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RESEARCH ARTICLE

MANDIBULAR PARAMETERS FOR AGE ESTIMATION: A DIGITAL ORTHOPANTOMOGRAPHIC STUDY IN HYDERABAD POPULATION

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Mandible, Age Estimation, Orthopantomograph, Condylar Ramus Height, Coronoid Ramus Height, Gonial Angle

Abstract

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Background: Mandible is one of the strongest facial bones, which exhibits great changes in size and morphology during growth and aging. The mandibular ramus and gonial angle in particular show notable alterations with aging. Orthopantomographywhich is a regularly used, non-invasive procedure can be used to assess mandibular morphology with ease.

Aim and objectives: To assess the correlation of dimensions of condylar ramus height, coronoid ramus height and gonial angle with chronological age of the individual, andevaluatetheirefficacy in estimating age of the individual.

Materials and methods: The study sample included 200 digital orthopantomographs of individuals of diverse age groups. Measurements of condylar ramus height, coronoid ramus height and gonial angle were made on the digital orthopantomographs and data was tabulated. Age estimation formulae were derived for each of the three parameters and age was estimated for each individual using the formulae.

Results: No statisticallysignificant difference was found on comparing the chronological age and estimated age obtained using condylar ramus height, coronoid ramus height, and gonial angle. Among the three parameters,coronoid ramus height displayed a statistically significant correlation with chronological age.

Conclusion: Present study indicates that coronoid ramus height can be used as a reliable indicator for age estimation.

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Introduction:-

A crucial component of medical jurisprudence is the identification of persons, and forensic odontology has grown to play a major role in this regard(Dhaka P et al., 2015). Accurate estimation of age will help to narrow down the number of probable identities that will have to be evaluated to establish a positive identification (Kathoju M et al., 2021). Estimating age is often required for criminal investigations, immigration-related civil proceedings, and possible legal infractions of age of marriage or old age pensions, and also in identifying the dead in situations like mass disasters and natural calamities (Motawei SM et al., 2020).Identification of an individual through analysis and comparison of dental records by a qualified forensic dentist is accepted in a court of law as a means to prove an individual's identity (Senn DR et al., 2019).

Conventionally, skeletal growth and dental development have been assessed to ascertain age, with the skull serving as a useful growth indicator.But in majority of cases the complete skull is unavailable for study, and at these times the age estimation techniques must be based on individual skullbones. The mandible being among the hardest and strongest of the skull bones is often utilised in forensic examinations (Behl AB et al., 2020).

The mandible shows changes in morphology and dimensions during growth, and an association between age and mandibular morphology, especially that of the mandibular ramus, has been observed in several studies (Motawei SM et al., 2020). The gonial angle of the mandible (the angle formed between tangents to the lower border of the mandible and posterior border of the ramus) (Aragão, 2014)alsoundergoes change with aging, being somewhat obtuse at birth, then decreasing with age for a period of time, and increasing again in old age. The angle becomes more acute throughout growth due to greater increase in height of the ramus compared to the length of the body of the mandible (Pereira JG et al., 2020).

The high number of orthopantomograph(OPG) prescriptions in dental clinics and hospitalsmakes them a useful instrument for visualising the changes in mandibular morphology that arise with aging (Leversha et al., 2016). OPGs allow for accurate linear and also angular measurements to be made (Jambunath et al., 2016). Minimal radiation exposure for the patient, quick image acquisition and theabsence of overlap of structures areadditional advantages(Kathoju M et al., 2021).

Hence, we performed this study in Hyderabad population visiting our institute to determine the efficacy of different linear and angular measurementsof the mandible as measured on orthopantomographs, in age determination, and to develop population-specific formulae for reliable age estimation.

Materials And Methods:-

Study design:

The present retrospective study was performed in Department of Oral and Maxillofacial Pathology utilizing **200** digital orthopantomographs (OPGs),taken for various diagnostic purposes in Government Dental College and Hospital, Afzalgunj, Hyderabad. The OPGs were of individuals of different chronological age groups within the age range of 10-70 years.

Inclusion criteria:

1. Good quality panoramic images devoid offaults in image exposure and positioning.
2. OPGs with clearly visible inferiorborder of the mandible.

Exclusion criteria:

1. Any developmental problems, fractures or deformities of mandible.
2. Edentulous mandible.

The orthopantomographs were split into 6 groups:
Group A: 11-20 years
Group B: 21-30 years
Group C: 31-40 years

Group D: 41-50 years
Group E: 51-60 years
Group F: 61-70 years

Digital orthopantomographs, were transferred to the ImageJ programme and stored in a JPEG file format. Using the software, linear dimension of coronoid and condylar ramus height, and gonial anglevalueswere recorded on the right side of mandible.

To standardise the measurements,a digitally drawn orientation line passing through the gonial anglewas used as a reference for measurements. The following measurements were made:
1. Condylar ramus height (red):Distance between the condylion (most posterior and superior point on the mandibular condyle) and a point at the lower border of the mandibular ramus through which the orientation line passes(Figure 1).
2. Coronoid ramus height (green):The distance from the coronion (tip of the coronoid process) toa point at the lower border of the mandibular ramus through which the orientation line passes (Figure 1).
3. Gonial angle (yellow):The angle formed at the meeting point of two lines, one line passing at a tangent to the lower border of the mandibular body, and the other line tangential to the posterior border of the mandibular ramus and condyle (Figure 2).

Results:-

The measured data of the 200 samples wasrecorded ina Microsoft 2010 Excel spreadsheet. Statistical analysis was doneusingthe statistical package for social sciences software (SPSS version 20.00)

Mean of condylar height, coronoid height and gonial angle for all the age groups was calculated (Table 1).**Age estimation formulae** were derived for each parameter by simple linear regression analysis:

Regression equation 1: Age = -0.0016 x Condylar ramus height + 5.585
Regression equation 2: Age = -0.0052 x Coronoid ramus height + 5.5841
Regression equation 3: Age = -0.0129 x Gonial angle + 122.48

Age was estimated for the entire sample using each variable independently using the derived formulae. The measured values of each parameter were substituted in the formula to acquire the estimated age. Paired t-test was done to compare chronological age with the estimated age obtained by the three variables (gonial angle,coronoid and condylar ramus height) (Table 2). Correlation between the chronological and estimated age was done by the Karl Pearson Coefficient test (Table 3).

The mean of the chronological ages of all the individuals was 40.17, and the mean of all the estimated ages obtained by the formulae was also 40.17 years (Table 2). This suggests that the estimated age is comparable to the chronological age. Table 3 shows correlation of chronological age with each of the three mandibular parameters. Among the three parameters,coronoid ramus height alone exhibited a statistically significant correlation with chronological age**(‘p’ value = 0.0375)**, suggesting that it is a reliable predictor of age.

Discussion:-

Given the rise in the rate of various crimes lately, one among the major responsibilities of forensic experts is the estimation of age (Behl A.B, 2020).Among the different maturational markers, bone growth is a dependable indicator of aging (Dhaka P, 2015). The mandibular morphology is impacted by aging and occlusal status of the individual (Kathoju M, 2021).The structure and actions of the muscles of mastication also influence the shape ofthe mandibular base, particularly the gonial angle. Mandibular remodelling is caused by the aging-related decrease in masticatory muscle density and contractile activity.(Meleveetil et al., 2020).

Of the mandible's morphological changes during growth, the ramus and gonial angle experience the most substantial remodelling and size alterations. Assessing the dimensions of these mandibular parameters through radiological examination is convenient due to the ease of its imaging, and absence of overlying bony structures (Dhaka P, 2015).

Utilising digital OPGs, we calculated the mean of coronoid ramus height for the whole sample, and maximum values were obtained for the age group B (21-30 yrs) followed by a steady decline in height with the increasing age groups. Whenwe assessed condylar ramus height, maximum values were obtained for group B (21-30 yrs), with decrease in group C (31-40 yrs) followed by constant values in group D (41-50 yrs) and E (51-60 yrs). Lowest value was seen in group F (61-70 yrs). Whereas gonial angle showed no trend among the various age groups.

The average of estimated age obtained using the derived formulae for condylar and coronoid ramus height, and gonial angle was 40.17 years, suggesting that the estimated age was comparable to chronological age (mean = 40.17 years).This is in accordance with the findings of **Kathoju et al. (2021)**who found no statistical significance on comparing the chronological age with the estimatedage (Kathoju, 2021).

When the individual parameters were considered, coronoid ramus height was found to increase from the age of 11-30 years, and thereafter decreased from 31-70 years. A statistically significant correlation of coronoid ramus height with age was seen with a **'p' value of 0.0375**.

These findings are similar to those of **Gupta A et al. (2022)** who found coronoid ramus height to increase during the 2nd and 3rd decades of life and thereafter decrease with age. The correlation of coronoid ramus height with chronological age was statistically significant ('p' = 0.0001) (Gupta A et al. 2022).One explanation for the decline in ramus height observed in older age groups is the anterior mandibular rotation. The vertical growth of ramus is also found to diminish in the later portion of the third decade(Gupta A et al. 2022).Our findings are also similar to the observations of **Al-Shamout et al.(2012).** They found an increase in ramus height from the age of 11-29 years, and then a decrease with increasing age (Al-Shamout, 2012).

Our results conflict with the observations of **Behl et al. (2020)** who observed ramus height increase with advancing age. This may be explained by the fact that their study comprised a different age range (10-40 years) (Behl AB, 2020).

When we assessed condylar ramus height, an increase in height from 11-30 years, and thereafter a decrease with advancing age was observed. But the correlation of condylar ramus height with chronological age was not found to be statistically significant.

Our findings are similar to the observations of **Gupta A et al. (2022)** who noted greater coronoid and condylar ramus height measurements in individuals of the 2 & 3rd decades i.e., the 19-to-39-yearage group, with a decrease subsequently with aging (positive correlation) (Gupta A et al. 2022).

This is also in accordance with the observations of **Behl et al. (2020)**who assessed mandibular ramus dimensions in subjects of North India population of 10-40 years of age. Mandibular ramus heightexhibited a statistically significant positive correlation with age (Behl AB et al. 2020).The decrease in ramus height in later stages with age might be explained by the anterior-rotation of the mandible and the various remodelling processes due to osteoporosis, which is seen in old age (Gupta A et al. 2022).

Our results are contrary to the findings of **Ramesh et al. (2018).** They assessed condylar ramus height in age groups of 20-70 years and found condylar height to be increasing with aging (Ramesh et al. 2018).

Our findings conflict with those of**Raustia et al. (1997)**who found no associationof ramus height with age in complete denture wearing individualsin the age limit of 42-74 years (Raustia AM et al. 1997).

On assessment of gonial angle measurement as a tool for age determination, we found no association between gonial angle and chronological age. This is in accordance with the findings of **Taleb at al. (2015)** who evaluated 191 digital OPGs and discovered no change in the gonial angle with aging (Taleb, 2015).Our findings also coincide with the observations of**Oksayan et al. (2014)**who studied gonial angle variation in young dentate, old dentate and completely edentulous individuals. They observed no variation of gonial angle among the different groups (Oksayan R et al. 2014).

Our findings conflict with those of **Kathoju et al. (2021)**and **Behl et al. (2020)** who foundgonial angle to decrease with advancing age which was statistically significant (Kathoju M, 2021) (Behl AB et al. 2020).

Our findings are contrary to the observations of **Leversha et al. (2016)** and **Upadhyay et al. (2012)**who noted a trend of gonial angle increase with age (Leversha J et al. 2016) (Upadhyay R.B et al. 2012).

The reason for the inconsistent findings of the association between gonial angle and chronological age in the different studies could be due to the inclusion of diverse age groups and dental statuses in these studies.

Conclusion:-

The findings of our study indicate that the mandibular ramus dimensions of condylar and coronoid ramus height are reliable indicators for estimating chronological age of an individual, with coronoid ramus height showing a statistically significant correlation with chronological age in our selected sample. Conversely, gonial angle values showed no trend with aging in our study sample.

Further research on a larger sample and across a vast area of Hyderabad will help ensure that the sample is more representative and accurately reflects the population, and will help to set our population standards for estimating age. Incorporation ofother imaging modalities and inclusion of individuals with different dental statuses will help in arriving at a more reliable method of age assessment.

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The authors report no conflicts of interest related to this study.

Graphics And Tables

Table 1:- Mean of condylar height, coronoid height and gonial angle for the different age groups.

		Condylar height	Coronoid height	Gonial angle
Age group	**N**	**Mean**	**Mean**	**Mean**
11-20 yrs	33	5.31	5.195	122.697
21-30 yrs	34	5.857	5.767	121.109
31-40 yrs	33	5.494	5.506	123.539
41-50 yrs	34	5.471	5.351	121.871
51-60 yrs	34	5.491	5.314	118.972
61-70 yrs	33	5.305	5.202	123.247

Table 2:-Paired t-test: Comparison between chronological age and estimated age (calculated using the3 parameters).

Parameters	Age	Mean	Standard deviation	Paired t	p value
Condylar ramus height	Chronological age	40.17	16.685	0	1
	Estimated age	40.17	0.581		
Coronoid ramus height	Chronological age	40.17	16.685	0	1
	Estimated age	40.17	2.201		
Gonial angle	Chronological age	40.17	16.685	0	1
	Estimated age	40.17	0.823		

(p value set at 0.05; p < 0.05 – Statistically significant.)

Table 3:-Karl Pearson Coefficient of Correlation test: Correlation between chronological age and estimated age (calculated using each of the 3 parameters).

VARIABLES	CORRELATION COEFFICIENT [r]	p value
Condylar ramus height	0.0348	0.6246
Coronoid ramus height	0.1678	**0.0375**
Gonial angle	0.0493	0.4881

(p value set at 0.05; p < 0.05 – Statistically significant.)

Figure 1:-Condylar ramus height (red line) and coronoid ramus height (green line) measured on a digital orthopantomograph.

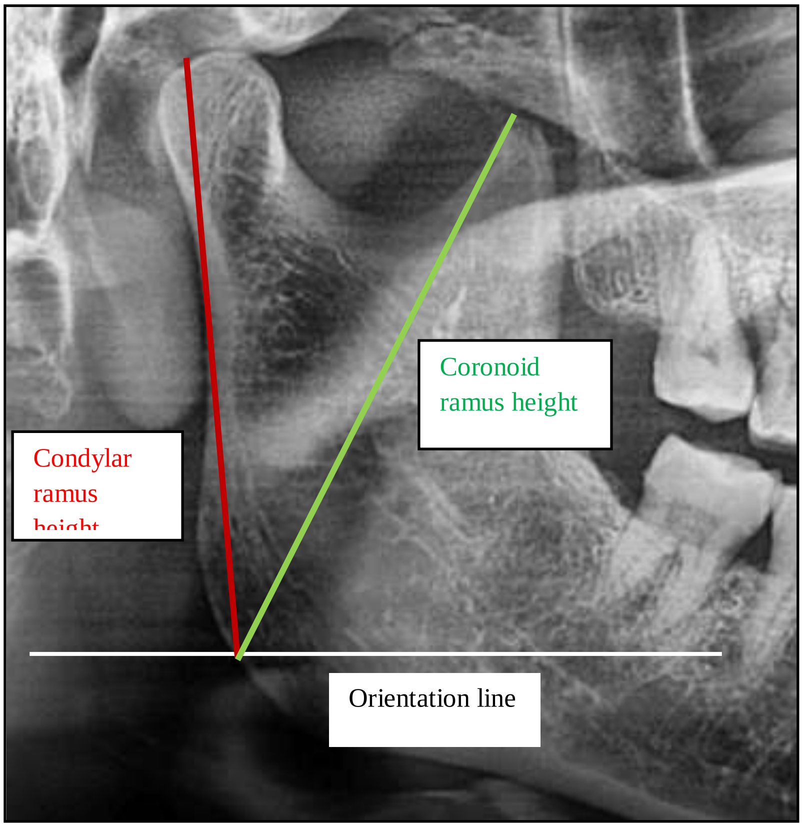
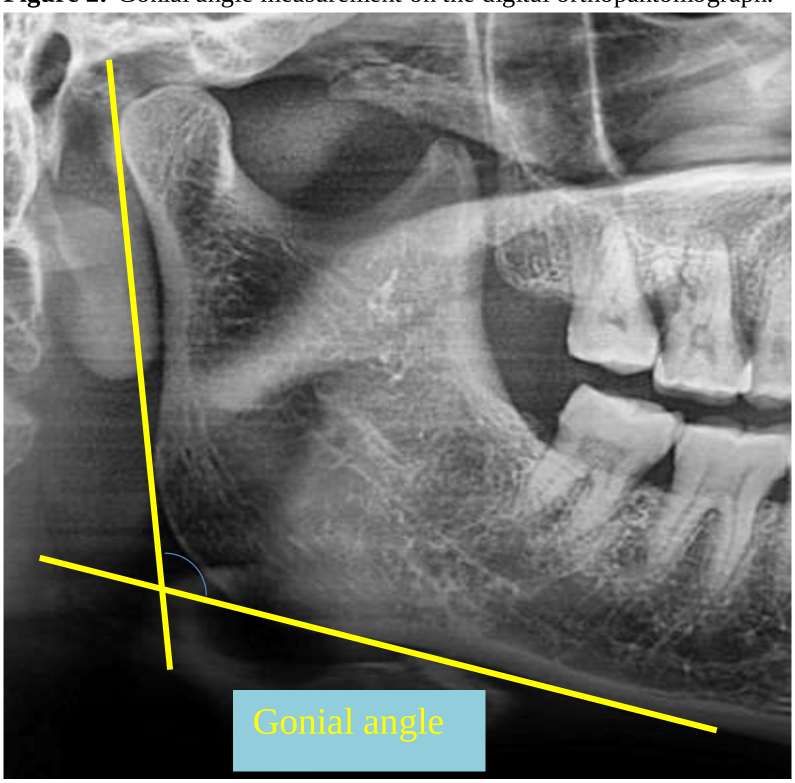


Figure 2:-Gonial angle measurement on the digital orthopantomograph.



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