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Age Estimation from Mandible Using Cephalometry

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Abstract

Introduction: The mandible is seen as an important tool for radiological identification because of several growth parameters that can be exploited using cephalometric analysis, ease of imaging, and no overlying bony structures. These parameters can be handy in age and gender assessment in extreme situations like mass murders, remains of dead exhumed and murderous mutilations, missing or severely burnt individuals, etc.

Materials and Methods: The study was conducted on 80 patients. The radiographs were taken with digital panoramic system under standard exposure factors, as recommended by the manufacturer. Mandibular linear measurements such as mandibular length, mandibular body length, mandibular height; gonial angle was determined by the tangent of the inferior border of the mandible and the most distal aspect of the ascending ramus and condyle cephalometric radiograph.

Results: A decrease in gonial angle was observed with increasing age in the present study and statistically significant result is obtained. A statistically significant increase in the mandibular length, mandibular body length, mandibular height is observed as age increases and gonial angle is decreased.

Conclusion: The linear and angular parameters used in the study, when combined together, might prove to be of

importance in studying the growth pattern of mandible in different age groups. Furthermore studies are recommended on a larger sample size of different ethnic inhabitants to derive an unvarying formula of age assessment.

Keywords: age estimation, cephalograms, mandibular length, gonial angle.

Introduction

Facial growth and development is essential in orthodontics as well as in forensic medicine for diagnosis and identification. Among several maturational indicators, skeletal development appears to be quite a simple and accurate one. Skeletal age can be determined by radiographs, relating the appearance and development of certain bones with given maturational stages[1] .Various studies have been conducted on the estimation of age from teeth and facial dimensions and their possible use in the forensic dentistry. Importance is given to mandibular growth because it has been reported that this bone enlarges the most during adolescence.[2,3] It has also been observed that the mandible grows in a posterior-superior direction resulting in at anterior inferior displacement.[4] It has been demonstrated that mandibular sagittal growth is due to posterior deposition and anterior resorption in the ramus. In the mandible, growth spurts may occur, but not in a uniform amount and duration and also because of ease of imaging, and no overlying bony structures. These parameters can be in age and gender assessment in extreme situations like mass murders, remains of dead exhumed and murderous mutilations, missing or severely burnt individuals.

Aims and objectives

To assess the mandibular growth parameters such as Total mandibular body length, mandibular length, mandibular height and gonial angle using lateral cephalogram in the study population for determination of the age of an individual.

Inclusion criteria

The criteria for sample selection demanded an ANB angle between 0 and 4. Radiographs with Class 1 skeletal base were included.

Exclusion criteria

Radiographs with skeletal class II or III skeletal base were excluded (because of exaggerated growth).Patients with missing teeth or with syndromes, cleft lip or palate, or other craniofacial pathology were also excluded.

Study design

The study was conducted on 80 patients coming to department of oral medicine and radiology and lateral cephalograms were obtained and divided into four different age groups, Group A (8-15yrs), Group B (16-20 yrs), Group C (21-25 yrs), Group D (26-35 yrs) . The study used the following cephalometric landmarks; condylon (Co), gonion (Go), and gnathion (Gn). Three linear measurements of mandibular growth were; mandibular body length (distance between Go and Gn) mandibular length (distance between Co and Gn) and mandibular height (distance between Co and Go) as per a study conducted by Rai et al (Fig 1). These measurements were done using mouse driven cursor. Gonial angle was measured as the angle formed by the ramus line (RL) and mandibular line (ML), where RL is a tangent to the posterior border of mandible and ML is the lower border of the mandible through the Gn with the help of a mathematical protractor (Fig 2).

Results

The study constituted of 80 participants 0f age range was 8–35 years. One way test (Table 1) reveals highest mean and SD for mandibular body length, mandibular length, mandibular height for group D age group people and gonial angle for group B age group people. Anova test

reveals linear measurements between the age groups are highly significant and gonial angle is significant (p value 0.013) (Table 2). Univariate analysis of variance tests reveal the variables mandibular body length, mandibular length and mandibular height are very highly significant (p value <0.0001) among the age groups(Tables 3-8) and gonial angle is significant (Table 9 & 10).

Discussion

In the present study, linear and angular parameters of mandibular growth were analyzed on cephalometric radiographs and were used to study the mandibular growth rate between different age groups. The study participants were divided into four groups that is, 8–15, 16–20, 21-25 and 26–35 years; the linear and angular measurements were compared between age groups. It has been observed that the mandible grows in a posterior superior direction resulting in at anterior inferior displacement and that mandibular sagittal growth is due to anterior resorption in the ramus. Hence, an increase in gonial angle was observed with increasing age in the present study but no statistically significant result could be obtained. Remarkable growth of mandible occurs during puberty and the pubertal growth spurts are dependent on gender and vary in their relationship to the chronologic age. In girls, pubertal growth spurt usually starts between the ages 10 and 12 years, in boys between 12 and 14 years. In the present study, the increased mandibular linear measurements like mandibular length, mandibular body length and mandibular height were observed among the age group of 21-25, 26-35 years. This finding is not in accordance with the fact that growth spurt in females is noted at the age of 10–12. A statistically significant increase in the mandibular length (Gn to Go) was observed in the age group of 16–20 years. Among the linear parameters, mandibular length (Gn to Go) showed the greatest variation among all age groups with least variation noted in mandibular height (Go to Co). The values obtained for average linear measurements and growth rates for the study population in the present study varied from previous studies. An extended database for different populations is thus required to achieve an accurate formula for age estimation using mandibular growth parameters. The angular measurement, gonial angle is increased in the age group 16-20 years followed by decrease as age increases.

Conclusion

In the present study, it was seen that the mandible has a higher mean between the age of 25-36. Furthermore, the gonial angle showed an decrease with age. Hence, it was noted that no single formula for age estimation could be arrived at for all age groups; it varied with age of an individual due to the continuing growth during the pubertal growth spurts. Hence, it can be concluded that the linear and angular parameters used in the study, when combined together, might prove to be of importance in studying the growth pattern of mandible in different age groups. Further more studies are recommended on a larger sample size of different ethnic inhabitants to derive an unvarying formula of age assessment.

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Legend Figure and Table

Fig. 1:The linear measurements between Gnathion, Gonion, Condylon

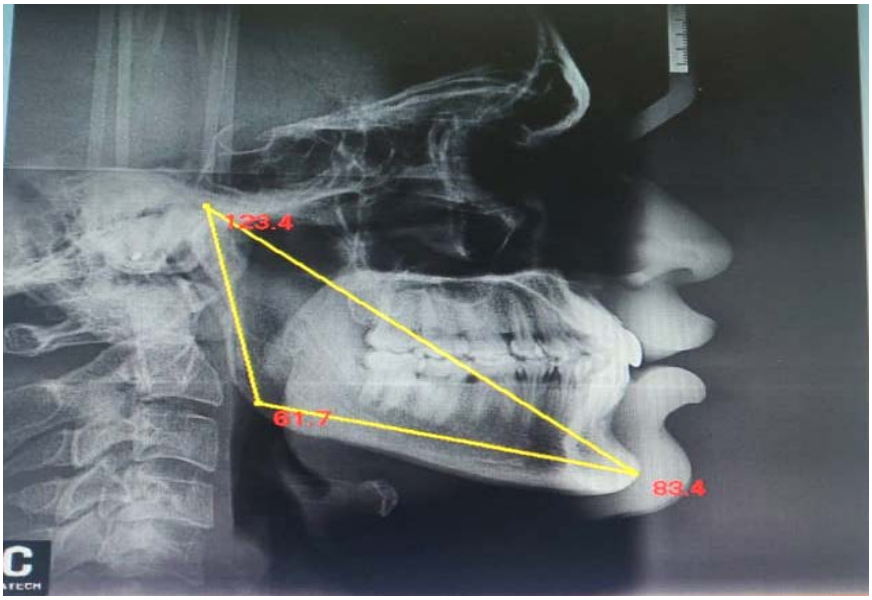
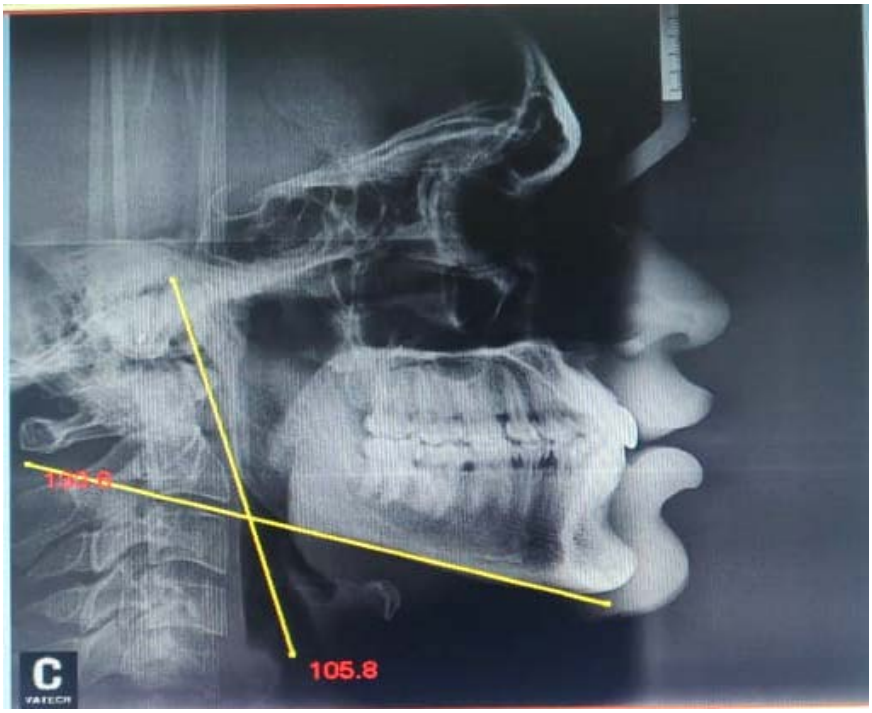


Fig. 2: Gonial angle angle formed by the ramus line and mandibular line



Onaway (Table 1)

Descriptive

		N	Mean	Std. Deviation	Std. Error	T value	P value	Upper Bound	Minimum	Maximum
Mandibular Body Length	Group A (8-15 Yrs)	29	73.05	3.36	.62	7.813	<0.0001	74.33	64.50	81.00
	Group B (16-20 Yrs)	18	71.32	5.76	1.36	VHS	68.45	74.18	61.40	82.00
	Group C (21-25 Yrs)	23	77.19	5.59	1.17	74.77		79.61	68.60	88.60
	Group D (26-35 Yrs)	14	78.67	7.03	1.88	74.61		82.73	68.50	93.00
	Total	84	74.75	5.87	.64	73.48		76.02	61.40	93.00
Mandibular Length	Group A (8-15 Yrs)	29	102.83	4.71	.88	9.136	<0.0001	104.63	89.00	110.10
	Group B (16-20 Yrs)	18	103.94	5.18	1.22		VHS	106.52	97.40	119.00
	Group C (21-25 Yrs)	23	109.92	6.86	1.43	106.95		112.89	100.10	123.20
	Group D (26-35 Yrs)	14	110.92	8.53	2.28	106.00		115.85	90.60	124.20
	Total	84	106.36	7.04	.77	104.83		107.89	89.00	124.20
Mandibular Height	Group A (8-15 Yrs)	29	46.07	4.06	.75	10.026	<0.0001	47.61	38.50	54.60
	Group B (16-20 Yrs)	18	47.83	3.80	.89	VHS	45.94	49.72	40.40	54.30
	Group C (21-25 Yrs)	23	52.50	6.87	1.43	49.54		55.47	43.10	68.50
	Group D (26-35 Yrs)	14	54.15	7.11	1.90	50.05		58.25	43.90	66.40
	Total	84	49.55	6.31	.69	48.18		50.92	38.50	68.50
Gonial Angle	Group A (8-15 Yrs)	29	124.07	4.81	.89	3.841	0.013			
	Group B (16-20 Yrs)	18	126.67	6.10	1.44	SIG	123.63			
	Group C (21-25 Yrs)	23	121.22	8.23	1.72	117.66				
	Group D (26-35 Yrs)	14	119.93	6.51	1.74	116.17				
	Total	84	123.15	6.77	.74	121.69				

Table 1: Highest mean and SD for mandibular body length, mandibular length, mandibular height is seen in group D age group people and gonial angle for group B age group people.

Anova (Table 2)

		Sum of Squares	df	Mean Square	F	P Value
Mandibular Body Length	Between Groups	648.186	3	216.062	7.813	<0.0001 VHS
	Within Groups	2212.344	80	27.654		
	Total	2860.530	83			
Mandibular Length	Between Groups	1048.548	3	349.516	9.136	<0.0001 VHS
	Within Groups	3060.533	80	38.257		
	Total	4109.080	83			
Mandibular Height	Between Groups	902.483	3	300.828	10.026	<0.0001 VHS
	Within Groups	2400.266	80	30.003		
	Total	3302.749	83			
Gonial Angle	Between Groups	478.284	3	159.428	3.841	.013 SIG
	Within Groups	3320.704	80	41.509		
	Total	3798.988	83			

Table 2: Linear measurements between the age groups are highly significant and gonial angle is significant

Univariate Analysis of Variance

Descriptive Statistics (Table 3)

Dependent Variable: Mandibular Body Length

SEX	AGE_GRP	Mean	Std. Deviation	N
MALE	Group A (8-15 Yrs)	73.2444	2.98462	27
	Group B (16-20 Yrs)	70.7714	6.81633	7
	Group C (21-25 Yrs)	78.8357	5.66509	14
	Group D (26-35 Yrs)	83.6333	6.22532	6
	Total	75.5278	6.09344	54
FEMALE	Group A (8-15 Yrs)	70.4500	8.41457	2
	Group B (16-20 Yrs)	71.6636	5.31776	11
	Group C (21-25 Yrs)	74.6333	4.65591	9
	Group D (26-35 Yrs)	74.9500	5.22029	8
	Total	73.3500	5.25611	30
Total	Group A (8-15 Yrs)	73.0517	3.36448	29
	Group B (16-20 Yrs)	71.3167	5.76483	18
	Group C (21-25 Yrs)	77.1913	5.58967	23
	Group D (26-35 Yrs)	78.6714	7.03316	14
	Total	74.7500	5.87062	84

Tests of Between-Subjects Effects (Table 4)

Dependent Variable: Mandibular Body Length

Source	Type III Sum of Squares	df	Mean Square	F	P Value
Corrected Model	1021.393[a]	7	145.913	6.030	.000
Intercept	287404.666	1	287404.666	11876.633	.000
SEX	175.648	1	175.648	7.258	.009 SIG
AGE_GRP	636.122	3	212.041	8.762	<0.0001 VHS
SEX * AGE_GRP	178.117	3	59.372	2.453	.070 NOT SIG
Error	1839.137	76	24.199		
Total	472215.780	84			

Corrected Total	2860.530	83			

a. R Squared = .357 (Adjusted R Squared = .298)

Tables 3,4: Mandibular body length is very highly significant (p value <0.0001) among the age groups

Descriptive Statistics (Table 5)

Dependent Variable: Mandibular Length

SEX	AGE_GRP	Mean	Std. Deviation	N
MALE	Group A (8-15 Yrs)	103.08	3.80	27
	Group B (16-20 Yrs)	104.73	7.41	7
	Group C (21-25 Yrs)	112.33	7.35	14
	Group D (26-35 Yrs)	117.77	5.39	6
	Total	107.32	7.64	54
FEMALE	Group A (8-15 Yrs)	99.55	14.92	2
	Group B (16-20 Yrs)	103.45	3.46	11
	Group C (21-25 Yrs)	106.18	3.99	9
	Group D (26-35 Yrs)	105.79	6.64	8
	Total	104.63	5.50	30
Total	Group A (8-15 Yrs)	102.83	4.71	29
	Group B (16-20 Yrs)	103.94	5.18	18
	Group C (21-25 Yrs)	109.92	6.86	23
	Group D (26-35 Yrs)	110.92	8.53	14
	Total	106.36	7.04	84

Tests of Between-Subjects Effects (Table 6)

Dependent Variable: Mandibular Length

Source	Type III Sum of Squares	df	Mean Square	F	P Value
Corrected Model	1778.021[a]	7	254.003	8.281	.000
Intercept	584231.740	1	584231.740	19047.825	.000
SEX	422.714	1	422.714	13.782	<0.0001 VHS
AGE_GRP	801.673	3	267.224	8.712	<0.0001 VHS
SEX * AGE_GRP	228.461	3	76.154	2.483	.067 NOT SIG
Error	2331.059	76	30.672		

Total	954367.610	84			
Corrected Total	4109.080	83			

a. R Squared = .433 (Adjusted R Squared = .380)

Tables 5,6 : Mandibular length is very highly significant (p value <0.0001) among the age groups

Descriptive Statistics (Table 7)

Dependent Variable: Mandibular Height

SEX	AGE_GRP	Mean	Std. Deviation	N
MALE	Group A (8-15 Yrs)	46.33	3.93	27
	Group B (16-20 Yrs)	47.14	4.79	7
	Group C (21-25 Yrs)	54.78	7.50	14
	Group D (26-35 Yrs)	60.43	5.50	6
	Total	50.19	7.28	54
FEMALE	Group A (8-15 Yrs)	42.45	5.59	2
	Group B (16-20 Yrs)	48.26	3.19	11
	Group C (21-25 Yrs)	48.97	3.89	9
	Group D (26-35 Yrs)	49.44	3.61	8
	Total	48.40	3.84	30
Total	Group A (8-15 Yrs)	46.07	4.06	29
	Group B (16-20 Yrs)	47.83	3.80	18
	Group C (21-25 Yrs)	52.50	6.87	23
	Group D (26-35 Yrs)	54.15	7.11	14
	Total	49.55	6.31	84

Tests of Between-Subjects Effects (Table 8)

Dependent Variable: Mandibular Height

Source	Type III Sum of Squares	df	Mean Square	F	P Value
Corrected Model	1535.526[a]	7	219.361	9.434	.000
Intercept	127107.076	1	127107.076	5466.280	.000
SEX	307.625	1	307.625	13.230	<0.0001 VHS

AGE_GRP	722.735	3	240.912	10.360	<0.0001 VHS
SEX * AGE_GRP	288.747	3	96.249	4.139	.009 SIG
Error	1767.223	76	23.253		
Total	209569.490	84			
Corrected Total	3302.749	83			

a. R Squared = .465 (Adjusted R Squared = .416)

Tables 7,8: Mandibular Height is very highly significant (p value <0.0001) among the age groups

Descriptive Statistics (Table 9)

Dependent Variable: Gonial Angle

SEX	AGE_GRP	Mean	Std. Deviation	N
MALE	Group A (8-15 Yrs)	123.85	4.849	27
	Group B (16-20 Yrs)	128.14	5.984	7
	Group C (21-25 Yrs)	119.71	8.071	14
	Group D (26-35 Yrs)	114.67	3.830	6
	Total	122.31	6.859	54
FEMALE	Group A (8-15 Yrs)	127.00	4.243	2
	Group B (16-20 Yrs)	125.73	6.262	11
	Group C (21-25 Yrs)	123.56	8.383	9
	Group D (26-35 Yrs)	123.88	5.167	8
	Total	124.67	6.429	30
Total	Group A (8-15 Yrs)	124.07	4.810	29
	Group B (16-20 Yrs)	126.67	6.097	18
	Group C (21-25 Yrs)	121.22	8.229	23
	Group D (26-35 Yrs)	119.93	6.510	14
	Total	123.15	6.765	84

Tests of Between-Subjects Effects (Table 10)

Dependent Variable: Gonial Angle

Source	Type III Sum of Squares	df	Mean Square	F	P Value
Corrected Model	893.254[a]	7	127.608	3.338	.004
Intercept	781719.523	1	781719.523	20446.015	.000
SEX	152.568	1	152.568	3.990	.049 SIG
AGE_GRP	540.035	3	180.012	4.708	.005 SIG
SEX * AGE_GRP	260.928	3	86.976	2.275	.087 NOT SIG
Error	2905.734	76	38.233		
Total	1277835.000	84			
Corrected Total	3798.988	83			

a. R Squared = .235 (Adjusted R Squared = .165)

Tables 9,10: Gonial angle is significant among the age groups