (2.9)	25.1 (3.1)	0.21
<b>Dentition:</b>							
ML6-L1	0.007	27.3 (3.2)	28.8 (3.7)	0.02	27.2 (2.6)	27.4 (3.2)	0.62
[L1-16]-[Go-Me]	1	94.8 (2.3)	96.3 (2.5)	0.001	94.7 (3.3)	96.3 (4.2)	0.02
<b>Facial Depth and Height</b>							
Ar-N	0.0001	83.1 (5.2)	85.2 (7.5)	0.003	91.3 (4.5)	93.5 (4.3)	0.006
Mid RmPt-A	0.0001	82.6 (4.3)	85.2 (4.7)	0.002	77.9 (3.8)	79.6 (4.4)	0.07
N-Me	0.0001	122.6 (5.9)	126.1 (5.4)	0.001	118.4 (6.1)	118.4 (6.1)	0.001
N-Pr	0.0001	73.4 (4.4)	75.2 (4.7)	0.03	69.7 (4.1)	69.7 (3.7)	0.002
Pr-Me	0.0001	52.6 (3.5)	55.2 (4.9)	0.002	49.2 (3.7)	49.2 (3.7)	0.001

Yoon-Tarlie [1] did not observe this small mandibular size in their studies. Such different findings might have been due to racial differences in the form and shape of the mandible. According to the present study, correction of skeletal mandibular discrepancies, which is possible in the specific age range, should be a part of the treatment approach to Class II Division 1 malocclusion. Therefore, in order to achieve a proper profile together with an ideal occlusion, Iranian Class II Division 1 schoolchildren should be examined at least 1 to 2 years before their adolescent growth spurt.

The decreased S-N-Pog and S-N-D angles in

both male and female Class II Division 1 patients, confirmed that mandibular deficiency was one of the major problems in this group, especially in the 12-13 year-old subjects. This might indicate chin retrusion, which in the male subgroups could be attributed to downward and backward rotation, posteriorly positioned articulation and smaller size of the mandible. Considering that mandibular rotation was not observed in the female patients, the retrusion may be the result of a smaller mandible. Our findings are in contrast to those of Rothstein and Yoon-Tarlie [1], who showed the S-N-Pog angle to be smaller only in the younger age groups (10-11 years) and not the

older ones (12-13 years). In addition, Bishara [16] reported a smaller angle in the female subgroups as compared to the normal controls. The present study also showed that the male subgroups had backward and downward rotation of the mandible which might have led to the increased facial height. This rotation resulted from increased linear (Pr-Me) and angular measurements (FMA and GoGn-SN angles) and indicated a vertical growth pattern. In order to prevent further increase in facial height, this vertical growth pattern should be taken into account when making treatment decisions such as choosing an appropriate appliance design and force system. The increase in rotation which occurred with age, was smaller in the female patients; therefore their increased facial height may be because of changes occurring in the maxilla. However, in contrast to our finding, vertical growth pattern and increased facial height was not observed by Rothstein and Yoon-Tarlie and Kerr et al [1, 13].

This study showed an increased lower incisor mandibular plane angle (IMPA), in male and female subjects with Class II Division 1 malocclusion, especially in 12-13 year-old children. Such incisal protrusion might compensate for the small size or retroposition of the mandible; consequently the distance between the lower incisor and the center of the posterior border of the mandible remains unchanged (Fig. 1A, line 5). Rothstein and Yoon-Tarlie reported this protrusion only in their male subjects [1].

## CONCLUSION

The findings of the present study demonstrated that increased total cranial base length, and cranial base flexure, mandibular retrusion and decreased mandibular size were all contributing factors in the development of Class II Division 1 malocclusion in Iranian children living in Shiraz. Protrusion of the lower anterior teeth and increased facial height were

also shown to be the most frequently-occurring characteristics in Class II Division 1 patients. Therefore these factors should be taken into consideration when designing the ideal treatment regime for Class II Division 1 malocclusion.

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