Available online at **www.ijmrhs.com**

ISSN No: 2319-5886

International Journal of Medical Research & Health Sciences, 2019, 8(11): 67-74

Mandibular Morphological Variations in Partially Edentulous Adult Patients: An Orthopantomographic Study

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ABSTRACT

Objectives: *This study was aimed to measure and evaluate the morphological changes of the mandible, related to age and gender in partially edentulous and completely dentate subjects using panoramic radiographs.* ***Methods:*** *This study included a sample of 150 partially edentulous patients and 150 completely dentate patients enrolled in the College of Dentistry, King Saud Bin Abdulaziz University for Health Sciences between January 2015 and December 2018. Five mandibular morphological and anatomical parameters were measured using a Romexis software including; Condylar height. Gonial Angle, Ramus height, Antegonial notch depth and Ramal notch depth.* ***Results:*** *There was a significant difference (p=0.00) seen in the mean values of GA when comparing the partially edentulous (130.01 ± 7.79°) and completely dentate group (126.95 ± 6.64°). The mean values of GA were significantly larger among the younger age group (20-40) in both partially edentulous patients (131.58 ± 8.27°) and completely dentate group (127.17 ± 6.9°) (p<0.05).* ***Conclusion:*** *There was no relationship between the changes in the morphological measurements related to age and gender except for GA where younger subjects have higher GA values. Also, the mean values of GA were significantly higher in the partially edentulous group compared to completely dentate.*

Keywords: Mandible morphology, Partially edentulous, Gonial angle, Condyle, Orthopantomogram

INTRODUCTION

Various morphological and anatomical changes could be observed in the mandible with progressive development in the growth and function of the jaws. Authors have described some changes that take place in the morphology of the human mandible with advancing age [1-3]. The morphology of the mandible also changes as a result of tooth loss. Some problems in the teeth cannot be solved except with tooth extraction. This therapy can cause partial or complete edentulism, which unfortunately may represent the beginning of various new problems.

The morphological and anatomical changes exhibited in mandibles depend on age, gender, and dentoalveolar condition of the patient. Several studies have measured and compared the mandibular morphological and anatomical changes between edentulous and dentate subjects [3-5]. The anatomical changes which have been evaluated in the subjects include Gonial Angle (GA), Condylar Height (CH), Ramus Height (RH), Ramal Notch Depth (RND), and Antegonial Notch Depth (AND).

Orthopantomogram (OPG) is the most common form of specialized radiological technique prescribed in dentistry. Both jaws are imaged on one radiograph, providing an estimation of vertical bone height and evaluation of the gross anatomy of the jaws. These advantages make OPG the best initial radiograph for both edentulous and partially edentulous patients. Moreover, it is a useful tool to assess GA [6,7]. Sicher and Dubrul defined a widening of GA as a result of disuse atrophy following teeth loss and even venture the statement that the widening of GA is more marked if no dentures were worn [8]. Recent studies validated this statement in which an increase in mean values of GA was

found in edentulous subjects [2,4,9-11]. AND is the upward curving of the inferior border of the mandible anterior to the angular process (gonion) [12]. Several studies have investigated the thesis that antegonial notch morphology predicts mandibular growth [13]. Recent studies concluded that deeper AND values found in patients with higher masticatory forces and male group [3,14,15].

Since the earlier studies compared the mandibular morphological and anatomical changes only between dentate and completely edentulous subjects, this study aimed to measure and evaluate these changes related to age and gender in partially edentulous and completely dentate subjects using OPG.

METHODS

The present study is a retrospective observational study of the mandibular morphological variations in partially edentulous patients attending King Saud Bin Abdulaziz University for Health Sciences, Dental Clinics in Riyadh, Saudi Arabia. The ethical approval was obtained from the institutional review board committee of King Abdullah International Medical Research Center (KAIMRC), Saudi Arabia (SP18/452/R).

The study was carried out in the College of Dentistry clinics at King Saud Bin Abdulaziz University for Health Sciences (KSAU-HS), Riyadh, KSA. The study was conducted on Saudi patients of both genders, above 20 years of age having partially edentulous areas in the mandible and having readable panoramic radiographs. All patients with a complete complement of permanent teeth with/ without third molars were included in the control group. Completely edentulous patients and patients with parafunctional habits, orthognathic surgery, craniofacial deformities, fractures, TMJ anomalies, condylar pathology, and bone pathology were excluded from the study.

Based on the power analysis, the sample size was 300 subjects. A convenient sampling technique was used. The sample of this study was selected conveniently from the patient records and included 150 partially edentulous patients and 150 completely dentate patients enrolled in the College of Dentistry, King Saud Bin Abdulaziz for Health Sciences between January 2015 and December 2018. The patient data was obtained from the Salud Dental Suite 2015 1.0 Patient Database. The relevant medical history was obtained from the Salud Database to facilitate patient selection.

The study was conducted using the panoramic radiographs of the eligible patients. All the radiographs were taken using the digital Planmeca Romexis machine. The criteria of selection of patients' panoramic radiographs were that they had to be of high quality and sharpness with no distortion. In addition, the image should give a clear representation for anatomical structures of interest to measure: Gonial Angle (GA), Condylar Height (CH), Ramus Height (RH), Ramal Notch Depth (RND) and Antegonial Notch Depth (AND) on both sides of the mandible.

1. Gonial Angle (GA): The angle between the imaginary tangential line along the posterior border of the mandibular ramus and the inferior border of the mandible (Figure 1)
2. Condylar Height (CH): The distance between a line perpendicular to the ramus tangent line at the level of the most lateral image of the condyle and the line perpendicular to the ramus tangent line at the level of the most superior image of the condyle. CH will be the perpendicular distance between the lines (Figure 1)
3. Ramus Height (RH): The distance between the line perpendicular to the ramus tangent line at the level of the most lateral image of the ramus. RH will be the distance between the lines (Figure 1)
4. Antegonial Notch Depth (AND): The distance along a perpendicular line from the deepest point of the antegonial notch concavity to a tangent to the inferior cortical border of the mandible (Figure 1)
5. Ramal Notch Depth (RND): The distance along a perpendicular line from the deepest point of the ramus notch concavity (Figure 1)

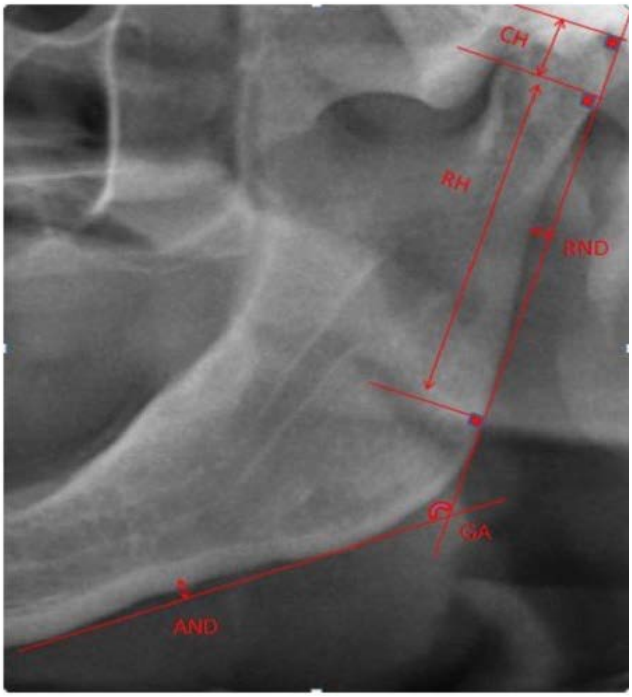

Figure 1 Mandibular landmarks used for measuring the gonial angle, ramus height, condylar height, antegonial notch depth and ramal notch depth on panoramic radiograph

The morphological measurements were evaluated on the selected digital radiographs using Planmeca Romexis software 4.5.2.R for both the right and left sides. The selected landmarks (as depicted in Figure 1) were digitized on the radiograph, calibrated and measured using the software. The patients' data and the mandibular morphologic measurements were manually entered in the assessment sheet (Appendix 1). The assessment sheet used for the study included the following sections: A) Age and gender. B) Dental status. C) Morphological measurements including GA, CH, RH, RND, and AND. The total sample of 300 patients was divided into two groups according to their age: 20-40 years and 41-65 years, and according to their dental status: dentate (control group) and partially edentulous (test group).

Data was collected by 6 examiners and each examiner received verbal instructions as well as training on landmark digitization and calibration for the standardization of measurements to reduce inter-examiner variability. In order to assess the error of the measurements, inter-observer reliability of 15 radiographs in each age group (a total of 45 radiographs) was selected at random and reexamined after a time gap of one week by the same observer. The collected data was entered manually into the Excel file and analyzed using IBM SPSS Statistical program version 22 (IBM Inc. NY, USA).

Statistical analysis used were the following: 1) Descriptive statistics, including the mean, standard deviation, median, minimum and maximum values, were calculated for all the measurements in both the test and control groups. 2) Chi-square analysis to assess the relationship between dental status with age and gender of the participants. 3) An independent t-test was used to compare morphological measurements of the mandible with age, gender, and dental status. The level of significance was set at a p-value of <0.05.

RESULTS

The sample included 156 males and 144 females. Among the study sample, there was a trend towards partial edentulousness seen in females (62% female to 38% male) and complete dentition in males (66% males and 34% females). A higher percentage of the participants in the study group (partially edentulous) were present in the older age group (60.7%) as opposed to 39% in the (20-40) age group. In comparison, completely dentate participants belonged mostly (80.7%) in the younger age group (20-40) (Table 1).

Table 1 Demographic data in cases and controls

Variable	Category	Partially Edentulous		Fully Dentate		Total	Chi-square value	p-value
		Percentage (%)	No.	Percentage (%)	No.			
Gender	Male	38.00%	57	66.00%	99	156	23.558	0.00
	Female	62.00%	93	34.00%	51	144		0.00
Age	20-40	39.00%	59	80.00%	121	180	53.389	0.00
	41-65	60.70%	91	19.30%	29	120		0.00

Table 2 shows the comparison of the mean values of the mandibular morphological measurements between partially edentulous (test) and completely dentate (control) groups in terms of Gonial Angle (GA), Condylar Height (CH), Ramus Height (RH), Ramal Notch Depth (RND) and Antegonial Notch Depth (AND). There was a significant difference (p=0.00) seen in the mean values of GA when comparing the partially edentulous (130.01 ± 7.79°) and completely dentate group (126.95 ± 6.84°). Similarly, the mean value of CH is (8.34 ± 4.87 mm) in the test group and (7.56 ± 0.98 mm) in the control group, with a p-value=0.05. There was no significant difference observed in the RND between the test (2.84 ± 0.85 mm) and control (2.62 ± 1.11 mm) group (p=0.05). No significant differences in the RH and AND between the groups.

Table 2 Comparison of mean measurements of test group and control group

Variable	Partially Edentulous		Fully Dentate		t-test value	p-value
	Mean	SD	Mean	SD		
GA (°)	130.01	7.79	126.95	6.84	3.61	0.00*
CH (mm)	8.34	4.87	7.56	0.98	1.92	0.05*
RH (mm)	44.11	8.96	43.93	6.95	0.19	0.84
RND (mm)	2.84	0.85	2.62	1.11	1.90	0.05*
AND (mm)	1.42	0.84	1.55	0.85	-1.39	0.17
p-value ≤ 0.05: Statistically significant*						

The mean values of GA were significantly larger among the younger age group (20-40) in both partially edentulous patients (131.58 ± 8.27°) and completely dentate group (127.17 ± 6.9°) (p<0.05). While the mean value of GA in the older age group was (128.99 ± 7.33°) in the partially edentulous patients and (126.0 ± 6.4°) in the dentate group (p=0.05). There was no significant difference in the CH, RH, RND, and AND between different age groups in both partially edentulous and dentate participants as shown in Table 3.

Table 3 Comparison of mean measurement of cases and controls in association to the age

Variable	Category	Partially Edentulous		Fully Dentate		t-test value	p-value
		Mean	SD	Mean	SD		
GA (°)	20-40	131.58	8.27	127.17	6.9	3.75	0.00*
	41-65	128.99	7.33	126.0	6.4	1.96	0.05*
CH (mm)	20-40	8.19	4.18	7.57	0.91	0.55	1.21
	41-65	8.44	5.29	7.51	1.25	0.93	0.35
RH (mm)	20-40	42.72	8.06	43.53	6.86	-0.69	0.48
	41-65	45.01	9.44	45.64	7.15	-0.32	0.74
RND (mm)	20-40	2.74	0.73	2.62	1.17	0.71	0.47
	41-65	2.9	0.92	2.64	0.81	1.39	0.16
AND (mm)	20-40	1.46	0.88	1.53	0.81	-0.51	0.6
	41-65	1.39	0.82	1.63	0.99	-1.29	0.19
p-value ≤ 0.05: Statistically significant*							

Both genders showed higher values for GA and CH in partially edentulous than in the completely dentate. However,

RH, RND, and AND was higher in males. These differences aren't statistically significant except for GA in the female gender ($p<0.01$). Moreover, females in both partially edentulous and completely dentate groups showed higher value for GA than their male counterparts. In the partially edentulous subjects, the mean values were higher in females than males for GA, CH, RH, RND except for AND; however, these differences were not statistically significant. In contrast, the mean values of CH, RH, RND, AND except GA were higher in males than females in the control group and they were not statistically significant as seen in Table 4.

Table 4 Comparison of mean measurements of test group and controls in association with the gender

Variable	Category	Partially Edentulous		Fully Dentate		t-test value	p-value
		Mean	SD	Mean	SD		
GA (°)	Male	128.7	8.50	126.47	7.01	1.76	0.07
	Female	130.82	7.25	127.88	6.46	2.41	0.01*
CH (mm)	Male	8.25	4.05	7.59	1.02	1.56	0.12
	Female	8.39	5.33	7.51	0.91	1.17	0.24
RH (mm)	Male	43.62	7.50	44.93	7.29	-1.06	0.28
	Female	44.41	9.78	42	5.82	1.61	0.11
RND (mm)	Male	2.8	0.94	2.88	1.18	-0.41	0.68
	Female	2.86	0.79	2.21	0.75	5.43	0.00*
AND (mm)	Male	1.5	1	1.72	0.9	-1.4	0.16
p-value ≤ 0.05: Statistically significant*							

DISCUSSION

Some problems in the teeth cannot be solved except with tooth extraction. This therapy can cause partial tooth loss which unfortunately may represent the beginning of various new problems [9]. After tooth extraction, resorption of the jaw bone is inevitable. Therefore, early diagnosis of bone structure morphological changes in the jaws is very important for the dentist during the process of treatment planning for partially edentulous patients [16]. In this study, five mandibular morphological and anatomical parameters were measured including; CH, GA, RH, AND, and RND. The panoramic radiographs were used to measure the previous parameters because they are frequently requested by dentists for screening the maxilla-mandibular region, allowing an evaluation of the general health of dentition and their supporting structures with a moderately low radiation dosage [7]. Moreover, these data will be useful as a standard for further comparative studies between completely dentate, partially edentulous and completely edentulous subjects [14]. Further studies should shed light on if dental rehabilitation with a removable partial denture and fixed dental prosthesis would alter the rate of morphological changes following tooth loss. The subjects included in the study should have readable panoramic radiographs, while subjects who are completely edentulous, patients with orthognathic surgeries, craniofacial deformities, fractures, TMJ anomalies, condylar pathology, and bone pathology were excluded.

Sicher and Dubrul define a widening of GA as a result of disuse atrophy following teeth loss and even venture the statement that the widening of GA is more marked if no dentures were worn [8]. Since there are limited studies done on partially edentulous, it has been assumed based on Sicher and Dubrul's definition and recent literature review that there will be an increase of GA in the area of tooth loss. An increase in the mean GA in partially edentulous subjects is observed in this study. The mean GA of the partially edentulous subjects was ($3.06 \pm 7.79°$) larger than completely dentate subjects ($p<0.05$). This result coincides with many recent studies that relate the GA with dental status especially the completely edentulous [2,4,9-11]. Ohm, et al., [2] found that the mean GA of partially edentulous subjects fall between the large mean GA of edentulous subjects and small mean GA of completely dentate. Xie, et al., [10] found that the mean GA of the edentulous subjects was 5.6° larger than that of the older dentate subjects ($p<0.001$), and 6.0° larger than that of the young dentate subjects ($p<0.001$). It was observed in this study that the mean GA decreases as age increases. In partially edentulous subjects, there was a statically significant difference between the two age groups. Xie, et al., [10] however, found no significant difference in measurements of the GA between the young and older dentate groups. Regarding the gender differences, in partially edentulous subjects, there was a noticeable increase in the mean GA among the female group but no significant differences. This agrees with Ohm, et al., [2] finding in which there was no statistically significant gender difference in the partially edentulous group. Huumonen, et al., [11] and Joo, et al., [4] however, found larger mean values of GA in female edentulous subjects.

The mean values of CH in this study were 8.34 mm in the partially edentulous group and 7.56 mm in the completely dentate group, with no significant differences. These findings coincide with Oksayan, et al., [9] where there was no significant difference found in CH between groups. However, the completely edentulous group showed higher mean values of CH than completely dentate. According to this result, it stated that there was no relationship between dentition and CH. CH values in both genders and different age groups were not statistically significant. Similarly, Joo, et al., [4] found no significant differences in CH were found between both genders ($p>0.05$). Moreover, Raustia, et al., [17] stated that CH did not correlate with the patients' age.

In the study performed, the mean values of RH in males was higher in the dentate group as well as in the partially edentulous, but it was not statistically significant ($p>0.05$). This finding was supported by other studies [9,18,19]. RH mean values were high in the older age group in both partially and dentate groups. This finding was correlated with a study performed by Sairam, et al., [18] that found old dentate subjects showed higher mean values of RH than these in the edentulous group. Moreover, the general trend in Leversha, et al., [19] research showed that as age increases, the RH decreases in dentate subjects.

Many factors may affect AND values like gender, masticatory function, bone condition, dental status, and mandibular growth. Osato, et al., [14] stated that as masticatory forces affect AND, it was found that patients who have higher masticatory forces have low GA and a deeper AND. It was found in this study the lower GA, the higher AND. According to Oksayan, et al., [9] it was demonstrated that the young dentate group had lower mean values of AND with no significant differences between groups. This study, in contrast, showed the higher AND mean values in the dentate group comparing to the partially edentulous group, but with no significant differences. Dutra, et al., [3] and Ghosh, et al., [15] concluded that the ANDs were significantly greater in males than females. The results were similar to what was found in this study where AND was higher in males than females in both groups.

In this study, there was no significant difference observed in the mean values of RND between the test and control groups. These findings correlate with Oksayan, et al., [9] where there were no significant differences between the mean values of the young dentate group, old dentate group, and completely edentulous group but they reported that the young dentate group demonstrated lower mean values of RND. Similarly, this study resulted in a lower mean of RND in dentate patients when compared to the partially edentulous group. The mean value of RND was higher in females than males in the partially edentulous group, while in the completely dentate group, it was higher in males. In a study conducted by Sairam, et al., [18] RND was significantly higher in males than females. In addition, Al-Bustani, et al., [20] concluded in their study that all the linear measurements in craniofacial morphology were significantly higher in males than females, except for RND which was not affected significantly by gender that might be attributed to the small mean values of RND.

This study shows the variation of mandibular morphology related to dental status, age, and gender. It can aid to understand the normal morphological changes and measurements in the complete dentate mandible as well as partially edentulous. It can give predictability and distinguishes from the pathological changes. This study might be of assistant for future studies to compare and measure the effect of denture wear on the changes and of these parameters. These measurements can also be used in forensic to identify gender. Although a lot of studies have emphasized the importance of edentate mandibular morphology, no studies have recorded the effects of partially edentulism.

According to the results of our study, both genders showed higher values for GA and CH in partially edentulous than in the completely dentate. Also, AND was higher in partially edentulous compared to the dentate group. These results highlight the consequences of tooth loss on the mandibular morphology. The importance of avoiding tooth loss by preserving the tooth as much as possible to maintain the form and function of the jaws.

One of the main limitations of the study is the small sample size which cannot be representative of the Saudi population, but it can give an idea about the morphological changes of the mandible compared to other populations. In addition, the percentage of female participants (62%) is more than males (38%).

CONCLUSION

This study concludes that there is no relationship between the changes in the morphological measurements related to age and gender except in GA where younger subjects have higher GA values. It also concludes that the mean values of GA were significantly higher in the partially edentulous group compared to completely dentate. These results

highlight the consequences of tooth loss on the mandibular morphology and it can be useful as standards for further comparative studies between completely dentate, partially and completely edentulous subjects.

DECLARATIONS

Conflict of Interest

The authors declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

REFERENCES

[1] Casey, David M., and Lawrence J. Emrich. "Changes in the mandibular angle in the edentulous state." *The Journal of Prosthetic Dentistry,* Vol. 59, No. 3, 1988, pp. 373-80.

[2] Ohm, Elisabeth, and John Silness. "Size of the mandibular jaw angle related to age, tooth retention and gender." *Journal of Oral Rehabilitation,* Vol. 26, No. 11, 1999, pp. 883-91.

[3] Dutra, Vinicius, et al. "Mandibular bone remodelling in adults: Evaluation of panoramic radiographs." *Dentomaxillofacial Radiology,* Vol. 33, No. 5, 2004, pp. 323-28.

[4] Joo, Jeong-Ki, et al. "Panoramic radiographic evaluation of the mandibular morphological changes in elderly dentate and edentulous subjects." *Acta Odontologica Scandinavica,* Vol. 71, No. 2, 2013, pp. 357-62.

[5] Ceylan, Gözlem, et al. "Changes in the mandibular angle in the dentulous and edentulous states." *The Journal of Prosthetic Dentistry,* Vol. 80, No. 6, 1998, pp. 680-84.

[6] Yanıkoğlu, Nuran, and Baykal Yılmaz. "Radiological evaluation of changes in the gonial angle after teeth extraction and wearing of dentures: A 3-year longitudinal study." *Oral Surgery, Oral Medicine, Oral Pathology, Oral Radiology, and Endodontology,* Vol. 105, No. 6, 2008, pp. e55-60.

[7] Abu Alhaija, Elham SJ. "Panoramic radiographs: determination of mandibular steepness." *Journal of Clinical Pediatric Dentistry,* Vol. 29, No. 2, 2005, pp. 165-66.

[8] Sicher H, DuBrul EL. 6th ed. St Louis: The CV Mosby Co; 1975. *Oral Anatomy,* p. 121

[9] Okşayan, Rıdvan, et al. "Effects of edentulism on mandibular morphology: Evaluation of panoramic radiographs." *The Scientific World Journal,* 2014, pp. 1-5.

[10] Xie, Qiu-Fei, and Anja Ainamo. "Correlation of gonial angle size with cortical thickness, height of the mandibular residual body, and duration of edentulism." *The Journal of Prosthetic Dentistry,* Vol. 91, No. 5, 2004, pp. 477-82.

[11] Huumonen, S., et al. "Influence of edentulousness on gonial angle, ramus, and condylar height." *Journal of Oral Rehabilitation,* Vol. 37, No. 1, 2010, pp. 34-38.

[12] Ali, I. M., K. Yamada, and K. Hanada. "Mandibular antegonial and ramus notch depths and condylar bone change." *Journal of Oral Rehabilitation,* Vol. 32, No. 1, 2005, pp. 1-6.

[13] Aki, Todd, et al. "Assessment of symphysis morphology as a predictor of the direction of mandibular growth." *American Journal of Orthodontics and Dentofacial Orthopedics,* Vol. 106, No. 1, 1994, pp. 60-69.

[14] Osato, Shigeo, et al. "Differences in 5 anatomic parameters of mandibular body morphology by gonial angle size in dentulous Japanese subjects." *Annals of Anatomy-Anatomischer Anzeiger,* Vol. 194, No. 5, 2012, pp. 446-51.

[15] Ghosh, Sujoy, et al. "Remodeling of the antegonial angle region in the human mandible: a panoramic radiographic cross-sectional study." *Med Oral Patol Oral Cir Bucal,* Vol. 15, No. 5, 2010, pp. e802-07.

[16] Knezović-Zlataric, Dubravka, Asja Celebic, and Biserka Lazic. "Resorptive changes of maxillary and mandibular bone structures in removable denture wearers." *Acta Stomatological Croatica,* Vol. 36, No. 2, 2002, pp. 261-65.

[17] Raustia, A. M., and M. A. M. Salonen. "Gonial angles and condylar and ramus height of the mandible in complete denture wearers-A panoramic radiograph study." *Journal of Oral Rehabilitation,* Vol. 24, No. 7, 1997, pp. 512-16.

[18] Sairam, V., et al. "Assessment of effect of age, gender, and dentoalveolar changes on mandibular morphology: A digital panoramic study." *Contemporary Clinical Dentistry,* Vol. 9, No. 1, 2018, pp. 49-54.

[19] Leversha, Jodi, et al. "Age and gender correlation of gonial angle, ramus height and bigonial width in dentate subjects in a dental school in Far North Queensland." *Journal of Clinical and Experimental Dentistry,* Vol. 8, No. 1, 2016, pp. e49-54.

[20] Al-Bustani, Ali Ismail, Yassir A. Yassir, and Sami K. Al-Joubori. "The relation between ramus notch depth and some of the craniofacial measurements in different skeletal patterns." *Journal of Baghdad College of Dentistry,* Vol. 21, No. 4, 2009, pp. 104-08.