Original Article / Özgün Araştırma

The Morphological Changes in the Mandible Bone: The Effects of Age, Gender and Dental Status

Mandibular Morfolojik Değişiklikler: Yaş, Cinsiyet ve Diş Durumunun Etkileri

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Abstract

Objective: This present study aimed to analzye the impact of age, gender and dental condition on remodeling of gonial and antegonial, condylar and ramus regions. We evaluated the changes in the antegonial angle (AGA), gonial angle (GA), antegonial depht (AGD), condylar height (CH), ramus width (RW) and ramus height (RH) in different age and dental groups on both genders.

Materials and Methods: Approximately nine hundred and ten panoramic radiographs that were gathered were arranged into groups of age, dental status and gender. An evaluation of the GA, AGA, AGD, CH, RW, and RH was made.

Results: There were no differences for CH in regard to gender, dental status and age groups on both sides ($p>0.05$). Age influenced RW in females and on AGD in males ($p<0.05$). Dental status influenced RW and AGA in females and on GA and RW in males ($p<0.05$). Gender also effected the GA, RH, AGA and AGD ($p<0.05$).

Conclusion: The results of this study demonstrated that age, gender, and dental status influenced the remodeling of the gonial, antegonial, and ramus regions. This remodeling influenced specific regions in the mandible. A conclusion can be made to say that the differences that are related to gender, age and dental status can be linked with the variance in the masticatory activity throughout this region of the mandible. Since age, gender and dental status do not affect the CH, the significant changes in the length of CH can be considered to be signs of an abnormal situation.

Keywords

Gonial angle, antegonial angle and depht, ramus height and width, dentate, age

Anahtar Kelimeler

Gonial açı, antegonial açı ve derinlik, ramus yüksekliği ve genişliği, dişli, yaş

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Öz

Amaç: Bu çalışmanın amacı yaş, cinsiyet ve diş durumunun gonial ve antegonial, kondil ve ramus bölgelerine etkilerini araştırmaktır. Her iki cinsiyette farklı yaş ve diş gruplarında gonial açı (GA), antegonial açı (AGA), antegonial derinlik (AGD), kondil yüksekliği (KY), ramus yüksekliği (RY) ve ramus genişliği (RG) değişikliklerini değerlendirdik.

Gereç ve Yöntemler: Dokuz yüz on panoramik radyografi elde edildi ve bunlar yaş, diş durumu ve cinsiyete göre gruplandırıldı. GA, AGA, AGD, KY, RY ve RG analiz edildi.

Bulgular: KY, her iki tarafta cinsiyet, yaş grupları ve diş durumuna göre fark göstermemekteydi ($p>0,05$). Yaşın kadınlarda RG, erkeklerde ise AGD üzerine etkili olduğu bulundu ($p<0,05$). Diş durumu kadınlarda AGA ve RG'yi etkilerken, erkeklerde GA ve RG üzerine etkili olduğu saptanmıştır ($p<0,05$). Ayrıca cinsiyetin GA, RY, AGA ve AGD'yi etkilediği tespit edildi ($p<0,05$).

Sonuç: Bu çalışmanın sonuçları, gonial ve antegonial ve ramus bölgelerinin yaş, cinsiyet ve diş durumundan etkilendiğini (remodeling) göstermektedir. Bu remodeling, mandibuladaki spesifik bölgeleri etkilemektedir. Yaş, cinsiyet ve diş durumu ile ilişkili farklılıkların çene kemiğinin bu bölgesindeki çiğneme aktivitesindeki varyansla ilişkili olduğu sonucuna varılabilir. Yaş, cinsiyet ve diş durumu KY üzerinde bir etkisi olmadığından, KY uzunluğundaki önemli değişiklikler bazı anormal durumların bulguları olarak düşünülebilir.

Introduction

Bone remodeling is an endless and a combination of complicated procedures which happen throughout our life (1). Mandibular stimuli which exist throughout the development phase to adulthood can alter the growth of the mandible and also effect its bone remodeling. Some of the evident changes that have been suggested are the change in the antegonial, gonial, condylar, ramus regions (2-5).

Long-term studies have shown that remodeling of the mandibular bone happens in relation to age (6,7). Casey and Emrich reported that (8), the average mandibular angle stayed the same throughout the time of adulthood to until at least the 7th decade of life with the exception of considerable tooth loss. They stated that gender had no effect on gonial angle (GA). Ohm and Silness (3) implied that differences in gender did not have much importance and age was not connected to the size of the GA. Futhermore, Dutra et al. (9) stated that age, gender and dental condition did not alter GA.

The cause of this remodeling is thought to be related to the absence and the presence of the teeth. The general organization of the remodeling fields in adolescents with a growing mandible has noticeable differences from edentate mandibles (10). In a report by Enlow et al. (1), it was stated that specific responses of remodeling happen due to tooth loss and alterations of the structural and functional relationships of the whole adult mandible takes place. These changes include modified mandibular rotation and occlusal relationships, remodeling and transformation of the mandibular body, changes in the muscle-bone alignment and alteration and reduction in the areas for muscle connection. Huumonen et al. (11) proposed that, morphological changes of the mandible in adults are associated with the person's occlusal relationship and age. Xie et al. (12) approved that long-term edentulousness and the probability of reduced masticatory forces may be associated with the changes to the angle of the mandible. Ghosh et al. (5) reflected that this is possible because the activities of masticator muscles are associated to the dimensions of the facial skeleton. The bone remodeling in these regions, however, have received little attention and the interaction of gender, age and dental status have not been subjected to detailed analysis.

This present study aims to investigate the influence of age, gender and dental status on remodeling of antegonial and gonial, condylar and ramus regions. We evaluated the changes in the GA, antegonial depth (AGD) and antegonial angle (AGA), ramus height (RH), ramus width (RW) and condylar height (CH) in different age and dental groups of both genders.

Materials and Methods

Nine hundred and ten panoramic radiographs which were taken from patients over the age of 18 years who applied for routine dental examination to the oral and maxillofacial radiology department of dentistry faculty were analyzed between the years of 2012 and 2013 (Table 1). The Ethics Committee of Selçuk University Faculty of Dentistry approved the research protocol (decision no: 2012/33). The

Table 1. The distribution of sample is presented as number (n) and percentage (%) by gender, age group and dental status

Characteristics	n	%
Gender		
Male	445	48.9
Female	465	51.1
Age (years)		
18-40	154	16.9
41-55	104	11.4
56-69	449	49.3
70 and above	203	22.3
Dental status		
18-40 years old dentate	150	16.5
Above 40 years old dentate	154	16.9
Above 40 years old partially dentate	150	16.5
Above 40 years old maxillary edentulous	150	16.5
Above 40 years old mandibular edentulous	156	17.1
Above 40 years old totally edentulous	150	16.5

same panoramic machine was used to gather all the panoramic images (Kodak® 8000 Rochester, New York, USA) by the same technician according to the manufacturer's reference guide.

Only the radiographs that were clear with a higher quality and with no signs of distortion were chosen. Criteria for the selection of the radiographs were based on the tympanic plate, mental foramen, condyle, the lower and the posterior border of the mandible to be precise and explicit on the radiograph to be able to evaluate the structures on both sides. This study excluded the panoramic radiographs that belonged to patients who had orthognathic surgery, fractures and facial asymmetry. Only a single experienced radiologist observed all the panoramic radiographic for the evaluation that was performed on the two sides of the mandible. Adobe Photoshop CS4 was used after the adjustment of a 27% magnification for an improved simulation of the clinical condition. The ruler tool of Adobe Photoshop CS4 was used to measure the SP.

Evaluations of the measurements were made at two different times by a single observer that was professionally experienced for a period of 3 years in the department of oral and maxillofacial radiology. To determine the intra-observer dependability, a random selection of 50 samples was made for the measurements which were repeated at an interval of one month.

The GA was evaluated by using a line that followed alongside the lower border of the mandible and a similar line which was alongside the distal border of the ramus on both sides. These lines intersected to form the mandibular angle (Figure 1) (13). Two lines which were parallel to the lower cortical border of the mandible bone were traced and the angle that they intersected at the deepest point throughout the antegonial notch was used to measure the AGA (Figure 1) (9). AGD was measured as the distance along a perpendicular line from the deepest point of antegonial notch concavity to a line which was parallel to the inferior cortical border of the mandible (Figure 2) (9).

A tracing line was drawn on the outer borders of the condyles and the ascending rami on the two sides of the mandible. The most lateral points of the condylar image and the ascending ramus were connected with a line that was traced between them. A line that was perpendicular to this line which is also known as the ramus tangent was traced from the most superior points of the condylar image. The vertical distance between the line on the ramus tangent and the most lateral point of the condyle that was projected on the ramus tangent was measured. This distance was referred to as CH (Figure 2) (14). The distance that was primarily marked between the most lateral points on the image was referred to as RH and was measured (Figure 2) (14).

The RW was measured as the distance between the posterior and anterior borders of the ramus on the line that was perpendicular to the ramus tangent which passes through the points that corresponds to the middle of the inferior border of the mandibular foramen (Figure 2) (15).

The following criteria were used for assessing dental status (third molars were excluded):

(1) 18-40 years old dentate,

(2) Above 40 years old dentate,

(3) Above 40 years old partially dentate (maximum 15 teeth),

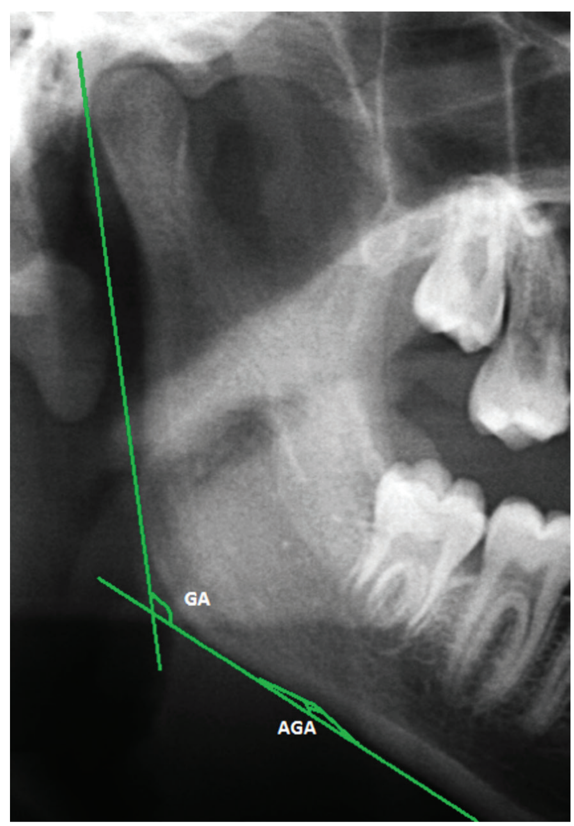

Figure 1. The presentation of anguler measurements
GA: Gonial angle, AGA: Antegonial angle

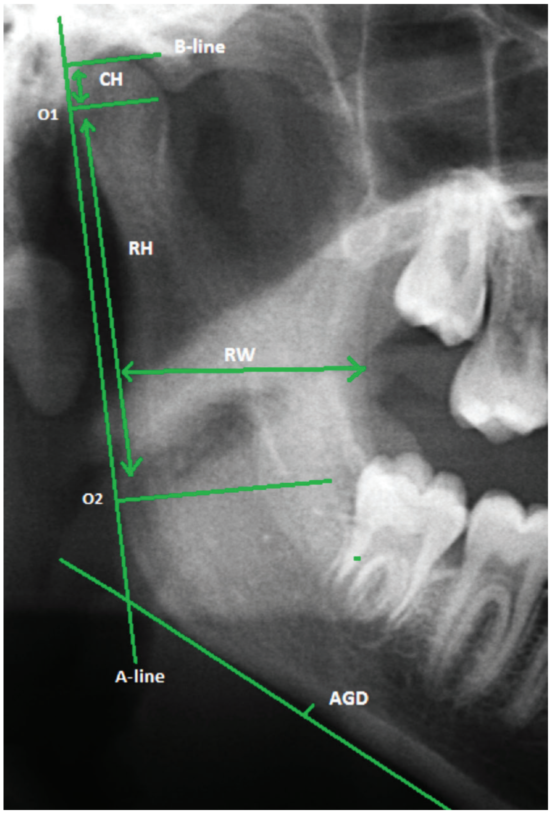

Figure 2. The presentation of linear measurements
RH: Ramus height, RW: Ramus width, AGD: Antegonial depth
CH: Condylar height

(4) Above 40 years old maxillary edentulous,
(5) Above 40 years old mandibular edentulous,
(6) Above 40 years old totally edentulous.

The age was based on four age groups as following: 18-40 years, 41-55 years, 56-69 years and 70 and above years of age.

Statistical Analysis

Software packages SPSS 21.0 was used for the statistical analysis of the data. Descriptive statistics for each variable were calculated. The intraclass correlation coefficient (ICC) was calculated for GA, AGA, AGD, CH, RH, RW. The Kolmogorov-Smirnov test, Wilcoxon test, Mann-Whitney U test, Kruskal Wallis, and chi-square test was used. The significant level was set at 5%.

Results

The present study consisted of all the available observations which were readable. The calculations of the distances were performed on both sides. For right and left ICC values were 0.879, 0.828, 0.891, 0.925, 0.935, 0.943, 0.962, 0.914, 0.882, 0.897, 0.927 and 0.916 (nearly perfect) for GA, AGA, AGD, CH, RH and RW, respectively.

The mean values of right and left measurements of lengths and angles are presented in Table 2 for both

Table 2. Mean measurement values in milimeters and angle by gender, quadrant and lineer (antegonial depth, condylar height, ramus height, ramus width) and anguler (gonial angle and antegonial angle) measurements. Standard error values for each measure are also included

	Female		Male		Total	
	Mean	SE	Mean	SE	Mean	SE
Right GA	122.39	6.34	119.58	6.90	121.02	6.77
Left GA	123.14	6.32	120.86	7.47	122.03	6.99
Right AGA	168.25	9.38	160.52	12.62	164.47	11.73
Left AGA	167.85	9.97	161.36	12.14	164.68	11.54
Right AGD	1.02	0.79	1.67	1.05	1.34	0.98
Left AGD	1.08	0.87	1.71	1.18	1.39	1.08
Right CH	8.17	1.79	7.88	1.80	8.03	1.80
Left CH	7.92	1.86	8.06	2.09	7.99	1.98
Right RH	46.91	6.36	51.99	7.16	49.39	7.22
Left RH	47.07	6.24	51.50	6.93	49.23	6.95
Right RW	31.84	4.84	32.34	4.97	32.08	4.91
Left RW	33.30	4.99	33.87	5.38	33.58	5.19

GA: Gonial angle, AGA: Antegonial angle, AGD: Antegonial depth, CH: Condylar height, RH: Ramus height, RW: Ramus width, SE: Standard error genders. There was a statistical variation between left and right sides (p<0.05) in the values of RW and GA calculations. The measurements of right side were significantly lower than left side's.

The mean and standard error values corresponding to gender, age groups and dental status were presented in Tables 2, 3, 4.

For bilateral GA, there weren't any statistical differences found in age groups. But, above 40 years dentate males had significantly smaller GA on both sides than the other dental groups (p<0.01). Also, females had significantly wider GA on both sides than males (p<0.05) (Table 5).

No significant difference was found for AGA in regard to age groups in both sexes (p>0.05). But females had significantly greater AGA than males (p<0.05). Also, above 40 years totally edentulous females had smaller AGA than the other dental groups (p<0.05) (Table 5).

For AGD, there were no significant differences in regard to dental status on both sides in both sexes (p>0.05). Significant differences were observed between females and males (p<0.05). Males had significantly greater AGD than females (p<0.05). Also, males in 41-55 age group had significantly higher AGD than the other age groups (p<0.05) (Table 5).

For bilateral CH, no significant differences were found as to gender, age groups and dental status on both sides (p>0.05) (Table 5).

For bilateral RH, both sexes did not have any differences to age groups and dental status on both sides (p>0.05). Yet, the measurements of males had significantly larger RH than females's (p<0.05) (Table 5).

There was not any significant difference in regard to gender for RW on both sides (p>0.05). Females in the 41-55 age group had smaller RW than the other age groups (p<0.05) (Table 5). The more prominent decline was seen for RW due to the decreased number of teeth in females. Totally edentulous males that were above 40 years of age had significantly smaller RW than the other dental groups.

Discussion

There were not any radiographic and medical criteria for the selection of the study group of patients. Also, patients were not chosen from any specific dental specialty. All of the calculations were made on panoramic radiographs which were obtained during the patient's routine dental examination. To guarantee consistency and reliability, evaluation of each image was managed by a single dentomaxillofacial

Table 3. Mean measurement values in milimeters and angle by age group, quadrant and lineer (antegonial depth, condylar height, ramus height, ramus width) and anguler (gonial angle and antegonial angle) measurements. Standard error values for each measure are also included

	18-40		41-55		56-69		Above and 70	
	Mean	SE	Mean	SE	Mean	SE	Mean	SE
Right GA	120.53	6.96	121.71	8.08	121.32	6.29	121.32	6.29
Left GA	121.24	7.04	122.54	8.4	122.3	6.7	122.3	6.7
Right AGA	166.38	11.47	162.31	12.09	164.28	11.53	164.28	11.53
Left AGA	165.96	11.11	161.97	12.07	165	11.28	165	11.28
Right AGD	1.34	1.02	1.5	1.05	1.33	0.97	1.33	0.97
Left AGD	1.4	1.06	1.72	1.21	1.33	1.02	1.33	1.02
Right CH	8.16	1.81	7.81	1.96	8	1.64	8	1.64
Left CH	7.98	1.77	7.78	1.86	8.09	2.02	8.09	2.02
Right RH	50.52	7.48	48.48	7.48	49.03	6.62	49.03	6.62
Left RH	50.52	7.16	48.34	7.32	48.96	6.71	48.96	6.71
Right RW	33.71	5.25	30.82	5.29	31.7	4.35	31.7	4.35
Left RW	35.05	5.36	32.62	5.9	33.3	4.76	33.3	4.76

GA: Gonial angle, AGA: Antegonial angle, AGD: Antegonial depth, CH: Condylar height, RH: Ramus height, RW: Ramus width, SE: Standard error

Table 4. Mean measurement values in milimeters and angle by dental status, quadrant and lineer (antegonial depth, condylar height, ramus height, ramus width) and anguler (gonial angle and antegonial angle) measurements. Standard error values for each measure are also included

	18-40 Aged dentate				Above 40 years old dentate			
	Female		Male		Female		Male	
	Mean	SE	Mean	SE	Mean	SE	Mean	SE
Right GA	121.36	6.38	119.46	7.33	121.43	5.64	116.43	6.22
Left GA	122.06	6	120.09	7.71	122.56	6.12	118.11	6.78
Right AGA	171.05	8.55	161.84	12.22	169.87	9.7	159.42	13.11
Left AGA	171.05	9.1	162.56	11.91	167.37	11.27	159.98	12.78
Right AGD	0.92	0.83	1.73	1.03	0.98	0.95	1.8	1.09
Left AGD	1	0.83	1.78	1.12	1.02	0.88	1.76	1.19
Right CH	8.49	1.91	7.83	1.67	8.21	1.87	7.87	1.61
Left CH	8.24	1.83	7.73	1.72	7.73	1.75	7.98	1.78
Right RH	48.27	7.78	52.78	6.51	47.25	6.12	52.19	6.77
Left RH	48.56	7.29	52.6	6.46	46.93	6.16	51.26	6.82
Right RW	33.98	5.34	33.64	5.16	33.02	4.63	33.45	4.82
Left RW	35.12	5.09	35.2	5.53	34.15	5.04	34.23	4.73
	Above 40 years old partial dentate				**Above 40 years old inferior edentulous**			
	Female		**Male**		**Female**		**Male**	
	Mean	**SE**	**Mean**	**SE**	**Mean**	**SE**	**Mean**	**SE**
Right GA	124.06	7.6	120.42	6.87	124.06	7.6	119.87	7.33
Left GA	124.86	6.77	122.73	7.78	124.86	6.77	119.98	8.75
Right AGA	169.98	8.05	160.53	11.92	169.98	8.05	159.59	12.33
Left AGA	167.56	9.56	160.74	9.73	167.56	9.56	160.68	14.54
Right AGD	2.87	0.75	1.75	0.94	0.99	0.75	1.65	1.05
Left AGD	1.25	0.88	2	1.19	1.25	0.88	1.58	1.28
Right CH	7.98	1.74	8.04	1.81	7.98	1.74	7.72	1.83
Left CH	8.47	1.65	7.76	1.73	7.68	1.65	7.73	2.14
Right RH	46.35	6.56	53.6	8.89	46.35	6.56	51.33	6.63
Left RH	46.23	6.32	52.65	8.34	46.23	6.32	50.3	6.7
Right RW	31.37	4.8	33.23	5.39	31.37	4.8	31.56	4.61
Left RW	33.1	5.29	34.9	5.79	33.1	5.29	32.76	5.31
	Above 40 years old superior edentulous				**Above 40 years old totally edentulous**			
	Female		**Male**		**Female**		**Male**	
	Mean	**SE**	**Mean**	**SD**	**Mean**	**SE**	**Mean**	**SE**
Right GA	122.61	5.64	121.29	6.57	122.11	5.75	120.25	6.13
Left GA	123.49	5.57	122.64	6.51	123.39	6.61	121.88	6.1
Right AGA	167.39	9.38	165.15	10.87	163.56	8.27	156.73	13.76
Left AGA	169.1	9.77	161.96	12.99	165.01	8.65	162.15	10.37

radiologist for the distinction of the radiographs that were of the highest quality. The ICC values were nearly flawless. This indicated that the method of indexes for evaluation is very dependable.

In some studies, the magnification values for the panoramic machines were roughly 15-30% (16-21). In the present study, all calculated values were scaled down to the original size of the mandibular features, which was a magnification of 27% used by the panoramic machine according to the manufacturer. This compensation gave the possibility of comparison with other studies because every panoramic machine has unique magnification factors. Regardless, this context has indicated that a common global magnification factor cannot reflect the complex magnification and distortion principle in panoramic radiographs that are theoretically well-understood. But even so, the use of indexes compensates considerably for the unknown local magnification in the image.

In the literature, morphometric evaluations were performed with panoramic radiographs by most authors who have researched mandibular remodeling (3-5,9,11,22-25). In the present study, it was used to obtain these measurements, too.

In this study, the analysis made on the left and right RW and GA measurements showed statistical variations. These variations may be due to the shape of the mandibular base, specifically the gonial region, which have correlations with the function and shape of the muscles of mastications (26). Furthermore, this difference may be the result of an increased function based on a favored chewing side. The effect of the

Table 4. Continued

Right AGD	1.04	0.7	1.3	1.01	1.2	0.62	1.72	1.07
Left AGD	0.94	0.83	1.56	1.32	1.28	0.8	1.55	0.94
Right CH	8.06	1.53	7.86	1.95	8.35	2	7.95	1.91
Left CH	8.25	2.06	8.48	2.58	8.18	1.99	8.67	2.31
Right RH	47.85	6.07	51.5	7.3	45.58	5.93	50.52	6.49
Left RH	47.49	5.93	51.22	7.04	46.41	6.62	50.91	6.03
Right RW	31.33	3.54	31.58	4.77	31.11	5.77	30.45	4.23
Left RW	33.07	3.93	33.86	5.08	32.03	5.57	32.18	5.3

GA: Gonial angle, AGA: Antegonial angle, AGD: Antegonial depth, CH: Condylar height, RH: Ramus height, RW: Ramus width, SE: Standard error

Table 5. The differences between age groups, gender and dental status

	Aged group		Dental status		Gender
	Female	Male	Female	Male	
Right GA	0.13	0.804	0.34	0.001*	0.000*
Left GA	0.296	0.306	0.155	0.000*	0.000*
Right CH	0.171	0.747	0.588	0.787	0.562
Left CH	0.235	0.247	0.062	0.071	0.443
Right RH	0.619	0.618	0.056	0.176	0.000*
Left RH	0.24	0.146	0.449	0.258	0.000*
Right RW	0.000*	0.092	0.000*	0.000*	0.063
Left RW	0,001*	0.056	0.001*	0.008*	0.091
Right AGA	0.063	0.095	0.000*	0.068	0.000*
Left AGA	0.232	0.145	0.029*	0.742	0.000*
Right AGD	0.435	0.014*	0.15	0.067	0.000*
Left AGD	0.323	0.010*	0.052	0.073	0.000*

*p<0.05, GA: Gonial angle, AGA: Antegonial angle, AGD: Antegonial depth, CH: Condylar height, RH: Ramus height, RW: Ramus width, SE: Standard error unilateral chewing on RW and GA measurements should be analyzed in the studies which other related parameters are fixed (27).

In correlation with the results of other studies (4,9,23), bilateral GA did not differ according to age groups in our study. Two papers were not in consistent with our results (3,28). The difference may result from using different radiographic method in their study (cephalometric radiography). Because the main disadvantage of lateral cephalometric radiography is the superimposition of images to the contralateral side (29).

In the present study, the influence of gender was statistically significant on the GA value on both sides and this observation showed similarity to the other reports (8,11,22,30), but there were also studies defending otherwise (3,4,9,31). These differences could be due to the unequal distribution of genders in sample of their studies. Females had wider GA than males in our study. The presence of strong activity of masticatory muscle would give rise to a small GA (24). According to the previous suggestion, females may have wider GA than male because the masticatory activity of females is lower.

It was reported in prior publications that results showed variation in regard to GA and dental status. It was concluded that GA was not affected by dental status (6,8,9,31-33), but it was also reported that GA also decreased and the GA increased and decreased with the tooth loss (3,7,7,11,22,28,34,35). In the present study, only in males, it was observed that the GA is shown changes according to the dental status on both sides. Above 40 years dentate males had significantly smaller GA on both sides than the other dental groups in males. In this dentate age group, the effect of bruxism should be investigated in males.

Dutra et al. (9) and Ghosh et al. (5) did not indicate any significant variations between age groups in measurements of AGA and AGD. They showed that the AGA in females was significantly larger than in males and that the AGD in females was significantly smaller than in males. They also indicated that edentulous patients had a smaller AGA than dentate and partially dentate patients. Tozoğlu and Cakur (31) found that there was a significant difference comparing the AGA with regards to dental status. Furthermore, they did not find any differences between dental groups for the AGD.

In this study, there wasn't any significant difference found among age groups in measurements of AGA on both sides of both genders. In males, 41-55 age-group had significantly greater AGD than the other age groups. This finding is contrast to some reports (5,9). In the study of Dutra et al. (9), the distribution of gender was not homogenous and above 40 years old individuals were not included. The age range of sample of Ghosh et al. (5) was also different from our sample. The present study showed that males had lower values of AGA as compared to females. With regards to AGD, males had larger values as compared to females. Our findings were similar to those obtained in different studies by other investigators (5,9,25,31). In this study, a statistically significant decline in the AGA value with a decreasing number of teeth in only females was observed. There were not any significant differences regarding AGD value in both sexes related to dental status. There are different findings about the effect of teeth number on AGA and AGD (5,9,31). However, the reliable comparison of the previous results between the findings of this study can't be possible due to many important differences such as grouping of dental status, radiographic method used and sample size. Differences related to gender, age and dental status can be considered to be due to masticatory activity and biting force for GA, AGA and AGD. Also, bruxism should be investigated as an effective clinical factor by new studies. It was kept in mind that the prevalence of bruxism was higher in women (36).

Prior publications have indicated varying results with respect to the relationship between age, gender, dental status and CH (4,11,22,33). In our study, age, gender, and dental status did not have any statistically significant impact on the CH on neither of the sides. These findings are different from the results of Huumonen et al. (11). The discrepancy may be due to differences in their sample age range (between 60 and 78 years). According to results of present study, CH can be accepted as relatively autonomous structure from gender, age and dental status.

Furthermore, in this study, no significant differences in RH were observed in regard to age and dental status on both sides. But, gender had a statistically significant impact on the RH on both sides. This outcome was consistent with the literature (4,11,22,33,37). However, this finding differed from the outcome of Huumonen et al. (11) and Okşayan et al. (33) studies for dental status. This could be due to differences of age range and dental grouping.

There is a single article in the literature which evaluated the RW (15). They indicated that gender had statistically significant impact on the RW on both sides. In this study, significant differences were observed regarding RW according to age (only females) and dental status (both gender) on both sides. But, gender did not have any statistically significant impacts on the RW on neither of the sides. The difference may be the cause of the differences in sample size. According to the results of this study, RW shows a decline due to the decrease in the number of teeth in females and total loss of teeth in males. This difference between genders also may be due to the fact that women inherently have a lower bone density than men (38).

Since the methods that were used in this study were identical to many studies, the conclusions were also similar. To present significant results, a lot of images were included and evaluated in this study with the use of the proper exclusion criteria. Furthermore, various indexes of the change in the mandible's morphology were used with the purpose of determining changes in regard to age, gender, and dental status (tooth loss).

Conclusion

As a result of this study, it has been indicated that gender, age, and dental status are factors that are connected to the remodeling that happens in the gonial, antegonial and ramus regions. Particular regions in the mandible may be affected by this remodeling. The analysis showed noticeable differences for people that were aged 40 or above. Aside from age, tooth loss which is more considerable for this age group may also be an effective additional factor. Furthermore, hormonal factors may be effective in this age group. CH is not affected by gender, age and dental status. Signs of situations that are abnormal can be considerably connected to the significant changes of CH. In conclusion, it can be said that the differences associated with gender, age and dental status can be connected to the variance in the masticatory activity in this region of the mandible. Future studies which were evaluated by different clinical parameters such as the duration of use and type of prosthesis, occlusion type, and habit of chewing, bruxism may give obvious information about the changes of mandibular bone. Radiographic findings should be supported by electromyographic results in future studies to clarify the relationship between masticatory activity and mandibular remodeling in this region. To determine the specific role of age and dental status in remodeling process of mandible, longitudinal studies can also be necessary for both genders separately.

Ethics

Ethics Committee Approval: The Ethics Committee of Selçuk University Faculty of Dentistry approved the research protocol (decision no: 2012/33).

Informed Consent: For this type of study, formal consent is not required.

Peer-review: Externally peer-reviewed.

Authorship Contributions

Surgical and Medical Practices: G.M., Concept: G.M., S.Ö.Ş., Design: G.M., S.Ö.Ş., Data Collection or Processing: G.M., Analysis or Interpretation: G.M., S.Ö.Ş., Literature Search: G.M., S.Ö.Ş., Writing: G.M., S.Ö.Ş.

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