



Analyzing the measurements of gonial angle by panoramic radiographs for forensic estimation in Iraqi population

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Abstract

Aim: this study aimed to measure the size of gonial angle on digital panoramic radiography and correlate these measurements with age, gender, and dentate status and this determination of sex and age is necessary in forensic practice and medicolegal purposes, therefore the usefulness of gonial angle measurements on digital panoramic images as indicators for sex and age in Iraqi population sample.

Materials and Methods: this study conducted on 40 Iraqi subjects (21 male and 19 female) aged from (20-80) years. Subjects were divided in to 2 study groups

- Dentulous study group (20 subjects)
- Edentulous study group (20 subjects)

Using digital panoramic image, the gonial angle was measured on both right and left sides for 2 study groups

Results:

- According to the age: in both dentulous and edentulous study groups, there was significant difference in mean gonial angle (GA) between 2 age groups (younger and older age groups) , the mean GA was significantly higher in the older age group , P value < 0.001
- According to the gender: in dentulous study group there was non-significant difference in mean GA between males and females , P value = 0.76 while in edentulous study group , the mean GA was significantly higher in females , P value = 0.01
- According to the dentate status: the edentulous study group statistically significant higher mean GA compared to dentulous study group, P value < 0.001

Conclusions: gonial angle does show changes with dentition status (edentulism) , therefore dentist role in qualitative and quantitative assessment of mandibular gonial angle by using digital panoramic radiography has become an essential aid for human identification in forensic dentistry.

Key words: Gonial angle, Age, Sex determination, Dentition status, Forensic.

Introduction

The angle of the mandible (gonial angle) is located at the posterior border at the junction of the lower border of the ramus of the mandible. The mandibular angle has been named as a

forensic tool for gender determination, but recent studies have called in to question whether there is any significant sex difference in humans in the angle⁽¹⁾. Despite the varying

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anatomical landmarks, numerous studies have been performed using different ramus metric measurements for sex^(2, 3) and age^(4, 5) estimation. As well, the gonial angle was used by some researches for sex^(3, 6) and age^(7, 8) estimation with controversial results.

Throughout one's lifetime, the mandible undergoes remodeling and morphological alterations occur in various area of the mandible, including the gonial region, antegonial region, condyle and ramus⁽⁹⁾. Differences in gonial angle are not seen only during the growth period and between the genders but also exist among races^(10, 11). Different parts of the mandibular bone are exposed to changes by means of many factors. The gonial angle values tend to increase in both sides after tooth extraction. Also there is a continuous remodeling in the mandibular cortex with age and this is influenced by dental status and gender^(12, 13, 14).

Little is known concerning remodeling in the gonial angle with aging in the dentulous and edentulous patients. Thus, this study intends to assess the reliability and accuracy of age and gender determination using gonial angle as parameter.

Panoramic radiographs are a useful tool for the measurement of gonial angle, which is an indicator of mandibular steepness and subsequently mandibular growth direction. The ability to determine growth direction from the orthopantomogram will be useful because majority of dentists request an OPG for patients during routine dental examination^(2,3).

Reliable measurement of individual gonial angles is difficult because of the superimposed images appearing on the lateral cephalograms. The gonial angle assessed from panoramic film was almost identical to that measured on the dried mandible⁽⁶⁾.

Materials and Methods

Sample of this study was consisting of 40 subjects of both gender (21 male and 19 female) aged from (20-80) years.

In Al-Mustansiriyah college of dentistry, panoramic radiographs were obtained for those 40 subjects who divided into 2 groups according to the presence of teeth in the mandible:

- Dentulous study group
- Edentulous study group

Using digital panoramic image, the gonial angle was measured on both right and left sides for 2 study groups.

In dentulous study group (20 subjects) right and left (40 sides) 20 males and 20 females and those divided into 2 age groups:

1- 20-35 years (younger age group)

2- 36-54 years (older age group)

In edentulous study group (20 subjects) right and left (40 sides) 22 male and 18 female and those divided into 2 age groups:

1- 55-70 years (younger age group)

2- 71-80 years (older age group)

The distribution of study groups was shown in table (1). Gonial angle was measured by tracing a line on panoramic radiograph tangential to the most inferior points at the GA and the lower border of the mandibular body, and another line tangential to the posterior border of the ramus and the condyle. The intersection of these lines formed the GA, which was measured on both the right and left sides of the mandible^(15, 16). GA measured in the right and left sides of the mandible as shown in figure (1).

Results

This study included (80) subjects with age ranged from (20-80) years divided into 2 study groups, dentulous

and edentulous group, distribution of age and gender of 2 study groups as shown in table (1).

- Dentulous study group: composed of 40 subjects sides (right and left) 20 male and 20 female, the age of this group was ranged from (20-35) years (younger age group) and (63-54) years (older age group).
- Edentulous study group: composed of 40 subjects sides (right and left) 22 male and 18 female, the age of this group was ranged from (55-70) years (younger age group) and (71-80) years (older age group).

The P (paired t-test) showed statistically non-significant difference between right and left sides measurements of the GA, P= 0.8 non-significant as shown in table (2).

· **Effect of age on gonial angle:**

In dentulous study group was divided into 2 age groups: younger age group (20-35) years and older age group (36-54) years. In edentulous study group was divided into 2 age groups: younger age group (55-70) years and older age group (71-80) years.

In dentulous study group there was statistically significant difference in mean GA between 2 dentulous age groups (younger and older age group) the mean GA was significantly higher in the older age group, P value < 0.001 significant difference as shown in table(3) figure (2), in edentulous study group there was statistically significant difference in mean GA between 2 edentulous age groups (younger and older age group) the mean GA was significantly higher in the older age group, P value < 0.001 significant difference as shown in table (3), figure(2).

· **Effect of gender on gonial angle:**

There was statistically significant difference in mean GA between 2

study groups in both males and females. In dentulous study group there was non-significant difference in mean GA between males and females, P value= 0.76 non-significant, while in edentulous study group there was statistically significant difference in mean GA between males and females, the mean GA was significantly higher in female in edentulous study group, P value= 0.01 significant difference as shown in table(4), figure(3).

· **Effect of dentate status on gonial angle :**

The edentulous study group has a statistically significant higher mean GA compared to dentulous study group, P value < 0.001 significant difference as shown in table (5), figure (3, 4).

Discussion

In our study there is non-significant difference in mean between right and left sides measurements of the GA, our study is in agreement with that of Gungor K et al. ⁽¹¹⁾ in 2007, Shahabi M et al. ⁽¹⁷⁾ in 2009, Al-Abboushi DS ⁽¹⁸⁾ in 2010, Mohammed MA ⁽¹⁹⁾ in 2008, as they found no significant differences in mean between right and left sides of GA.

· **Effect of age on gonial angle:**

From esthetic point of view, the gonial angle plays an important role in ensuring harmonious facial profile ⁽²⁰⁾.

In our study showed that older age group increase GA compared to younger age group in 2 study groups.

Xie QF and Ainamo A ⁽⁶⁾ in 2004, Huuomonen S et al. ⁽²¹⁾ in 2010, stated that elderly edentulous subjects had larger GA than did dentate subjects which was in agreement with our finding.

The result of our study disagree with that of Lin SJ and Hang CH ⁽²²⁾ in

1997, as they found no statistically significant difference in the size of GA at different age groups this may be because of different sample size.

• **Effect of gender on gonial angle :**

In our study showed that female gender increase GA compared to male in edentulous study group while gender had no statistically significant effect on GA in dentulous study group.

The result of our study is in agreement with that of Lin SJ and Hang CH ⁽²²⁾ in 1997, they mentioned that female GA was larger than the male in edentulous study group.

Our study is in agreement with that of Xie QF and Ainamo A ⁽⁶⁾ in 2004, Huuonen S et al. ⁽²¹⁾ in 2010 as they found difference in GA size between elderly edentulous male and female.

The result of our study is in agreement with Sakar O et al. ⁽²³⁾ in 2008, showed that edentulous females had wider GA.

Such finding is disagreed with that of Raustia AM and Salonen AM ⁽⁴⁾ in 1997 who found no statistically significant difference between genders in size of GA this may be because of different sample size.

• **Effect of dentate status on gonial angle:**

In this study gonial angle showed statistically significant difference between dentulous and edentulous study groups.

Morphology of the mandible changes as a consequence of tooth loss which can be expressed as a widening of the gonial angle, shorting of the ramus and condylar height ⁽²¹⁾.

Our study is in agreement with Casey DM and Emrich LJ ⁽²⁴⁾ in 1988, Engstrom C et al. ⁽²⁵⁾ in 1985, showed that edentulous subjects had larger angle than in subjects in possession of all teeth.

The result of our study is in agreement with Merrot O et al. ⁽²⁶⁾ in 2005, and Yanikoglu N and Yilmaz B ⁽¹³⁾ in 2008 they found that the size of the angle was different between continuous measurements and values tend to increase after tooth extractions.

This finding is in disagreement with Ohm E and Silness J ⁽²⁷⁾ in 1999 who found that the number of teeth had a decisive influence on the size of the GA and the difference could be related to race.

Conclusions

Edentulism associated changing in gonial angle.

The gonial angle serve as an adjuvant and additional forensic parameter and scientific growth scale, which guides for age group assessment, subject to odontological status.

References

- 1- Ram BU, Juhi U, Pankaj A, and Nirmala NR: Analysis of gonial angle in relation to age, gender, and dentition status by radiological and anthropometric method. *J Forensic Dent Sci.* 2012; 4: 29-33.
- 2- Saini V, Srivastava R, Rai RK, Shamal SN, and Singh TB: Mandibular ramus: an indicator for sex in fragmentary mandible. *J Forensic Sci* 56 Suppl. 2011; 1: 513-16.
- 3- Al- Shamout R, Ammouh M, Alerabata R, and Al- Hababhab A: Age and gender differences in gonial angle, ramus height and bigonial width in dentate subjects. *Pakistan Oral and Dental Journal.* 2012; 132: 81-87.
- 4- Raustia AM and Salonen AM : Gonial angles and condylar and ramus height of the mandible in complete denture wearers- a panoramic radiograph study. *J Oral Rehabil.* 1997; 24: 512-516.
- 5- Oksayan R, Asarkaya B, Palta N, Simsek I, and Sokucu O: Effect of edentulism on mandibular morphology: evaluation of panoramic radiographs. *Scientific World Journal.* 2014; 254932.
- 6- Xie QF and Ainamo A: Correlation of gonial angle size with cortical thickness, height of the mandibular residual body,

- and duration of edentulism. *J Prosthet Dent.* 2004; 91: 477-482.
- 7- Chole RH, Patil RN, Balsaraf CS, Gondivkar S, and Gadail AR: Association of mandible anatomy with age, gender, and dental status: a radiographic study. *ISRN Radiol.* 2013; 453763.
 - 8- Ghaffari R, Hosseinzade A, Zarabi H, and Kazemi M: Mandibular dimensional changes with aging in three dimensional computed tomographic study in 21 to 50 years old men and women. *Journal of Dentomaxillofacial Radiology Pathology and Surgery.* 2013; 2: 7-12.
 - 9- Ghosh S, Vengal M, and Pai KM: Remodeling of the human mandible in the gonial angle region: a panoramic radiographic cross-sectional study. *Oral Radiol.* 2009; 25: 2-5.
 - 10- Bayat M, Jafarian M, and Habashi OG: Correlation between gonial angle and different variables after bilateral sagittal split ramus osteotomy. *Journal of Dentistry, Tehran University of Medical Sciences.* 2006; 3(1): 19-23.
 - 11- Gungor K, Sagir M, and Ozer I: Evaluation of the gonial angle in the Anatolia population: from past to present. *Coll Antro Pol.* 2007; 31(2): 375-378.
 - 12- Ardakani FE, and Niafar N: Evaluation of changes in the mandibular angular cortex using panoramic images. *J Contemp Dent Pract.* 2004; 5(3): 1-15.
 - 13- Yanikoglu N, and Yilmaz B: 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 Endodontics.* 2008; 105(6): E55-E60.
 - 14- Dutra V, Devlin H, Susin C, Yang J, Horner K, and Fernandes AR: Mandibular morphological changes in low bone mass edentulous females: evaluation of panoramic radiographs. *Oral Surg Oral Med Oral Pathol Oral Radiol Endod.* 2006; 102(5): 663-8.
 - 15- Xie Q, Wolf J, and Ainamo A: Quantitative assessment of vertical heights of maxillary and mandibular bones in panoramic radiographs of elderly dentate and edentulous subjects. *Acta Odontol Scand.* 1997a; 55: 155-61.
 - 16- Xie Q, Wolf J, Tilvis R, and Ainamo A: Resorption of mandibular canal wall in edentulous aged population. *J Prosth Dent.* 1997b; 77: 596-600.
 - 17- Shahabi M, Ramazanadeh BA, and Mokhber N: Comparison between the external gonial angle in panoramic radiographs and lateral cephalograms of adult patients with class I malocclusion. *J Oral Sci.* 2009; 51: 425-429.
 - 18- Al-Abboushi DS: Evaluation of dental health and thickness of mandibular inferior cortex among menopausal Iraqi female cigarette smokers sample by using digital panoramic radiography. A master thesis, Department of oral and maxillofacial radiology, College of dentistry, University of Baghdad. 2010.
 - 19- Mohammed MA: Investigation of differences in the mandibular inferior cortical thickness on digital panoramic image in women at different age group. A master thesis, Department of oral and maxillofacial radiology, College of dentistry, University of Baghdad. 2008.
 - 20- Claudio R, Claudio U, Alessandro A, Massimilianot T, and Angelo M: Variation of the gonial angle in vertical surgical reduction of the maxillary-mandibular complex. *J Craniofac Surg.* 2005; 16: 716-9.
 - 21- Huuonen S, Sipilak K, Haikola B, Tapio M, Soderholm AL, Remes-Lyly T, Oikarinen K, and Raustia AM: Influence of edentulousness on gonial angle, ramus and condylar height. *J Oral Rehabil.* 2010; 37: 34-38.
 - 22- Lin SJ, and Hang CH: The relationship between gonial angle and age in adult Taiwanese. *Chin Dent J.* 1997; 16(1): 1-6.
 - 23- Sakar O, Sulun T, and Ispirgil E: Correlation of the gonial angle size with residual ridge resorption in edentulous subjects. *Balk J Stom.* 2008; 12: 38-41.
 - 24- Casey DM, and Emrich LJ: Changes in the mandibular angle in the edentulous state. *J Prosthet Dent.* 1988; 59(3): 373-80.
 - 25- Engstrom C, Hollender L, and Lindquist S: Jaw morphology in edentulous individuals, radiographic cephalometric study. *Journal of Oral Rehabilitation.* 1985; 12: 451.
 - 26- Merrot O, Vacher C, Merrot S, Godlewski G, Frigard B, and Goudot P: Changes in the edentate mandible in the elderly. *Surg Radiol Anat.* 2005; 27: 265-70.
 - 27- Ohm E, and Silness J: Size of the mandibular jaw angle related to age, tooth retention and gender. *J Oral Rehabil.* 1999; 26(11): 883-91.

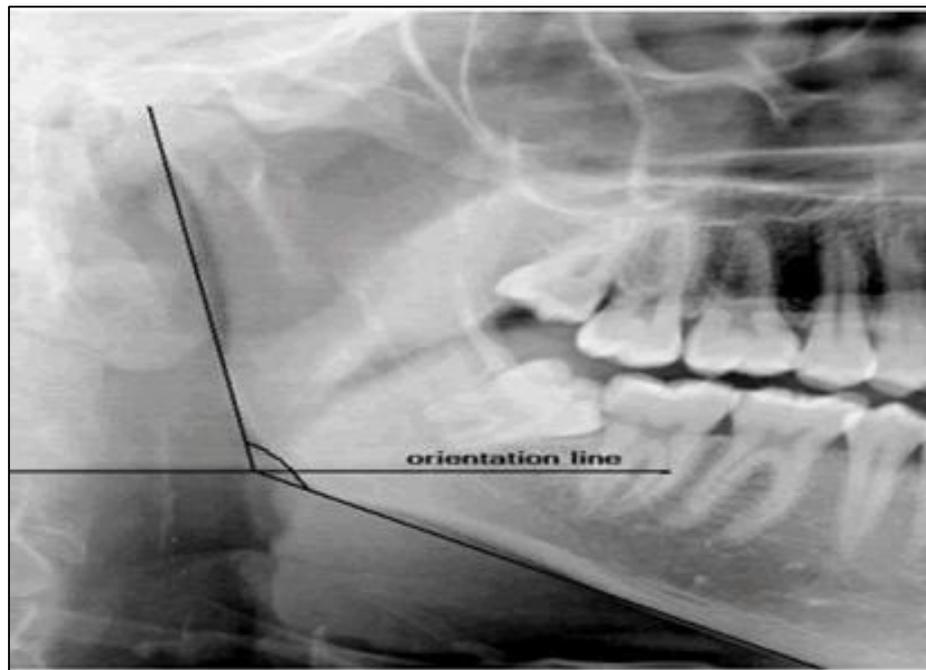


Figure (1): Measurements of the gonial angle on the digital panoramic image

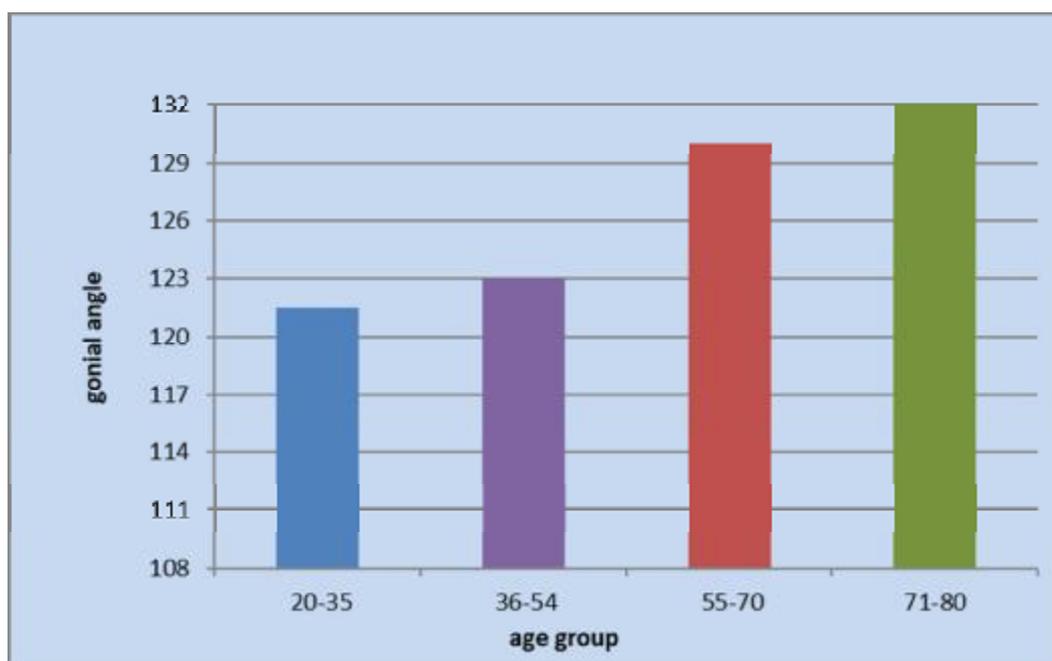


Figure (2): GA variation between groups of the study according to age

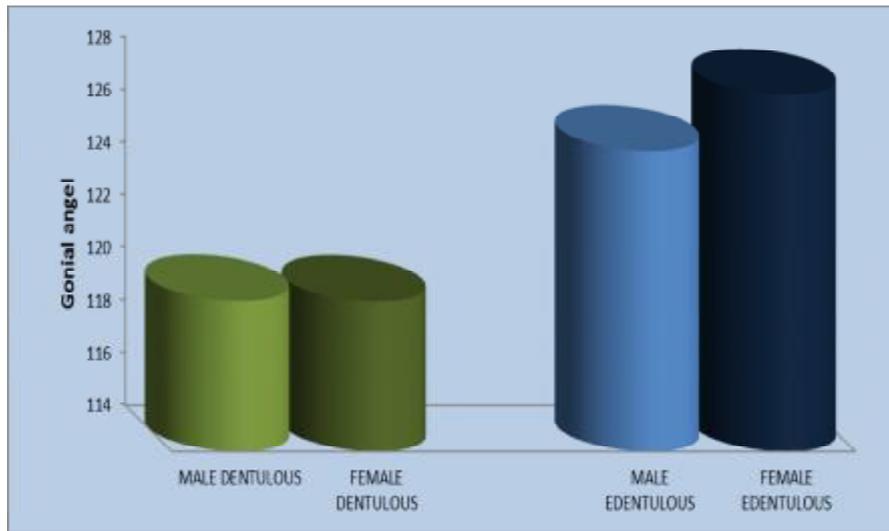


Figure (3): GA variation between groups of the study according to gender and dentate status

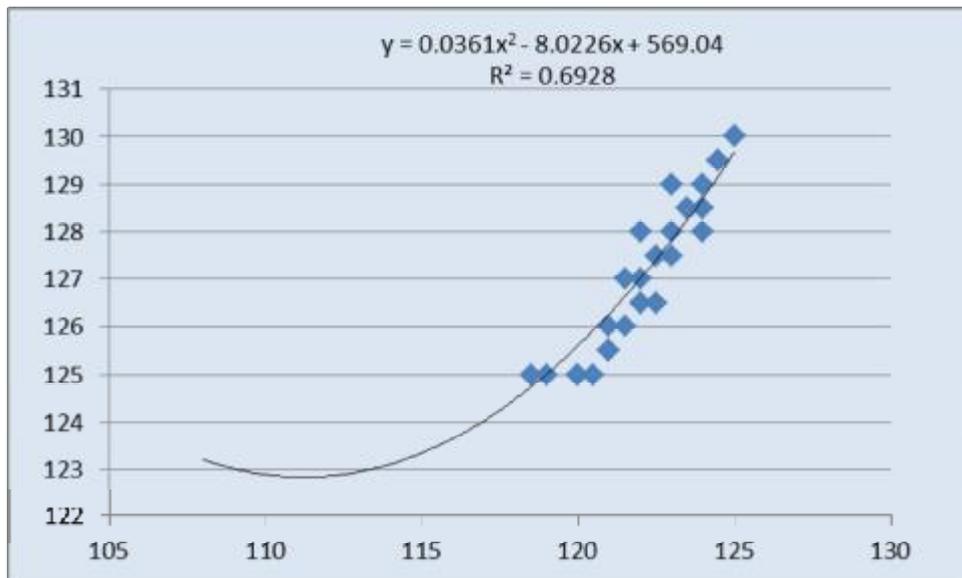


Figure (4): Correlation positive between dentulous and edentulous group study
 Chi square = 0.69; $P < 0.001 < 0.05$ significant

Table (1): Gender and Age distribution between two study groups

| variable | study group | |
|------------------|-------------------|-------------------|
| | dentulous | Edentulous |
| Gender | N | N |
| Female | 20 | 18 |
| Male | 20 | 22 |
| Total | 40 | 40 |
| Age group | 26 (20-35year) | 20 (55-70year) |
| | 14 (36-54year) | 20 (71-80year) |

Table (2) – comparison of GA between right side and left side of the selected sample

| | GA | | P value (T-test) |
|-------|------------|-----------|--|
| | Right side | Left side | |
| Range | 108.5-130 | 108-130 | 0.8 NS P>0.05, non-significant |
| Mean | 123.1375 | 122.9 | |
| SD | 4.67 | 4.65 | |
| N | 40 | 40 | |

Table (3): GA variation between groups of the study according to age

| Dentulous | Age group | Range | Mean | SD | N |
|------------------|--|-----------|-------|------|-----------|
| | 20-35 | 108-122.5 | 118.4 | 4.17 | 26 |
| | 36-54 | 121.5-125 | 123.4 | 1.16 | 14 |
| P value (T-test) | P value <0.001 significant < 0.05 between 2 dentulous age group | | | | |
| Edentulous | Age group | Range | Mean | SD | N |
| | 55-70 | 123-131 | 124.8 | 2.14 | 20 |
| | 71-80 | 125-130 | 127.6 | 1.42 | 20 |
| P value (T-test) | P value < 0.001 significant between 2 edentulous age group | | | | |

Table (4) – GA variation between groups of the study according to gender

| Gender | Dentulous | | | | Edentulous | | | | P value (T-test) between groups |
|--|---|-------|-----|----|--|-------|-----|----|---|
| | Range | Mean | SD | N | Range | Mean | SD | N | |
| Male | 110-124.5 | 120.1 | 3.9 | 20 | 123-131 | 125.8 | 2.5 | 22 | P value < 0.001 significant < 0.05 |
| Female | 108-125 | 119.7 | 4.6 | 20 | 125-130 | 127.5 | 1.7 | 18 | P value < 0.001 significant < 0.05 |
| P value (T-test) between male and female | P value 0.76 non-significant > 0.05 | | | | P value= 0.01 significant < 0.05 | | | | |

Table (5) – Comparison of GA between two groups of the study according to dentition status

| | Dentulous | Edentulous | P value (t-test) |
|-------|-----------|------------|--|
| Range | 108.5-125 | 123-130 | P value <0.001 <0.05 highly significant |
| Mean | 120.167 | 126.244 | |
| SD | 4.253 | 2.263 | |
| N | 40 | 40 | |