

## An Osteological Study to Evaluate the Morphology, Position and Dimensions of the Genial Tubercles with Its Clinical Relevance

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### Abstract:

**Background:** Genial tubercles (GT) show different patterns in their shapes and position.

**Aim:** To evaluate the position and dimensions of the GT.

**Material and methods:** 60 mandibles from the anatomy department of MVJ Medical College were studied. The morphology and measurements of GT were recorded.

**Results:** Type I, type II patterns were noted in 23.33% and 35%, type III and type IV in 26.67% and 13.33%. GT was absent in 1.67% of the mandibles examined. The mean height and width of GT was  $6.3 \pm 2.9$  mm and  $5.6 \pm 1.6$  mm. Mean distance from superior genial tubercle to the apices of lower incisors was  $15.4 \pm 4.1$  mm. Mean distance from the menton to the upper and lower margins of superior genial tubercles were  $14.6 \pm 2.3$  mm and  $8.5 \pm 3.3$  mm.

**Conclusion:** Genioglossus advancement is one of the popular procedure for the treatment of obstructive sleep apnoea (OSA). This procedure is usually performed with mandibular osteotomy and advancement of genial tubercle (GT). The present study could help the maxillo-facial surgeons in designing the location for osteotomies.

**Key words:** Genial tubercles, genioglossus advancement, morphology, morphometry, sleep apnoea.

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### I. Introduction

Genial tubercles also known as mental spines, genial apophysis, spinae mentalis are small bony projections present on the lingual surface of the mandible. They are four in number, two superior and two inferior. The superior genial tubercles (SGT) gives origin to the genioglossus and inferior genial tubercles (IGT) to geniohyoid muscles. [1]

Obstructive sleep apnoea-hypo apnoea syndrome (OSAHS) is a condition causing serious physical and psychological consequences. The patients have excessive daytime somnolence, depression, cardiac arrhythmias, pulmonary hypertension and cerebrovascular accidents. [2]

Various surgeries are proposed for the treatment of OSAHS like genioplasty, mortised genioplasty, box (inferior sagittal) osteotomy, mandibular trapezoid osteotomy, rectangular and the circular osteotomy. The most important step in genioglossus advancement is to accurately identify the bone segment attached to genioglossus muscle there by avoiding complications such as mandibular fracture, de-vitalisation of the inferior incisor roots and incomplete incorporation of the genioglossus muscle hence accurate measurements and location of the genial tubercles play a vital role. [3]

Yin SK has studied anatomical and CT measurements of the genial tubercles in Chinese population and has correlated between them. [3]

According to Hueman et al, the superior horizontal cut for the mandibular osteotomy must be located at least 5mm below the root apices (central or lateral incisor) to minimise the risk of root damage and paraesthesia of the dentition. [4]

Zhang has measured the distance between the apex of the central incisor and the attachment of the genioglossus muscles on cadaver specimens using both anatomical and radiological methods. [5]

SC Selvamuthukumar et al has reported incidental finding of an enlarged genial tubercle in case of oral carcinoma. [6]

Oda LS has studied the morphology of the genial spines in Brazilian whites and negroes. [7]

The main aim of this present study is to evaluate the size, morphology and the position of the genial tubercles in south Indian population.

### II. Material and methods

Sixty adult human mandibles were obtained from the anatomy department of MVJ Medical college and research hospital. Mandibles with second molar and canine tooth on the same side were chosen and edentulous, damaged mandibles were excluded from the study. To avoid error, the measurements were taken on three different occasions and the average values were noted. Vernier caliper calibrated to measure upto 0.1mm was used in the study.

The morphological patterns of the genial tubercles were studied and it was classified as follows. Type I - the classical pattern of two superior and two inferior genial tubercles placed one above the other. Type II - Two superior genial tubercles and a median ridge representing fused inferior genial tubercles below them. Type III - Two superior genial tubercles and a rough impression below them. Type IV - A single median eminence or projection. Type V - Absence of the genial tubercles.

**Figures: 1-5**

The morphometric measurements to assess the position and size of the genial tubercles were recorded as follows.

- The distance from the upper border of the SGT to the menton
- The distance from the lower border of the SGT to the menton
- The distance of the upper border of the SGT to the apex of the lower central incisors
- The mandibular thickness at the level of the GT
- The inter-canine distance at 5mm below the lower incisor apices.
- The height of the GT
- The width of the GT

The collected data was tabulated and subjected to statistical analysis to calculate the mean and standard deviation.

### **III. Results**

The distribution of the genial tubercles based on their morphology is tabulated in **TABLE:1**

Type - I pattern were seen in 23.33%, type - II in 35%, type - III in 26.67% and type - IV in 13.33% and type - V in 1.67% of the mandibles examined. In majority of the cases, two SGT with a median ridge below it was noted (type II) followed by two SGT and a rough area below it (type III).

The mean genial tubercle height (GTH) measured was  $6.3 \pm 2.9$  mm, the mean width (GTW) was  $5.6 \pm 1.6$  mm. The average distance from the apices of the lower central incisor to the SGT was  $15.4 \pm 4.1$  mm and the average distance from the upper border of the SGT to the menton was  $14.6 \pm 2.3$  mm. The mean distance from the lower border of the IGT to the menton was  $8.5 \pm 3.3$  mm. The thickness of the mandible at the level of the genial tubercle was  $14.1 \pm 1.9$  mm and the inter-canine distance at the level 5mm below the lower central incisor was  $20.7 \pm 1.4$  mm. **TABLE:2**

### **IV. Discussion**

The genial tubercles are a group of bony extensions that surround the lingual foramen bilaterally in the midway between the superior and inferior borders of the lingual surface of the mandible.

Obstructive sleep apnea syndrome is a complex disease with multifactorial etiology which is poorly understood. The usual genioglossal muscle advance osteotomy is based on a quadrangular bicortical osteotomy of the anterior mandible involving the genial tubercle and genioglossal muscle advancement, without causing dental occlusion alteration or maxillo-mandibular advance. [8]

Thomson examined 1,670 mandibles from anthropoids and concluded that the genial tubercles may be absent, replaced by pits and in some cases well-developed. [1]

Izhar Shohat et al has reported that enlarged genial tubercle acts as a frequent site of fracture in patients wearing a complete mandibular denture. [9]

V.Singh has studied the patterns of the mental spines and mental foramina and has classified the patterns into type I to type V. In his study he found type II pattern of distribution of genial tubercles to be more followed by type III. The present work is comparable to this study in terms of the morphology of the genial tubercles. [10]

Hueman EM, has done both cadaveric study for anatomical analysis and radiographic study using cone beam CT to determine the location of the genial tubercles. His results show the accuracy of the 3D cone beam CT in the anatomic location of the genial tubercle. [4]

Oda et al has observed and analysed 275 human adult mandibles of both sexes and ethnic groups and found that the spina mentalis exists in  $90.04 \pm 1.8$  % of the mandibles of Brazilian Whites and Negroes. The typical form with four tubercles, as described by some authors, is rarely found. In most cases it is characterized by the presence of two upper tubercles ( $27.27 \pm 7.2$  %), two superior tubercles and one inferior ( $24.72 \pm 6.7$  %), and one elongated median tubercle ( $24.0 \pm 6.6$  %). The forms and volumes of the tubercles are very irregular and seem not to depend on age, sex or ethnic group. The GT was absent in  $9.8 \pm 3.2$  % of the cases, especially in mandibles of white teeth less individuals. [5]

An hypertrophic spina mentalis generally formed at the expense of the upper tubercle is observed in only  $1.45 \pm 0.5$  % of the cases. [7]

Ten randomly selected adult cadavers with intact mandibular dentition and without periodontal disease were sectioned by Silverstein K and measurements were taken to evaluate the dimensions of GT and its attachments. According to his study the average thickness of the mandible at the GT was 12.6mm. The average thickness of the mandible at the inferior border at pogonion was 14.5mm. The average distance from the GT to the inferior border was 14.2 mm. The average distance from the apex of the incisors to the GT was 11.8 mm. The width of the genioglossus muscle was 13.8 mm. [11]

Yin SK studied the morphometry of the genial tubercles in Chinese population both by the anatomical and imaging technique and correlated between them. He concluded that the height of SGT which were measured by anatomy and spiral CT were  $(5.82 \pm 0.71)$  mm and  $(6.17 \pm 0.71)$  mm respectively. The width of SGT were  $(6.98 \pm 1.35)$  mm and  $(7.01 \pm 1.13)$  mm. The distance between menton and inferior margin of SGT were  $(11.08 \pm 2.05)$  mm and  $(10.41 \pm 1.55)$  mm. The distance between mandibular incisor apex and superior margin of SGT for male were  $(15.57 \pm 1.82)$  mm and  $(14.34 \pm 2.06)$  mm and for female were  $(9.36 \pm 2.79)$  mm and  $(8.78 \pm 2.53)$  mm. The thickness of mandibles at GT were  $(11.95 \pm 1.59)$  mm and  $(12.19 \pm 1.64)$  mm. The distance from menton to superior margin of SGT were  $(16.1 \pm 2.30)$  mm and  $(15.73 \pm 2.12)$  mm. [3]

The morphometric measurements of the present study are comparable to the anatomical study of Yin SK et al.

## V. Conclusion

When the genioglossus and geniohyoid are advanced simultaneously the inferior horizontal bone cut should be approximately 5 mm above the menton, which should be 11 mm if the genioglossus is advanced singly. The superior horizontal bone cut should be approximately 18mm above the menton. The lateral vertical cut should be 4 mm lateral to midline. The findings of the present study could help estimate the dimensions of osteotomies made in the anterior mandible for the treatment of obstructive sleep apnea to offer the greatest amount of muscular advancement.

This study will also guide the otolaryngologists to avoid complications such as mandibular incisor apex injury, muscle injury and mandibular fractures in various maxillo-facial surgeries.

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**Table:1 Distribution of the genial tubercles based on the morphology in 60 adult human mandibles**

Patterns	Number (N=60)	Percentage (%)
Type I	14	23.33
Type II	21	35.00
Type III	16	26.67

Type IV	08	13.33
Type V	01	1.67

**Table:2 Measurements of the genial tubercles showing its position in relation to various landmarks.**

Distance (mm)	Minimum	Maximum	Mean	SD
GTH	02	12	6.3	2.9
GTW	03	09	5.6	1.6
SGT-LI	02	27	15.4	4.1
Sup. SGT-M	10	23	14.6	2.3
Inf.SGT-M	01	15	8.5	3.3
MT	06	18	14.1	1.9
ICD	17	23	20.7	1.4



**Fig:1 Lingual surface of the mandible showing a pair of superior and inferior genial tubercles. (type I)**



**Fig :2 Mandible with two superior genial tubercles and a median ridge below it formed by the fusion of the two inferior genial tubercles. (Type II)**



**Fig :3 Mandible showing two superior genial tubercles and a rough impression below it (Type III)**



**Fig: 4 Mandible showing a single median ridge (type IV)**



**Fig:4a A single median eminence is present (type-IV)**



**Fig: 5 Mandible with absence of superior and inferior genial tubercles (type V)**

**Legends for the tables and figures:**

SGT -- Superior genial tubercle

IGT -- Inferior genial tubercle

GTH -- Genial tubercle height

GTW -- Genial tubercle width

MT -- Thickness of the mandible at the genial tubercle

ICD -- Inter-canine distance at the level of 5mm below the lower incisor apices

SGT- LI -- Distance from upper margin of superior genial tubercle to the apices of the lower incisor

Sup. SGT-M -- Distance from the superior margin of the superior genial tubercle to the menton

Inf. SGT-M -- Distance from the inferior margin of the superior genial tubercle to the menton