Research Journal of Biological Sciences 4 (4): 531-536, 2009
ISSN: 1815-8846

Mandibular Size and Position in a Group of 13-15 Years Old Iranian Children with Class II Division 1 Malocclusion

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Abstract: This research was designed to evaluation the mandibular size and position in a group of 13-15 years old Iranian children with Class II division I malocclusion. A retrospective study was conducted on a series of patient's files including radiographs for mandibular size and position in 923 individuals from Iranian southern community. The pretreatment lateral head radiographs were used from 504 children with Class II division I malocclusion (case group) and 419 children with Class I malocclusion (control group). The coordinates of 22 points were digitized and converted into 9 angles and 16 linear measurements describing the position and size of the mandible in relation to the cranial base and the dentition. Data from both groups were divided into 3 age-groups (13-15) and gender subgroups. Comparisons were made using the student's t-test to identify differences between groups. Most of the subjects with Class II division I malocclusion represented with a larger cranial base angle, smaller and retro-positioned mandible, a protrusive dentition, a vertical growth pattern and increased facial height. A retro-positioned and short mandible seemed to be responsible for the Class II division 1 malocclusion. Such factors should be taken into account when planning the treatment for patients.

Key words: Class II, division I, malocclusion, mandible, position, size, Iranian children

INTRODUCTION

A precise treatment of Class II division 1 malocclusion depends to a great extent on the diagnosis of the size and position of the mandible. It is important to know, whether a skeletal discrepancy is associated with or is the cause of the malocclusion Rothstein and Yoon-Tarlie (2000). In a Class II division 1 malocclusion, the size, form, position and growth of the mandible may differ from those found in other malocclusions. Knowledge of the differences and/or similarities may allow clinicians to control the treatment outcome in a much better manner (Rothstein and Phan, 2001).

To date several studies have investigated the relation between mandibular deficiency and Class II malocclusion (McNamara, 1981; Pancherz *et al*., 1997; Johnson, 1998). Some of these reports have suggested that a combination of mandibular size and position were responsible for Class II division I malocclusion (Baccetti *et al*., 1997; Buschang *et al*., 1986), while others have attributed the malocclusion to a smaller mandible (Gilmore, 1950; Menezes, 1974) and even to the retro-position of a normal-sized mandible (Kerr *et al*., 1994).

It is believed that either a short and undeveloped or a retrusive/retro-position mandible can be the main causes of Class II division I malocclusion (Rosenblum, 1995). Kerr *et al*. (1994) showed that in subjects with a Class II division I malocclusion, the mandible is joined to the cranial base in a more retruded position. Pancherz *et al.* (1997) found that most Class II patients had mandibular deficiency with 97% showing a short the lower anterior facial height was short. Rothstein and Yoon-Tarlie (2000) stated that the more anterior position of point N, the more SNB angle being smaller in Class II patients. Excessive anterior cranial base length, characterized by enlarged frontal and maxillary sinuses, may be a contributive factor in the development of Class II division 1 malocclusions (Rothstein and Yoon-Tarlie, 2000).

These differences can be attributed to a number of factors including: small samples, wide variation in patients, lack of control and/or unreliability of some angular measurements used to determine mandibular position.

The importance of mandibular size, position and growth is highlighted for orthodontic treatment planning. This study was designed to compare mandibular size,

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position and growth in a group of young Iranians with Class II division I malocclusion to that of individuals with Class I malocclusion.

MATERIALS AND METHODS

A total of 504 individuals (male and female) were included from those referred to the department of orthodontics at Shiraz Dental School during 2002-2004. The inclusion criteria were: a-Class II division I malocclusion diagnosed from the pretreatment clinical examination, dental casts and lateral cefhalogram (convex profile, Class II molar and canine relationships, overjet >4 mm, ANB angle >4°); b-age range of 10-15 years; c-normal FH-SN angle (7-8°); d-presence of all permanent teeth (except the third molars); e-presence of high quality radiographs. Only cases with cephalograms being taken by a unique machine (Planmeca Co., USA) were included using a Proline-cephalostat performed by the same technician. The exclusion criteria were: a-any earlier orthodontic treatment; b-history of severe interfering medical illness.

The control group (N = 419) was also, assigned, which was consisted of 512 skeletal Class I patients who had attended the same institution for short-term non-extraction orthodontic treatment to correct their minor crowding. The inclusion criteria for the control group were: a pretreatment straight or mild convex profile, Class I molar and canine relationships, over jet and overbite of 2-4 mm, crowding <5 mm, the inclination of the incisors within the normal range and lateral cephalometric assessment of ANB angle = 1-4° and Wit's appraisal = 1±1 mm. Patient's files were divided into 3 subgroups according to their age (13, 14 and 15) in order to enable an assessment of the growth changes. Each of these subgroups were further divided into 2 subgroups according to gender.

All points on pretreatment lateral cephalograms were identified followed by a further confirmation with three readings of the investigators. Tracings were then orientated on a scanner so that Sella (S) represented the origin of a Cartesian coordinate system. The X-axis was defined as a line parallel to the Krogman-Walker horizontal plane (through sella), which was defined by 2 highly reproducible points of maxillon and occipitale. Maxillon is the point just below the K-ridge, midway between the upper and lower border of the palate. Occipitale is the lowest point on the occipital bone. The Y-axis was perpendicular to the X-axis through the sella (Fig. 1b). The coordinates of the 22 points on the tracings were digitized and converted to 9 angles and 16 linear distances in the cranial base, mandible, alveolar processes and dentition (Table 1-3 and Fig. 1 and 2). A magnification coefficient for each film was calculated from the scale on

Table 1: Comparison of angular (°) and linear (mm) variables of 13 years old Iranian boys and girls with class II division 1 and class I malocclusions

	Boys (13 years old)			Girls (13 years old)		
Definition	Class II division 1 sample (83)	Control sample (71)	p-value	Class II division 1 sample (87)	Control sample (68)	p-value
Cranial base						
Ba-S-N°	133.5±5.1	130.8±5.1	0.005**	132.7±4.9	130.9±5.1	0.06
Ba-N mm	109.3±4.5	104.6±3.3	0.001***	104.6±4.9	101.9±4.8	0.005**
S-N mm	72.4±3.6	71.0±2.9	0.02*	69.5±3.8	68.9±2.9	0.39
Ba-S mm	26.1±3.1	25.7±2.3	0.35	26.6±1.9	26.1±2.7	0.68
N-S-Ar°	123.6±4.6	121.4±6.6	0.04**	122.9±6.1	121.0±4.3	0.09
Mandible						
Ar- Gn mm	101.4±4.9	104.9±4.6	0.001**	97.3±4.8	99.8±5.2	0.01**
Ar-Go mm	39.1±3.4	41.4±3.8	0.001**	37.3±4	38.4±4.2	0.17
S-Pog mm	77.1±4.8	79.3±5.3	0.01**	76.8±4.8	78.7±4.2	0.015*
S-Gn mm	107.0±4.5	109.0±4.9	0.01**	108.0±5.1	109.0±4.3	0.02*
S-Go mm	70.8±3.9	72.4±4.5	0.04*	66.7±3.8	67.7±3.9	0.009**
S-N-Pog°	77.2±3.5	78.9±3.3	0.007**	77.3±3.2	79.8±2.8	0.002**
S-N-B°	75.1±2.5	77.8±3.8	0.001**	76.1±3.9	78.6±3.3	0.03*
A-N-B°	77.3±2.3	3.2±2.2	0.001***	5.5±2.4	3.2±2.3	0.001***
S-N-D°	70.1±2.5	71.2±3.6	0.001**	69.4±2.8	71.5±3.4	0.02*
[S-N]-[Go-Gn] °	34.5±2.8	33.2±3.6	0.03*	34.5±2.6	33.1±2.7	0.02*
[Or-Po]-[Me-Go] °	26.9±2.9	25.6±3.9	0.03*	26.2±2.7	25.8±2.5	0.17
Dentition						
S-DL6 mm	32.3±4.7	32.7±3.6	0.61	29.4±3.5	30.3±4.8	0.009**
ML6-L1 mm	27.8±3.5	26.8±3.7	0.08	26.4±3.8	25.9±3.2	0.42
Mid RmPt-DL6 mm	42.8±3.3	42.3±3.1	0.28	38.3±4.3	39.5±4.4	0.62
[L1-16]-[Go-Me] °	95.2±3.1	94.7±2.9	0.36	96.6±3.8	94.3±3.8	0.01*
Facial height and depth						
Ar-N mm	94.8±4.7	92.4±4.9	0.006**	90.8±3.9	89.2±4.8	0.21
Mid RmPt-A mm	82.3±4.0	80.7±3.9	0.001***	75.6±4.9	74.6±4.5	0.12
N-Me mm	123.3±5.1	122.8±4.4	0.56	116.8±5.2	116.1±4.7	0.82
N-Pr mm	70.3±4.5	69.1±3.9	0.012*	67.3±4.7	66.6±4.7	0.003**
Pr-Me mm	53.4±4.6	50.6±3.6	0.001***	51.3±4.7	49.9±3.5	0.9

*p<0.05, **p<0.01, ***p<0.001

Table 2: Comparison of angular (°) and linear (mm) variables of 14 years old Iranian boys and girls with class II division 1 and class I malocclusions

	Boys (14 years old)			Girls (14 years old)		
Definition	Class II division 1 sample (94)	Control sample (73)	p-value	Class II division 1 sample (90)	Control sample (74)	p-value
Cranial base						
Ba-S-N°	132.6±2.3	130.3±4.7	0.001***	133.3±5.2	132.3±5.3	0.03*
Ba-N mm	110.7±4.7	107.6±4.7	0.002**	106.6±5.3	103.2±4.3	0.003**
S-N mm	73.8±2.5	72.6±3.6	0.06	71.5±3.6	69.3±3.2	0.007**
Ba-S mm	27.1±2.5	25.9±2.7	0.04*	25.4±3.6	24.9±3.3	0.43
N-S-Ar°	124.6±5.4	122.3±6.1	0.01**	124.7±5.2	122.5±4.8	0.01**
Mandible						
Ar- Gn mm	104.5±5.5	108.5±5.4	0.001***	98.1±4.3	101.9±4.8	0.001***
Ar-Go mm	41.3±4.2	44.8±4.7	0.001***	38.4±3.8	40.6±3.9	0.001***
S-Pog mm	60.2±4.2	63.8±4.7	0.001***	56.7±4.3	59.6±4.8	0.005**
S-Go mm	75.4±3.4	77.3±3.8	0.004**	68.2±3.5	69.9±4.4	0.026*
S- Gn mm	110.9±5.3	112.3±5.5	0.02*	103.2±5.1	105.3±5.5	0.05*
S-N-Pog°	78.4±3.6	81.3±3.2	0.001***	77.4±3.2	80.3±2.6	0.001***
S-N-B°	77.3±2.3	80.4±3.5	0.001***	77.2±2.3	79.1±3.4	0.001***
S-N-D°	70.3±2.4	72.9±3.7	0.001***	70.2±2.7	72.5±3.67	0.001***
ANB°	6.5±2.7	3.2±2.2	0.001***	5.5±2.4	3.2±2.3	0.001***
[S-N]-[Go-Gn] °	35.1±2.6	33.5±2.8	0.001***	34.3±2.9	33.8±3.1	0.36
[Or-Po]-[Me-Go°]	28.9±2.4	26.7±3.1	0.001***	25.1±3.1	24.4±2.9	0.21
Dentition						
S-DL6 mm	32.5±4.5	31.8±4.2	0.07	31.9±4.6	31.2±5.2	0.07
ML6-L1 mm	28.8±3.7	27.3±3.2	0.02*	27.4±3.2	27.2±2.6	0.62
Mid RmPt-DL6 mm	42.6±3.4	42.4±3.1	0.32	41.8±3.3	42.5±3.7	0.65
[L1-16]-[Go-Me] °	96.3±2.5	94.8±2.3	0.001***	96.3±4.2	94.7±3.3	0.02*
Facial depth and height						
Ar-N mm	85.2±7.5	83.1±5.2	0.003**	93.5±4.3	91.3±4.5	0.006**
Mid RmPt-A mm	85.2±4.7	82.6±4.3	0.002**	79.6±4.4	77.9±3.8	0.07
N-Me mm	126.1±5.4	122.6±5.9	0.001***	118.4±6.1	115.0±5.7	0.001***
N-Pr mm	75.2±4.7	73.4±4.4	0.03*	69.7±3.7	67.4±4.1	0.002**
Pr-Me mm	55.2±4.9	52.6±3.5	0.002**	49.2±3.7	48.8±2.9	0.06

*p<0.05, **p<0.01, ***p<0.001

Table 3: Comparison of angular (°) and linear (mm) variables of 15 years old Iranian boys and girls with class II division 1 and class I malocclusions

	Boys (15 years old)			Girls (15 years old)		
Definition	Class II division 1 sample (75)	Control sample (65)	p-value	Class II division 1 sample (75)	Control sample (68)	p-value
Cranial base						
Ba-S-N°	137.3±4.9	133.7±2.4	0.001***	135.1±5.2	134.2±5.3	0.02*
Ba-N mm	112.8±4.5	110.8±4.8	0.002**	105.5±5.5	103.9±4.2	0.005**
S-N mm	74.7±2.7	75.5±3.3	0.07	72.6±3.4	69.8±3.1	0.006**
Ba-S mm	25.2±2.6	26.7±2.5	0.04*	24.7±3.4	25.2±3.5	0.61
N-S-Ar°	126.4±5.9	123.1±6.3	0.01**	125.8±5.0	123.7±4.7	0.01**
Mandible						
Ar- Gn mm	101.8±5.2	102.7±5.9	0.01*	96.4±4.4	102.0±4.5	0.001***
Ar-Go mm	38.4±4.3	45.9±4.3	0.001***	32.5±3.7	39.8±3.7	0.001***
S-Pog mm	59.6±4.4	66.5±4.6	0.001***	57.8±4.5	60.2±4.6	0.006**
S-Go mm	71.3±3.7	78.8±3.5	0.004**	66.1±3.4	70.7±4.2	0.015**
S- Gn mm	110.4±5.9	111.7±5.2	0.061	104.6±5.3	106.4±5.8	0.04*
S-N-Pog°	77.7±3.1	83.6±3.3	0.001***	75.3±3.5	81.1±2.7	0.001***
S-N-B°	76.1±2.2	81.5±3.6	0.001***	76.6±2.7	78.9±3.3	0.001***
S-N-D°	68.2±2.5	74.7±3.1	0.001***	69.1±2.8	71.8±3.7	0.001***
ANB°	6.0±2.8	3.4±2.8	0.001***	5.4±2.2	3.6±2.4	0.001***
[S-N]-[Go-Gn] °	36.2±2.2	32.2±2.3	0.001***	34.2±2.8	31.6±3.5	0.001***
[Or-Po]-[Me-Go°]	27.6±2.3	25.5±3.4	0.001***	24.3±3.3	21.6±2.8	0.001***
Dentition						
S-DL6 mm	33.3±5.3	32.8±4.7	0.12	31.3±5.1.	31.6±4.4	0.27
ML6-L1 mm	27.5±3.5	26.6±3.5	0.02*	28.5±3.4	26.3±2.7	0.55
Mid RmPt-DL6 mm	42.8±3.0	43.3±3.3	0.55	41.7±2.7	42.4±3.5	0.08
[L1-16]-[Go-Me] °	94.3±2.8	92.1±2.8	0.001***	96.5±3.6	95.6±4.4	0.03*
Facial depth and height						
Ar-N mm	81.5±7.3	86.3±5.8	0.003**	94.8±4.6	97.4±4.7	0.007**
Mid RmPt-A mm	83.6±4.3	84.5±4.9	0.002**	78.4±4.5	78.1±3.9	0.08
N-Me mm	123.3±5.1	121.7±5.2	0.001***	117.2±6.6	116.6±5.9	0.001***
N-Pr mm	73.5±4.8	72.2±4.3	0.04*	67.5±3.6	66.1±4.3	0.002**
Pr-Me mm	52.6±4.5	51.5±3.7	0.001**	48.3±3.3	47.5±3.8	0.04*

*p<0.05, **p<0.01, ***p<0.001

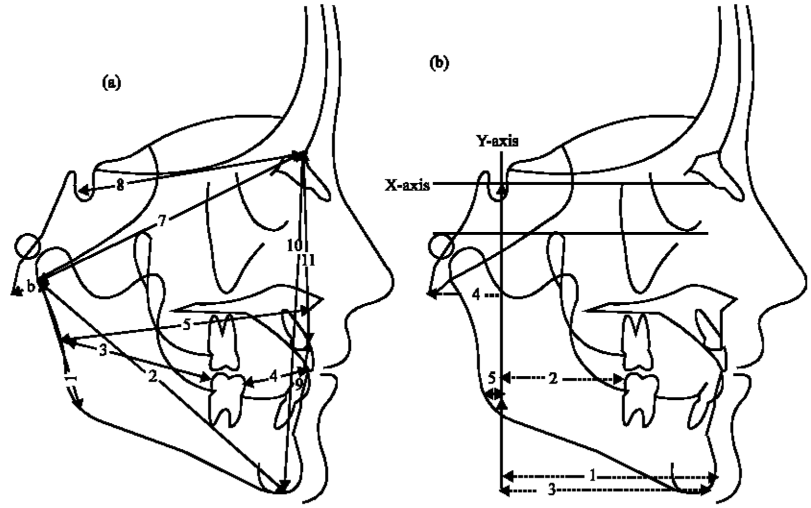

Fig. 1: The linear measurements used in this study, (a): 1: Ar-Go, 2: Ar-Gn, 3: Mid RmPt-DL6, 4: ML6-L1, 5- Mid RmPt-A, 6-Ba-N, 7: Ar-N, 8-S-N 9- Pr-Me, 10- N-Me, 11- N-Pr, (b): 1: S-Pog, 2: S-DL6, 3: S-Me, 4: S-Ar, 5: S-Go

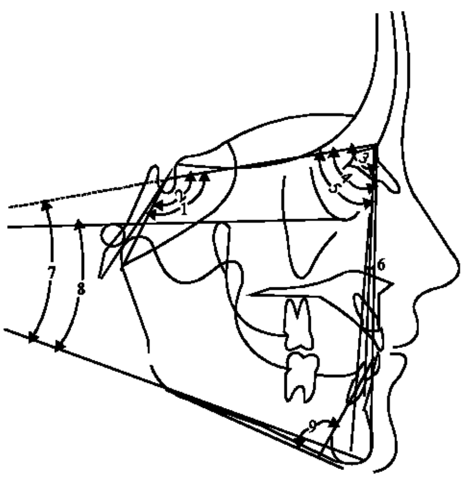

Fig. 2: The angular measurements used in the study, 1-N-S-Ba, 2-N-S-Ar, 3-S-N-Pog, 4-S-N-B, 5-S-N-D, 6-A-N-B, 7-[S-N]-[Go-Gn], 8-[Or-Po]-[Me-Go], 9-[L1-16]-[Go-Me]

each radiograph and the data was then subjected to a correction phase. Descriptive statistics were used to determine the initial differences between groups. Student t-test was used to compare the various groups and subgroups.

To determine any errors in method the X and Y coordinates of the landmarks on the radiographs of three female and three male subjects of both groups were calculated with Photoshop 7 (Adobe system incorporated, USA). The coefficient reliability was estimated to be 0.8 for landmarks and measurements (Houston, 1983).

RESULTS

The total cranial base lengths (Ba-N) from Class II division I subjects were significantly larger than those in the control groups in all age ranges. Moreover, cranial base flexure (Ba-S-N) and saddle angle (Ar-S-N) were larger in the Class II division I subjects, reaching statistical significance in most instances (Table 1-3). The overall length of the mandible (Ar-Gn), ramal height (Ar-Go) and body length (S-pog) were shorter in subjects with Class II division I than those in control groups, reaching statistical significance in most of the comparisons (Fig. 1 and Table 1-3). Pogonion, B and D points, from case group were significantly retruded than those in corresponding control groups. Also FMA and GoGn-SN angles were larger in case subjects than in the matching controls, reaching statistical significance in most of the subjects. S-Pog and S-Go distances and S-Gn distance with the exception of boys in the 15 years age group, being significantly smaller in the case group compared to that of the matched controls (Fig. 1).

Molar-incisor distance in the 3 age ranges was greater in case subjects than their matched controls, reaching statistical significance in the 14 and 15 years old boys. The inclination of the lower incisors (IMPA) were higher in Class II division1 subjects than in the controls, reaching statistical significance level in 13 years old girls, 14 and 15 years old boys and girls (Table 1-3). The total anterior facial height (N-Me) in 14 and 15 years old subgroups was significantly higher in case subjects than in the controls. The upper anterior facial heights (N-Pr) were higher in all subjects with Class II division I malocclusion than the controls. The lower anterior facial heights (Pr-Me) were significantly higher in case than controls except for the 13 and 14 years old girl subgroups.

Posterior facial heights (S-GO) were significantly lower in Class II division I subjects than in matching controls, except for the 13 years old boys and 14 years old girls (Table 1-3).

DISCUSSION

Investigation of mandibular size and position in early teen age groups has been proved to be useful for an efficient treatment planning and future decision making. Knowledge of the skeletal factors contributes to the management of cases with malocclusion including cases of Class II division I. Results of this investigation showed that in cases of Class II division I malocclusion, the mandible size is not only smaller, but also retro-positioned. This was seen more in 14 and 15 years old children. It was also, revealed that children with Class II division I malocclusion had a notable vertical growth pattern resulting in an increase of facial height, which progresses by age and finally resulted in protrusion of lower anterior teeth.

An increased cranial base length was seen along with cranial base flexure and saddle angle in almost all Class II division I subgroups. This could imply the posterior articulation of the mandible to the cranial base, which directly affects the treatment approach. Similar to the findings reported earlier by Houston (1983), Buschang *et al*. (1986) and Kerr *et al*. (1994). A series of different findings have also been reported by Rosenblum (1995) and Rothstein and Yoon-Tarlie (2000) showing the position of the mandible as being similar to those of normal groups. Rothstein and Yoon-Tarlie (2000) reported that point N is positioned more anteriorly while, point B is positioned more posterior. This was referred to as being attributed to smaller SNB angle in Class II division I subjects (Bishara, 1998).

Results of this investigation have revealed that mandibular length and ramal heights are smaller in Class II Division I subjects, especially in 14 and 15 years old subgroups. Such small mandibular sizes, together with its retro-positioning are important factors, which should be considered for treatment planning. However, there is no agreement as to whether a small sized mandible can always be considered as a component of Class II malocclusion. Gilmore (1950), Menezes (1974) and Buschang *et al.* (1986) however, considered small mandibular size as a contributing factor to Class II malocclusion. Kerr *et al.* (1994) stated that the larger gonial angle in addition to short mandibular body length contributes to the problem. Moreover, Bishara (1998) suggested that smaller mandibular body length is a contributing factor only in early (primary and mixed dentition periods) and not in the later stages of development (after third molar eruption). Rothstein and Yoon-Tarlie (2000) did not report small mandibular size as contributor in their studies. Such different findings might have been due to racial differences in the mandibular form and shape. According to this 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. To gain a proper profile together with good occlusion children with this malocclusion are recommended to be checked at least 1 to 2 years before the adolescent growth spurt.

The decreased S-N-Pog and S-N-D angles in both male and female subjects of case group, confirmed that mandibular deficiency as being one of the major problems in Class II division 1 malocclusion especially in higher age groups. This might indicate chin retrusion, which in male subgroups could be due to down and backward rotation, posteriorly positioned articulation and smaller size of the mandible. In female subjects however, it might have been due to the smaller size mandible. Their findings are different from those of Rothstein and Yoon-Tarlie (2000), which showed the S-N-Pog angle as decreased only in lower (13 years) and not in higher age groups (14 and 15 years). Moreover, Bishara (1998) believed that a lower angle can only be seen in the female subgroups and not in normal controls.

The male subgroups of this investigation had also a backward and downward rotation of the mandible, which might have led to the increased facial height. This Rotation was assumed as resulted from increased linear (Pr-Me) and angular measurements (FMA and GoGn-SN angles), indicating a vertical growth pattern. Considering all these details are necessary for the correct treatment through the design of the appliances and the force system to be applied to prevent further facial height changes. Rotation is usually increased with age, in a lesser degree for females. Their increased facial height could therefore be due to the maxillary changes. However, in contrast to these finding, vertical growth pattern and increased facial height was not reported as being seen by Rothstein and Yoon-Tarlie (2000) and Kerr *et al.* (1994).

An increased lower Incisor Mandibular Plane Angle (IMPA), in most subjects with Class II Division I. Such protrusion of incisors might compensate the small size or retroposition of the mandible, leading to the unchanged position of the lower incisor distance from the center of posterior border of the ramus (Fig. 2). Surprisingly this protrusion was only reported in male subgroup by Rothstein and Yoon-Tarlie (2000).

CONCLUSION

Increased total cranial base length, flexure, mandibular retrusion and decreased mandibular size were all contributing factors in the development of Class II division 1 malocclusion. Protrusion of the lower anterior teeth and increased facial height were the most frequently seen finding in Class II division I malocclusion.

ACKNOWLEDGEMENT

Authors would like to express their gratitude and thanks to the Orthodontic research center and the office of the Vice-Chancellor for Research, Shiraz University of Medical Science for financial support and Dr Ali Akbar Nekooeian from the Center for Development of Clinical Studies at Nemazee Hospital for their valuable help.

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