RAMUS HEIGHT AND ITS RELATIONSHIP WITH SKELETAL AND DENTAL MEASUREMENTS

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ABSTRACT

Background: The purpose of this study was to assess mandibular ramus height and to assess the relationship of ramus height with various craniofacial and dental measurements in a sample of Iraqi adults with skeletal and dental Class I.

Materials and method: The sample consisted of 95 Iraqi adults (54 females and 41 males) having normal occlusion and Class I skeletal pattern aged between 18 and 31 years. Each individual was subjected to clinical examination and digital true lateral cephalometric radiography. The radiographs were analyzed using AutoCAD 2007 software computer program to determine ten linear and seven angular measurements. Descriptive statistics were obtained and independent samples t-test was performed to evaluate the gender differences, while Pearson's correlation coefficient test was used to identify correlations between ramus height and other measurements.

Results: All linear measurements were significantly higher in males, while angular measurements showed non-significant differences between males and females, except for SN-MP, SN-PP, and N-S-Ar angles which were significantly higher in females than in males. For both genders, there were significant positive correlations between ramus height and posterior facial height, maxillary and mandibular molar dentoalveolar heights, while there were significant negative correlations with SN-MP, PP-MP, and Ar-Go-Me angles. Ramus height in females showed a significant positive correlation with N-S-Ar angle, and a significant negative correlation with S-Ar-Go angle.

Conclusions: Ramus height was directly correlated with intermaxillary space in the posterior region, and inversely correlated with angles of mandibular rotation.

Key words: ramus height, skeletal measurements, dental measurements, dentoalveolar heights.

INTRODUCTION

In orthodontics skeletal growth is emphasized more than other aspects of craniofacial development, perhaps because the methods for its study were developed earlier. Knowledge of skeletal morphology and growth is routinely applied in clinical practice; these can be visualized easily in the cephalogram. Craniofacial skeletal growth is very important in orthodontics, since variations in craniofacial morphology are the source of most serious malocclusions, and induction of changes in inter-maxillary relationships are fundamental to orthodontic treatment. (Moyers, 1988)

Logically, any alteration or adjustment of one part of the dentofacial complex will require a like adjustment by another part of the complex for its own accommodation and so on. (Bibby, 1980)

The main significance of the ramus of the mandible is in providing attachment for masticatory muscles. However, the ramus is also integral to placing the corpus and dental arch into harmonious relationship with the the maxilla and other facial structures. Correct relationships are maintained by critical remodeling and adjustments in ramus alignment, vertical length, and anteroposterior dimensions. A best fit with the maxillary arch and middle cranial fossa is thereby provided. Indeed, the special developmental significance of the ramus is integral to craniofacial growth. These alterations are induced by osteogenic, chondrogenic, and fibrogenic connective tissues receiving local input control signals producing progressive compensatory changes in the shape and size of the ramus. (Enlow and Hans, 1996)

The purpose of this study was to evaluate the relationship between ramus height and various craniofacial and dental measurements in a sample of Iraqi adults with dental and skeletal Cl I.

MATERIALS AND METHOD

The sample included 95 digital true lateral cephalometric radiographs taken in the Orthodontic department at the College of Dentistry, University of Baghdad. All individuals were Iraqi adults (54 females and 41 males), their age ranged between 18 to 31 years. They were determined radiographically to have Class I skeletal patterns (ANB: 2°±2°) (Riedel, 1952), and clinically to have a normal Angle Class I occlusion, with complete permanent dentitions. They were clinically healthy with no craniofacial syndromes or anomalies, such as a cleft lip and palate. Subjects were excluded if they had a history facial trauma or previous orthodontic, orthopedic or surgical treatment.

Each individual was examined clinically and had a lateral cephalometric radiograph taken by using Planmeca ProMax radiographic unit. The individual was positioned within the cephalostat with the sagittal plane of the orientated vertical, the Frankfort plane horizontal, and the teeth in centric occlusion. The radiographs were analyzed using the AutoCAD 2007 software computer program to calculate the angular and linear measurements. After importing the picture to the AutoCAD program, points and planes were determined, and then the angular and linear measurements were obtained. Angular measurements were taken directly as they are not affected by magnification. Linear measurements, however, were divided by a scale for each picture to adjust for magnification. The scale was obtained depending on the measurement from the ruler in the nasal rod.
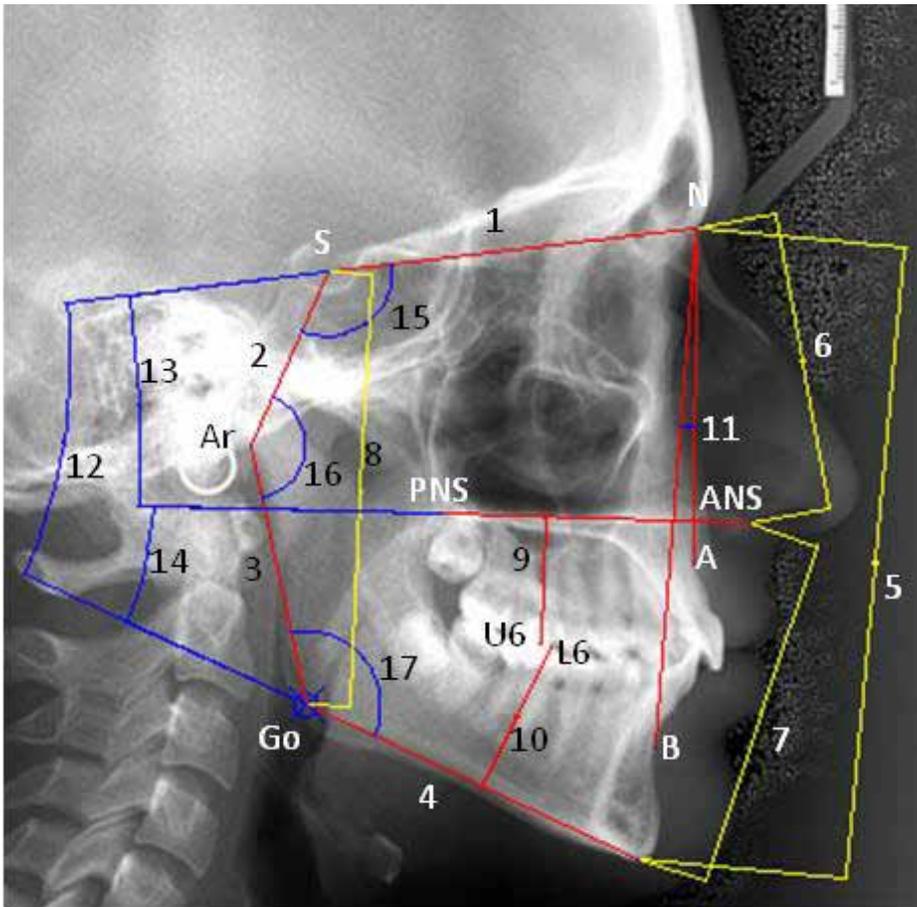
Figure 1: Cephalometric landmarks and measurements: N: nasion. S: sella turcica. Ar: articulare. Go: gonion. Me: menton. A: subspinale. B: supramentale. ANS: anterior nasal spine. PNS: posterior nasal spine. U6: point upper 1st molar. L6: point lower 1st molar. 1: S-N. 2: S-Ar. 3: Ar-Go. 4: Go-Me. 5: N-Me. 6: N-ANS. 7: ANS-Me. 8: S-Go. 9: MxMDH. 10: Md-MDH. 11: ANB. 12: SN-MP. 13: SN-PP. 14: PP-MP. 15: N-S-Ar (Saddle angle). 16: S-Ar-Go (Articular angle). 17: Ar-Go-Me (Gonial angle).

Cephalometric measurements (Fig. 1)

S-N: It is the anteroposterior extent of anterior cranial base, the distance between sella turcica and nasion. (Rakosi, 1982)

S-Ar: Posterior cranial base, the distance between sella turcica and articulare. (Rakosi, 1982)

Ar-Go: Length or height of the ramus, the distance between articulare to gonion. (Rakosi, 1982; Jarabak and Fizzel, 1972)

Go-Me: Extent of mandibular body, the distance between gonion and menton. (Rakosi, 1982)

N-Me: Total anterior facial height, the distance between nasion and menton. (Rakosi, 1982)

N-ANS: Upper anterior facial height, the distance between nasion and anterior nasal spine. (Rakosi, 1982)

ANS-Me: Lower anterior facial height, the distance between anterior nasal spine and menton. (Rakosi, 1982)

S-Go: Posterior facial height, the distance between sella turcica and gonion. (Rakosi, 1982)

MxMDH: Maxillary molar dentoalveolar height, the distance between the mesiovestibular cuspid of upper first molar and palatal plane along the long axis of the molar. (Martina et al, 2005)

MdMDH: Mandibular molar dentoalveolar height, the distance between the mesiovestibular cuspid of lower first molar and mandibular plane along the long axis of the molar. (Martina et al, 2005)

ANB angle: The angle between lines N-A and N-B. It represents the difference between SNA and SNB angles or it may be measured directly as the angle ANB. It is the most commonly used measurement for appraising anteroposterior disharmony of the jaws. (Riedle, 1952; Steiner, 1953)

SN-MP angle: The angle between the S-N plane and the mandibular plane. (Rakosi, 1982)

SN-PP angle: The angle between the S-N plane and the palatal plane. (Hang et al, 1990)

PP-MP: The angle between palatal plane and mandibular plane. (Rakosi, 1982)

N-S-Ar: Saddle angle, between the anterior and the posterior cranial base. This angle formed at the point of intersection of the S-N plane and the S-Ar plane. (Rakosi, 1982)

S-Ar-Go: Articular angle, formed at the point of intersection of the S-Ar plane and the Ar-Go plane. (Rakosi, 1982)

Ar-Go-Me: Gonial angle, formed at the point of intersection of Ar-Go plane and the mandibular plane (Go-Me). (Rakosi, 1982)

Statistical analyses

The data were subjected to computerized statistical analysis using SPSS (Version 15). The statistical analyses included descriptive statistics with mean values, standard deviation, minimum, and maximum values for continuous measurements. Inferential statistics include the independent samples t-test to compare variables between both genders. The Pearson's correlation coefficient test was used to assess relationships between the ramus height and other craniofacial and dental measurements.

The following levels of significance were used:

Non-significant   NS $P > 0.05$
Significant   * $0.05 \geq P > 0.01$
Highly significant   ** $0.01 \geq P > 0.001$
Very highly significant *** $P \leq 0.001$

RESULTS

Descriptive statistics for males and females are illustrated in Table 1, with independent samples t-test was used to assess gender differences. Out of the sixteen variables measured in this study, thirteen showed significant differences between genders; the ANB angle was used to discriminate the sample as skeletal Class I and was not included as a test variables. All linear measurements were significantly higher in males, while angular measurements showed non-significant differences between males and females, except for the SN-MP, SN-PP, and N-S-Ar angles which were significantly higher in females than in males.

Table 1: Descriptive statistics and gender differences (independent samples t-test)

Variables	Descriptive Statistics								Gender Differences (df=93)	
	Females (N=54)				Males (N=41)					
	Min.	Max.	Mean	SD	Min.	Max.	Mean	SD	t-test	p-value
S-N	60.45	70.58	66.48	2.36	63.38	77.06	70.86	2.90	-8.087	0.000***
S-Ar	23.98	38.84	32.35	2.70	31.21	45.03	36.94	2.54	-8.391	0.000***
Ar-Go	35.57	56.39	45.08	4.10	38.72	58.95	51.41	4.47	-7.170	0.000***
Go-Me	64.04	77.98	69.89	3.45	65.67	86.43	74.95	3.84	-6.743	0.000***
AFH	97.09	118.76	110.87	4.38	106.81	139.12	121.70	6.48	-9.707	0.000***
UFH	44.94	55.59	50.58	2.49	45.31	60.99	53.46	3.00	-5.110	0.000***
LFH	50.50	69.04	61.84	3.97	59.07	86.80	69.94	5.52	-8.299	0.000***
PFH	64.52	87.45	73.18	4.35	74.92	93.19	83.77	4.78	-11.238	0.000***
MxMDH	19.56	26.29	22.05	1.51	20.84	29.69	25.44	2.25	-8.761	0.000***
MdMDH	23.88	34.62	29.82	2.22	26.44	39.97	34.38	2.68	-9.040	0.000***
SN-MPº	21.00	39.00	32.12	4.01	22.00	40.00	30.09	4.58	2.296	0.024*
SN-PPº	2.00	18.00	9.33	3.23	2.00	13.00	7.31	3.01	3.097	0.003**
PP-MPº	11.00	34.00	22.72	4.41	13.00	34.00	22.87	4.89	-0.162	0.871
N-S-Arº	114.00	141.00	126.79	5.73	110.00	134.00	122.97	5.04	3.386	0.001***
S-Ar-Goº	126.00	156.00	141.92	6.41	129.00	157.00	142.87	6.17	-0.728	0.469
Ar-Go-Meº	110.00	138.00	123.44	4.87	116.00	140.00	124.26	5.36	-0.781	0.437

For males and females, Pearson's correlation coefficient test (Table 2) revealed significant positive correlation for ramus height and posterior facial height, and maxillary and mandibular molar dentoalveolar heights. Significant negative correlations were noted for SN-MP, PP-MP, and Ar-Go-Me angles. Ramus height in females showed a significant positive correlation with N-S-Ar angle, and a significant negative correlation with S-Ar-Go angle.

Variables		Females (N=54)	Males (N=41)
		Ar-Go	Ar-Go
S-N	r	0.113	0.290
	p	0.417	0.066
S-Ar	r	0.002	-0.087
	p	0.990	0.588
Go-Me	r	0.053	-0.015
	p	0.703	0.924
AFH	r	0.248	0.205
	p	0.071	0.198
UFH	r	0.202	0.213
	p	0.143	0.182
LFH	r	0.143	0.112
	p	0.304	0.487
PFH	r	0.807	0.834
	p	0.000***	0.000***
MxMDH	r	0.376	0.332
	p	0.005**	0.034*
MdMDH	r	0.397	0.412
	p	0.003**	0.007**
SN-MP	r	-0.535	-0.504
	p	0.000***	0.001***
SN-PP	r	-0.033	0.069
	p	0.812	0.669
PP-MP	r	-0.449	-0.479
	p	0.001***	0.002**
N-S-Ar	r	0.365	0.086
	p	0.007**	0.595
S-Ar-Go	r	-0.300	-0.065
	p	0.028*	0.687
Ar-Go-Me	r	-0.470	-0.439
	p	0.000***	0.004**

Table 2: Pearson's correlations coefficient test for the ramus height and other measurements

DISCUSSION

This study aimed to quantify ramus height in skeletal I Iraqi adults and to relate variations in ramal height with a range of craniofacial and dental measurements. The mean values for ramus height reported in the present study for females (45.08 ±4.1 mm) and males (51.41 ±4.47 mm) are close to those described by Burstone et al who reported mean values of 46.8 ±2.5 mm and 52 ±4.2 mm for females and males, respectively (Burstone et al, 1978).

All linear measurements were significantly higher in males; this finding is in accordance with previous studies by Ali (1988), Al-Sahaf (1991), Al-Attar (2006), and Al-Joubori et al (2009) suggesting that the craniofacial skeleteon of males is larger in all linear dimensions than in females. This finding may be attributed to the fact that maturation is attained earlier in females than males with a longer growth period in males. Johannsdottir et al (2004) reported that males had consistently larger values for linear dimensional variables, including anterior and posterior facial heights, mandibular length, cranial base dimensions and nasal bone length.

The significantly higher mean values of SN-MP, and SN-PP angles in females than males together with the non-significant difference in PP-MP angle, means that the maxillary and mandibular planes are more downward positioned relative to the cranial base in females compared to males; this may relate to a caudal jaw growth rotation in females. The significantly higher N-S-Ar angle in females denotes the more backward position of the female mandible. Given that the lower facial height tends to be shorter as the severity of the overbite increases, and the total anterior facial height is affected in essentially the same fashion by the degree of overbite as in lower facial height. Two previous studies (Diamond, 1943; Wylie, 1946) considered ramus height and its effect on intermaxillary space both anteriorly and posterioly. Diamond (1943) suggested that deficient growth in length of the mandibular ramus is the cause of deficient intermaxillary space. However, Wylie (1946) failed to substantiate the contention that development of ramus height is crucially important for the development of intermaxillary space, however desirable it may be for satisfactory facial contour. Moreover, Wylie (1946) found non-significant differences between total facial height, lower facial height, and intermaxillary space in the molar region with respect to ramus height, measured either from the condylar head to the gonial angle, or from the semilunar notch to the lower border of the mandible.

The findings of present study showed that the increase in ramus height in both genders were associated with increase in intermaxillary space in the molar region, illustrated by the highly significant positive correlation with maxillary and mandibular molar dentoalveolar heights. However the increase in ramus height was associated with a non-significant increase in total anterior and lower facial

heights, suggesting a limited effect of ramus height on the intermaxillary space in anterior region. This finding may be explained by highly significant negative correlations between ramus height and angles of mandibular rotation (SN-MP, PP-MP, and Ar-Go-Me), which compensate the effect of downward mandibular movement with the increase in ramus height and hence decrease its effect on anterior facial height and intermaxillary space anteriorly. Isaacson et al (1971) found that the mean height of the ramus was inversely related to the SN-MP angle. In other words, the ramus was shortest in the high angle group and longest in the low angle group.

We may conclude from this study that the increase in ramus height provides space for the eruption of molars, or that the eruptions of molars during growing age lead to compensating ramus growth. In both cases the increase in ramus height mainly correlated with posterior intermaxillary area with a little effect on anterior facial heights, as the increase in ramus height is associated with forward rotation of the mandible. The molars will act as a fulcrum for this rotation, which occurs during periods of maximal facial growth.

McLaughlin et al (2001) and Proffit et al (2007) mentioned that adolescent patients can tolerate molar extrusion, because any extrusion is compensated by vertical growth of the ramus, but in adults this extrusion tends to rotate the mandible downward and backward, also helping to address increased overbite. Graber et al (1985) reported that during the growth period, tooth eruption can be stimulated in the posterior and inhibited in the anterior segments. The vertical growth component in the condylar and sutural areas is also amenable to therapeutic influence. Extrusion of the molars and premolars also implies a skeletal growth stimulus with vertical rotation of the mandible, with concomitant downward-backward mandibular rotation.

Yousif (2010) found a positive association between maxillary and mandibular molar dentoalveolar heights from the divergency of the jaws in Iraqi males. This finding is in accordance with the widespread belief that hyperdivergent facial types have excessive posterior dentoalveolar development which was also found in different ethnic population (Schendel et al, 1976; Janson et al, 1994; Tsang et al, 1998; Martina et al, 2005; Kucera et al, 2001) and that the hypodivergent facial types have deficient posterior dentoalveolar development (Isaacson et al, 1971). On the contrary decreases in maxillary and mandibular posterior dentoalveolar heights in the permanent dentition have been reported by Betzenberger et al (1999) and Martina et al (2005) in high-angle malocclusions.

CLINICAL IMPLICATIONS

Further studies are required to study the effect of increase in vertical measurements of the molars and the ramus during growth to detect the possibility of treating patients with a steep mandibular plane

and average or reduced facial height by extrusion of molars to compensate for backward rotation by increasing the forward mandibular rotation with minimal effect on anterior vertical facial dimensions. This may be applied during treating adolescent patient with skeletal Class II caused by small size of the ramus and body of the mandible. This relationship often results in a decreased posterior facial height, a steeper mandibular plane angle, an increased ANB angle, a normal SNA angle with a decreased SNB angle, an increased angle of convexity, and an increased overjet. The treatment can be achieved by the use of activator with subsequent trimming of the interocclusal acrylic portion to enhance the extrusion of the buccal teeth, so that the face can be more harmonized.

CONCLUSIONS

In a group of skeletal I Iraqi adults, ramus height was directly correlated with intermaxillary space in the posterior region, and inversely correlated with angles of mandibular rotation.

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