

# Analysis of gonial angle in relation to age, gender, and dentition status by radiological and anthropometric methods

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## Abstract

**Background:** With development and function, the mandibular angle has shown changes in size and shape. A variation in mandibular angle with age, gender, and even the dental status has been observed, which is supported by radiographic and anthropometric studies. **Aims:** The aim of this study were to evaluate relationship between complete loss of teeth and changes in the gonial angle; the study further intends to evaluate any variation in gonial angle with age and gender. The study intends to assess the reliability and accuracy of age and gender determination using gonial angle as a parameter. **Materials and Methods:** A total of 185 subjects (91 males; 89 females) were included in the study and were divided into five groups on the basis of the chronological age. Physico-forensic anthropometry and lateral cephalometric methods were used to record the gonial angle. **Results:** The present study shows a definite decrease in the gonial angle with advancing age, but the intergroup analysis does not follow a significant pattern. The study showed no correlation of gonial angle with gender. However, the study observed a 6° increase in gonial angle for edentulous subjects. **Conclusion:** Gonial angle has been used as an adjuvant forensic parameter, but its reliability is questionable, as the mandible does not follow one characteristic pattern. Gonial angle does show changes with dentition status, which may be attributed to physiologic function of the mandible. However, when evidence is scanty, it can be used to direct the investigation.


**Key words:** Dentulous state, edentulous state, gonial angle

## Introduction

Identification of human remains is an important part of medicolegal practice, where forensic odontology has taken a significant place.

Few studies have focused on mandibular angle, its alternations throughout aging, and changing relation to dental status. The lower jaw angle is formed by the ramus line (RL) and the mandibular line (ML), where RL is the tangent to the posterior border of the mandible and ML is the lower border of the mandible through the gnathion (gn).<sup>[1]</sup> Jensen E and Palling M preferred to call this structure gonial angle [Figure 1].<sup>[2]</sup>

Izard G in 1927 cited the following averages of the variability in the gonial angle: 135 to 150 degrees at birth; 135 to 140 degrees when the first dentition is finished; 120 to 130 degrees up to the time of eruption of the second molars; and 120 to 150 degrees in old age.<sup>[3]</sup>

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Apart from the normal assessment of age and gender, identification of human remains can be attained through various landmarks and measurement of many parameters on the mandible. The gonial angle can also be a handy tool in near age assessment in extreme situations like mass disaster, remains of human dead exhumed and murderous mutilations, missing individuals, etc. However, gonial angle as a tool in forensic odontology has received little attention.

Little is known concerning remodeling in the gonial angle with aging in the dentulous and edentulous patients. The aims of this study were to evaluate any relationship between complete loss of the teeth and changes in the gonial angle; The study further intends to evaluate any variation in gonial angle with age and gender. Thus, the study intends to assess the reliability and accuracy of age and gender determination using gonial angle as a parameter.

## Materials and Methods

A total of 185 subjects (91 males; 89 females) at different chronological ages were included in the study and were divided into five groups (group 1 to group 5) on the basis of the chronological age. The data of the study subjects are summarized in Table 1. The study material was obtained from the Department of Orthodontics and Dentofacial Orthopedics, MCODS Manipal; The Medical Record Department of Kasturba Medical College, Manipal; Department of Anatomy, KMC, Manipal; and from Department of Forensic Medicine, KMC, Manipal.

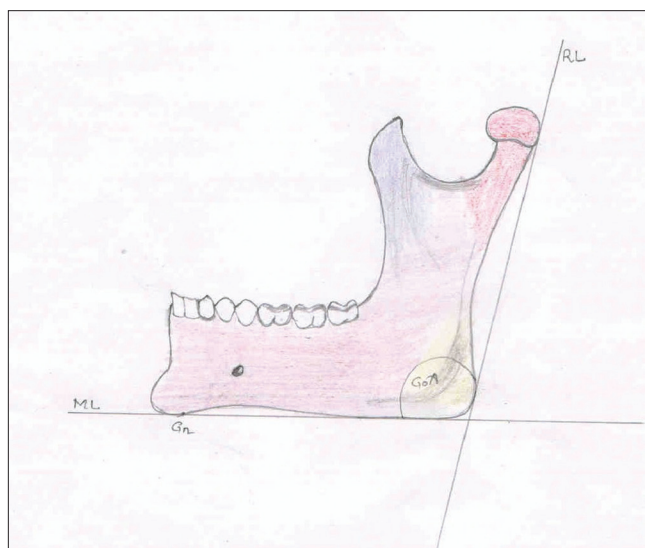
Simple and repeatedly reproducible methodology was employed wherein the data was analyzed by two main methods:

1. Physico-forensic anthropometry: Here, the gonial angle was measured as the angle formed by the base of the mandible and posterior border of ramus by the scale of protractor, which is placed over the angle of the mandible in such a way that basic line or base of protractor coincides with the base of the mandible. The angle is recorded in degrees [Figure 2].

2. Lateral cephalometric analysis: The gonial angle was measured on the lateral cephalometric radiograph using a mathematical protractor [Figure 3].

The gonial angle was measured for each by two separate observers, each angle measured three times, with the mean taken as final record. Insignificant variability was observed between left and right sides on physico-forensic anthropometry, and for uniformity the left side of the mandible was measured. The measurements of both the observers were subjected to intra-class correlation coefficient (ICC), and the interobserver variation was found to be non-significant ( $r = 0.783$ ). Further analyses were done using the mean of the angle recorded.

Analysis of variance (ANOVA) was applied to compare the mean values of the size of the gonial angle in the groups. Independent t-test for samples was used to test the difference between genders in the total sample size. The level of statistical significance was set at  $<0.5\%$ .



**Figure 1:** Diagrammatic representation of gonial angle (GoA), formed by the ramus line (RL) and the mandibular line (ML), where RL is the tangent to the posterior border of the mandible and ML the lower border of the mandible through the gnathion (gn)

**Table 1: Data of the subjects included in the study**

Study groups	Subjects (n)	Age	Gender	Physico-forensic anthropometry	Lateral cephalometric analysis
Group 1	10	Neonatal and natal	Males: 4 Females: 6	10	0
Group 2	25	Deciduous dentition 1–5 years	Males: 13 Females: 12	15	10
Group 3	50	Mixed dentition: 6–16 years	Males: 21 Females: 24	5	45
Group 4	50	Adult permanent dentition: 17–35 years	Males: 28 Females: 22	10	40
Group 5	50	Post-adult dentition and middle age: 35–72 year	Males: 25 Females: 25	30	20

## Results and Observations

Although muscle function should preserve the bony structure of the gonial angle and symphyseal regions irrespective of the dental status and age, the gonial angle has been found to vary with the type of dentition and also with age.<sup>[4-6]</sup>

The present study shows a definite decrease in the gonial angle with advancing age, but the intergroup analysis does not follow a significant pattern [Table 2]. There seems to be no significant difference between prenatal, natal, and neonatal group (group 1) with that of deciduous dentition group (group 2), or between adult permanent dentition group (group 3) and post-adult and middle age group (group 4). Further, group 3 and group 4 together did not show any significant difference with group 5. A significant difference was observed between group 3 and group 5 [Table 3]. On comparison of gonial angle for gender, no significant difference was observed between males and females [Table 4]. In group 5, there was a significant difference between dentulous and edentulous subjects, indicating a mean of 6° higher in edentulous subjects. Further, a greater angle was observed for non-denture wearers compared to denture wearers in the edentulous group; however, the results were not statistically significant [Table 5].



Figure 2: Anthropometric method used in determination of gonial angle

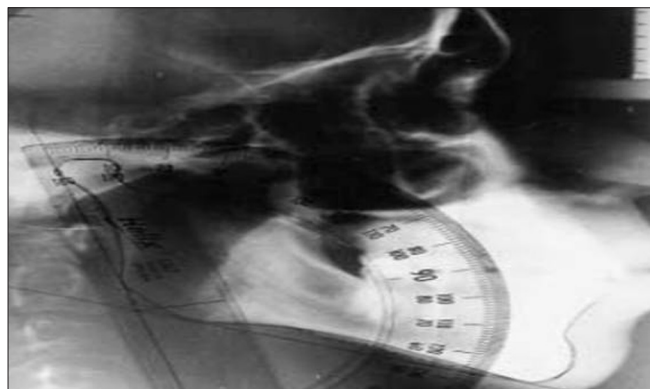


Figure 3: Radiological method used in determination of gonial angle

## Discussion

Cross-sectional studies have promoted the concept that the gonial angle (GoA) could be used as an indicator of age and gender. However, such views hold little significance as increasing literature shows contrary and variable results.

In our study, we came across the near matching averages of variability in the gonial angle with mean decrease in the angle with age. We could not find any significant difference between the mixed dentition group and adult group, and post-adult to middle aged group. An increase in gonial angle with increasing age was observed in this study. This is in agreement with study of Ohm E and Silness J who found a close positive association between gonial angle and age.<sup>[7]</sup> However, the results of the present study were not statistically significant enough to be reliable and lead to any conclusive results. Sicher H and DuBrul EL describe a

Table 2: Mean gonial angle in relation to different age groups

Groups	No. of subjects	Min to max mandibular angle	Mean mandibular angle ± SD
Group 1	10	138–156	145.90 ± 5.33
Group 2	25	136–146	140.90 ± 2.76
Group 3	50	112–140	133.96 ± 8.15
Group 4	50	121–156	129.36 ± 7.58
Group 5	50	96–142	127.29 ± 10.88

Table 3: Intergroup comparison for mandibular angle

Groups	P value	Significance
B/W 1 and 2	0.655	No
B/W 3 and 4	0.286	No
B/W 3 and 5	0.044	Yes
B/W 4 and 5	0.904	No
B/W 3-4 and 5	0.089	No

Table 4: Mean gonial angle difference in genders

Groups	Males		Females		Statistically significant
	n	Gonial angle (in degrees)	n	Gonial angle (in degrees)	
Group 1	4	146 ± 2.47	6	144 ± 3.24	No
Group 2	13	142 ± 3.24	12	140 ± 1.97	No
Group 3	21	135 ± 1.16	24	133 ± 2.57	No
Group 4	28	132 ± 1.89	22	129 ± 1.32	No
Group 5	25	128 ± 2.36	25	126 ± 2.41	No

Table 5: Comparison between edentulous and dentulous state in group 5

Group	No. of subjects	Mean mandibular angle ± SD	P value
Edentulous Total subjects	22	132.17 ± 4.80	0.001 Statistically significant
Denture wearers (for ≥5 yrs)	10	124.33 ± 2.2	
Non-denture wearers	12	131.16 ± 3.2	
Dentulous subjects	23	126.42 ± 11.02	

widening of the angle as a consequence of disuse atrophy following the loss of the teeth and even venture the statement that the widening of the angle is more marked if no dentures are worn.<sup>[8]</sup> On the contrary, concerning the significance of age per se, Lonberg P noted an actual decrease in the angle for both edentulous and dentate groups.<sup>[9]</sup>

Difference in the gonial angle of the two sexes has been found in the previous studies, and the general trend was that the gonial angles in males are greater than those measured in females.<sup>[2]</sup> Usually the mean angle is 3–5° greater in males.<sup>[10]</sup> This is consistent with the knowledge that males generally have a larger mandible than females. Findings concerning gender differences may also be explained by the fact that, on average, men have greater masticatory force than women.<sup>[11]</sup>

However, the present study showed no correlation between genders with gonial angle, and this is in agreement with Raustia AM and Salonen mam and Ceylan *et al.*<sup>[12,13]</sup> Wafa Al-Faleh could not establish any significant difference between sexes and gonial angle, further supporting the findings of our study.<sup>[14]</sup>

Keen JA supports the concept of a widening of the angle as a consequence of the loss of teeth.<sup>[15]</sup> The morphological change in the gonial region in the edentulous individual compared to a young individual has received little attention in the literature. Literature holds diverse studies, where a few observed no significant change in gonial angle, with others concluding gonial angle to be greater in edentulous individuals than in dentate ones.<sup>[16-18]</sup> The present study also observed a 6° increase in gonial angle for edentulous subjects. In accordance with our observation, Keen found an increase in the gonial angle of edentulous individuals by an average of 5°, and also Casey DM and Emrich LJ in their study found an increase in the mean gonial angle by 2.4° in the edentulous group.<sup>[15,10]</sup> This may be attributed to the atrophic alterations of the basal part of the mandibular bone.<sup>[19]</sup> Enlow *et al.*, and Xie *et al.*, found that bone deposition takes place throughout the inferior border, except in the antegonial region.<sup>[20,21]</sup>

The antegonial region underwent resorption in the edentulous individuals, perhaps due to the reduced muscle function in this region in comparison with that of the gonial angle. Muscle function tends to preserve bone at its point of insertion; therefore, the structure of the gonial region will be maintained by the insertion of the medial pterygoid and masseter muscles.<sup>[22]</sup>

When teeth are present, the muscular activity associated with mastication preserved the angle from any change in size. However, with loss of teeth, the bone undergoes remodeling and, consequently, an increase in size is seen. Also, other factors affecting this parameter are tooth loss due to lack

of awareness, occupation, as well as social and attitudinal aspects relating to tooth extraction and early loss of teeth.

Although several studies found no significant differences between dentulous and edentulous individuals,<sup>[14,22]</sup> in a cephalometric study of the gonial angle measurement, Ohm E and Silness J found the mean gonial angle measurement for edentulous patients to be 131 degrees versus 127 degrees for partially dentate, without consideration of gender.<sup>[7]</sup> Casey DM and Emrich LJ used panoramic radiographs and they found that the mean size of the gonial angle was 126.3 for the edentulous and 123.9 for dentate patients.<sup>[10]</sup>

There have been studies carried out on other factors that could affect the gonial angle, as that of Heath in 1976 concluded that the postural and functional interrelationships of the cheek, lips and tongue in edentulous individuals can alter the gonial angle.<sup>[23]</sup> Weinmann JP and Sicher H stated that the consecutive atrophy of the masticatory muscles in old edentulous people, after many years of increased function, leads to changes in the region of the mandibular angle.<sup>[24]</sup> Resorption of the bone at the posterior or inferior border of this region, the area of the masseter muscle insertion, leads to increasing obtuseness of the mandibular angle. Sicher H and Du Brul EL reported that after loss of all teeth, Non-denture wearers had a wider gonial angle than denture wearers.<sup>[8]</sup>

The considerable transformative changes in gonial angle may be attributed to several factors, and it is known that the mandible does not follow one characteristic pattern throughout life. As most of the data available is based on cross-sectional studies, there is a need for a large longitudinal study to ascertain a definitive conclusion and the reliability of gonial angle as sole indicator of age, gender, and dentition status.

## Conclusion

The present study concludes that during the deciduous dentition period, there seems to be no significant difference in gonial angle, and later as the development of mandible is completed, the gonial angle decreases until about the age of 25 to 30 years and later maintains the steady state. The gonial angle definitely shows an increase in edentulous individuals, especially if no dentures are worn. There seems to be a difference in gonial angle with different age groups, but not significant and definitively reliable. Thus, gonial angle can serve as an adjuvant and additional forensic parameter and scientific growth scale, which guides for age group assessment, subject to odontological status.

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