ORIGINAL ARTICLE

Sex Determination using Condylar Height in south Indian population - A Retrospective Study

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Abstract :

Mandibular parameters evaluation has been used to determine sex in forensics and for treatment planning in dentistry. The present study aims to determine condylar height in a group of 20 to 70 years old males and females using panoramic radiographs for sex determination. This study was performed to measure the height of the condyle indicating that females and males showed significant differences for condylar height by 5.81 mm. The results of the present study indicate that condylar ramus height can be used effectively for sex determination.

Keywords: Sex determination; Condylar height; Panoramic radiograph; Orthopantomograph.

Introduction :

Growth and development are parallel processes that are influenced by internal factors (heredity, race, gender, genetics, etc.) and external factors (nutrition, function, etc.). The mandibular growth process is a complex process with intramembranous and endochondral ossification.[1,2] The mandible grows in various directions, including vertical, horizontal, lateral, and rotational. Acceleration of mandibular growth runs in parallel with the accelerated phase of height. In other words, the increase or decrease in skeletal maturity has variability similar to facial growth, especially mandibular growth.[3,4] Mandibular assessment was used in the forensic field to determine age and sex,[3,5,6] Mandibular growth was a constant remodelling process. Bone juxtaposition and bone resorption. The mandible is a bone with many morphological changes and shows the most postnatal growth compared to other facial bones.[7,8] Morphological changes, calcification and fusion at the centre of ossification. Panorama radiographs can provide morphological information and bone morphology during growth. In some studies, panoramic radiographs have also been used to measure the vertical and horizontal dimensions of the lower jaw, and the only method for assessing the growth of lower jaw length is the height of the condyle. Mandibular growth is also assessed by measuring the distance of mandibular landmarks.[9] The purpose of this study is to determine the condylar height of 20 to 70 years old men and women using panoramic radiographs for role in sex determination.

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Article History

DOR : 18.05.2022; DOA : 24.09.2022

Materials and methods:

The present study titled "Sex Determination using Condylar Height - A Retrospective Study" was conducted in the Department of Forensic Odontology, JSS Dental College and Hospital, Sri Jagadguru Sri Shivarathreeshwara Academy of Higher Education and Research (JSSAHER), Mysuru, Karnataka.

This study was undertaken with an aim of establishing certain mandibular parameter as criteria, thereby setting a population specific standard for sex determination. Digital orthopantomograms (OPG) archived in the Department of Oral Medicine and Radiology, JSS Dental College and Hospital, Mysuru were used for this study. The study sample consisted of 400 OPG (200 male and 200 female subjects) that were divided into five groups on the basis of chronological age by decades (40 in each group for male and female subjects), in the age range of 20-70 years(Table 1). Mandibular parameter condylar height was studied and assessed whether they aid in determining the sex.

Digital orthopantomograms were obtained from PLANMECA PROMAX SCARA 3 Digital OPG Machine, (70 kVp, 8 mA for 16 seconds), Manufactured by PLANMECA OY, Helsinki, Finland, with a 1:1 ratio. The digital orthopantomograms were imported into Planmeca Romexis Viewer Software 2.9.2.R., and the measurements were done. Microsoft Office Excel (2016) sheet was used for compiling the data. The statistical analysis was carried out using SPSS Software Package version 20.

Eligibility Criteria of samples: The digital orthopantomograms were selected according to the selection criteria in which Panoramic radiographs on which all structures were visible clearly.

Table 1. Sample size distribution.

Study Groups	Age group	Male	Female
Group 1	20-30 years	40	40
Group 2	31-40 years	40	40
Group 3	41-50 years	40	40
Group 4	51-60 years	40	40
Group 5	61-70 years	40	40
	Total	200	200

Table 2. Mean value of condylar ramus height for females and males in relation to different age groups.

Age group (years)	Female		Male		Statistically significant
	No.	Mean (mm)	No.	Mean (mm)	
Group 1: 20-30	40	68.73 4.60	40	78.24 6.67	Yes (P = 0.00)
Group 2: 31-40	40	68.55 4.82	40	76.29 6.66	Yes (P = 0.00)
Group 3: 41-50	40	69.34 4.87	40	76.57 5.07	Yes (P = 0.00)
Group 4: 51-60	40	70.10 5.21	40	76.92 5.29	Yes (P = 0.00)
Group 5: 61-70	40	78.20 0.00	40	75.95 6.02	Yes (P =0.02)
Overall: 20-70	200	70.98 5.66	200	76.79 5.97	Yes (P = 0.00)

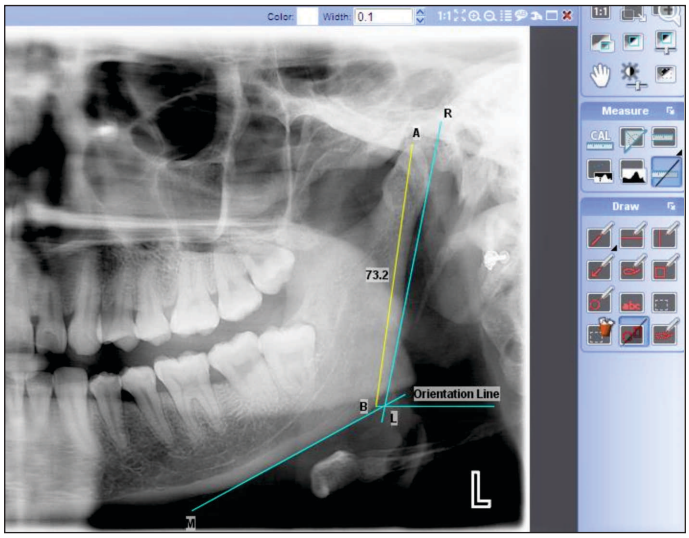

Figure 1. Condylar ramus height A-B (in yellow).

Methodology:

Ethical clearance was obtained from JSS Dental College & Hospital's Institutional Ethical Committee prior to conducting the study (No: JSS/DCH/IEC/2017-18 /02). The digital orthopantomograms were selected based on the inclusion and exclusion criteria mentioned above. The selected radiographs were imported to Planmeca Romexis Viewer 2.9.2.R software, where the Condylar Height was digitally traced and the measured values noted (FIG 1). Literature states that a very high degree of symmetry exists between the left and the right sides, therefore all the measurements were made on the left side of the radiograph for uniformity.[10,11] The measurements were calibrated in millimeters (mm) and the measured values were entered in Microsoft Office Excel sheet.

1. Condylar Height (A-B): The distance from the condylion (A) to the intersection of the orientation line with the inferior border of the ramus (B). This methodology is obtained from Taleb NSA, Beshlawy ME, 2015.[10] One line drawn horizontally (orientation line) at the intersection of the tangents along the posterior border of the ramus (RL) and along the inferior border of the mandible

Table 3. Comparison of mean value of condylar height in different studies in Indian population.

Sl.No	Study (mm)	Male	Female
1.	Indira et al. 2012[12]	131.30 ± 9.26	123.27 ± 7.36
2.	Anupam Datta et al. 2015[18]	67.98 ± 4.40	55.72 ± 5.33
3.	Chaudhary S et al. 2015[23]	66.78 ± 5.47	59.99 ± 5.07
4.	Usha J et al. 2016[24]	70.30 ± 7.90	61.84 ± 5.79
5.	Sairam et al. 2016[25]	65.01	59.48
6.	More CB et al. 2017[26]	70.2	64.3
7.	Maloth KN et al. 2017[27]	70.72 ± 5.40	65.43 ± 4.65
8.	Kartheeki B et al. 2017[28]	78.3 ± 5.09	71.3 ± 5.06
9.	Samatha K et al. 2017[29]	65.34 ± 4.33	61.69 ± 10.11
10.	Aditi Ramesh et al. 2018[30]	59.03 ± 6.28	54.15 ± 7.21
11.	Shivaprakash et al. 2018[16]	59.21 ± 4.69	55.55 ± 4.93
12.	Pangotra N et al. 2018[31]	70.26 ± 3.90	60.88 ± 3.47
13.	Altaf Hussain et al. 2019[32]	71.07 ± 4.37	68.21 ± 2.50
14.	Aruleena et al. 2019[33]	71.55 ± 5.6	66.21 ± 4.09
15.	Mehta H et al. 2020[34]	58.69 ± 4.84	53.95 ± 4.48
16.	Kaur R et al. 2021[35]	73.31 ± 5.83	67.11 ± 5.22
17.	Ghata savoriya et al. 2021[36]	69.27 ± 1.1	61.71 ± 0.75
18.	Present study 2021	76.79 ± 5.97	70.98 ±5.66

(ML), serve as reference lines to aid in the measurement of the condylar ramus height.

Group 1: 20-30 years: The mean value of condylar height in females was 68.73 mm +/- 4.60 with a standard error mean of 0.72, while for males it was 78.24 mm +/- 6.67 and standard error mean was 1.05. The mean difference between females and males was 9.51 mm.

Group 2: 31-40 years: In female subjects, the mean condylar height was calculated to be 68.55 mm +/- 4.82. The SEM was 0.76. In males, mean condylar height was 76.29 mm +/- 6.66, SEM being 1.05. The mean difference between females and males was 7.7375 mm. The P value was 0.000, thus indicating that it was statistically significant (P > 0.05), thereby implying that condylar height showed significant differences between females and males by 7.7375 mm.

Group 3: 41-50 years: In the 41-50 years age group, the mean value for condylar height in females was calculated to be 69.34 mm +/- 4.87, with SEM being 0.77. In males the mean was calculated to be 76.57 mm +/- 5.07, SEM being 0.80. The mean difference between females and males was 7.23 mm. The P value was 0.000 (P < 0.05) indicating that significant differences exist between females and males for condylar height by 7.23 mm.

Group 4: 51-60 years: The mean value for condylar ramus height in females was 70.10 mm +/- 5.21 with a SEM of 0.82. The mean value in males was 76.92mm +/- 5.29, SEM = 0.83. The mean difference between females and males was 6.825 mm. The P value calculated was 0.000 (P < 0.05). In other words, significant differences were seen between females and males for condylar ramus height by 6.825 mm.

Group 5: 61-70 years: The mean value for condylar height in the 61-70-year age group was 78.20 mm +/- 0.00, SEM was 0.00 in females and for males it was 75.95 mm +/- 6.02 with SEM being 0.95. The mean difference between females and males was 2.2475 mm. The P value was 0.021 which is lesser than 0.05 thus indicating that significant differences exist between females and males by 2.24 mm.

Overall Age Group: 20-70 years: The overall group statistics reveals that the mean condylar height was 70.98 mm +/- 5.66, SEM of 0.40 for females and 76.79 mm +/- 5.97, SEM of 0.422 for males. The mean difference between females and males was 5.811 mm. The P value obtained was 0.000, which was statistically significant ($P < 0.05$), indicating that females and males showed significant differences for condylar height by 5.81 mm.

Discussion: The mean condylar ramus height obtained in the present study was 70.98 mm +/- 5.66 for females and 76.79 mm +/- 5.97 for males. Thus, the mean value was larger in male subjects than in female subjects. Also, the P value was calculated to be 0.000 ($P < 0.05$), implying that mean condylar ramus height was statistically significant. In other words, females and males showed significant differences. The present study revealed that the condylar ramus height showed difference between sexes irrespective of age groups. In the present study, the condylar height decreases with age in the 3rd decade of life, remains constant up to the 5th decade and then decreases in the 6th decade of life in males. In females it increases with age (Table 2). Mandibular condyle and ramus in particular are generally the most sexually dimorphic as they are the sites associated with the greatest morphological changes in size and remodelling during growth.[10,12,13] Generally, the overall size and bone thickness of the male skeleton is greater than that of the female; however, this is not universal, since bone size and thickness are related to many things other than sex; better nutrition and heavy physical activity.[14] On an average, males have greater masticatory force than females that influences the bone size.[15] This accounts for the larger dimensions seen in male subjects compared to female subjects.

Table 3 shows that mean condylar ramus height shows larger values for male than female subjects and also in comparison with different studies all over India till date using orthopantomographs . This shows that males have greater condylar height dimensions than female subjects. The result obtained in this study is similar to those obtained by Shivaprakash S, Ashok KR 2018,[16] Nagaraj et al., 2017,[17] Anupam Datta et al., 2015[3] and Indira et al., 2012[28] all of which show greater mandibular dimensions in males than females. Shivaprakash S, Ashok K's study (2018) involved 200 adult mandibles in a South Indian population.[16] Nagaraj et al., 2018 conducted a study by taking orthopantomograph of 50 males and 50 females in an Indian population.[17] In the study conducted by Anupam Datta et al., (2015) on an Indian population, 50 adult, dry, complete human mandibles were assessed.[3] Indira et al., 2012 conducted a study wherein 100 orthopantomograms from an Indian population were analyzed.[12] The condylar ramus height was measured as the distance from the highest point on the mandibular condyle to gonion.[16,17,3,12] The mean values of females (70.98 mm) and males (76.79 mm) in the present study is similar to the mean values obtained by Nagaraj et al., 2017[17] for females (68.72 mm) and males (73.80 mm) with a difference of 2.26 mm for females and 2.99 mm for males. Smaller mean condylar ramus height measurements were observed in Anupam Datta et al., 2015, 55.72 mm for females and 67.98 mm for males[18] and in Shivaprakash S et al., 2018, where mean values were 55.55 mm for females and 59.21 mm for males.[16] This could be due to the fact that measurements were made on mandibular specimens. Larheim and Svanaes in their study have found that an image magnification of approximately 18% to 21% was seen when measurements were done on radiographs compared to dry specimens.[19] The mean value obtained by Indira et al., 2012[12] was considerably higher than those obtained in the present study and other studies as well. This could be due to the magnification factor since the software used for obtaining the orthopantomograms and measuring the mandibular dimensions were different. It has been stated however, that all images were uniformly magnified in their study.[12] Studies conducted by Taleb NSA and Beshlawy, 2015,[10] N Ongkana and P Sudwan, 2009[20] and Vodanovic et al., 2006[21] all show that males have higher mean mandibular condylar height than females.

Sex:

All of the above-mentioned studies showed statistically significant P values indicating that significant differences exist between females and males.[3,10,12,17,16,20,21] These results are in concordance with those obtained in the present study. This indicated that condylar ramus height is a reliable parameter that can be used to determine the sex of an individual. Studies conducted by Taleb NSA et al., 2015 showed that condylar ramus height can be used effectively in determining sex,[10] while studies conducted by Indira et al., 2012, Nagaraj et al., 2017 and Shivaprakash S, Ashok KR, 2018 revealed that condylar ramus height plays a significant role in the determination of sex.[12,17,16] This is in accordance with the present study. In the present study condylar ramus height was statistically significant with $P = 0.000$ for males and females thus showing that females and males have significant differences. This indicates that condylar ramus height is a good parameter for determining the sex of an individual. This study contradicts the results of a previous study conducted by Kedarisetty et al., 2015 (South Indian population, 60 lateral cephalograms) where there was no statistically significant difference between male and female subjects in height of the condyle.[22]

Conclusion:

Mass disaster victims often go unnoticed due to a lack of readily available material on site, challenging forensic experts to think beyond their capabilities. "When all else fails, teeth and bones prevail." The jawbone, the largest bone in the skull, is the most resistant to damage and disintegrate, and is believed to be an important tool for sex determination. It provides sex-specific measurements and is reliable in sex determination. This study demonstrates that mandibular index is a reliable instrumental parameter for sex determination in forensic odontology.

Conflict of Interest: 'The Author(s) declare(s) that there is no conflict of interest'

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