

## MORPHOMETRIC CHARACTERISTICS AND TYPOLOGY OF THE CORONOID PROCESS OF THE MANDIBLE

SINAN BAKIRCI<sup>1</sup>, İLKNUR ARI<sup>2</sup>, İLKER MUSTAFA KAFA<sup>3</sup>

<sup>1</sup>Department of Anatomy, Faculty of Medicine, Düzce University, Düzce - <sup>2</sup>Department of Anatomy, Faculty of Medicine, Uludağ University, Bursa - <sup>3</sup>Department of Anatomy, Faculty of Medicine, Uludağ University, Bursa, Turkey

### ABSTRACT

We aimed to investigate morphological types of the coronoid process, the angle between coronoid process and condylar process and the area of the coronoid processes of mandibles from two different time periods (Contemporary and Byzantine). We found that 60% and 64.2% of all coronoid processes were hook shaped, 20% and 21.4% were triangular shaped and 20% and 14.28% were rounded shaped at right and left sides respectively in contemporary period group; while in Byzantine group, 66.6% and 61.4% of all coronoid processes were hook shaped, 17.9% and 13.6% were triangular shaped and 15.4% and 25% were rounded shaped at right and left sides respectively. Bilateralism has been found in 74.2% (65.2% hook, 13% round, 21.8% triangular) in contemporary period group and 21.2% (64.3% hook, 14.3% round, 21.4% triangular) in Byzantine period group. Mean areas of the coronoid processes were  $1.94 \pm 0.5$  cm<sup>2</sup> and  $2.21 \pm 0.4$  cm<sup>2</sup> at right and left sides respectively in contemporary period group and  $2.00 \pm 1.0$  cm<sup>2</sup> and  $2.22 \pm 0.6$  cm<sup>2</sup> on right and left sides respectively in Byzantine period group. The means of the angle between two processes were  $99.1 \pm 10.5^\circ$  and  $94.9 \pm 7.6^\circ$  for contemporary group and  $101.01 \pm 9.2^\circ$  and  $98.9 \pm 8.5^\circ$  for Byzantine group at right and left sides respectively. We found that the types of the coronoid processes showed laterality for both groups and there was significant difference between areas of left and right sides of the coronoid processes of contemporary group ( $p < 0.05$ ). These comparisons and population specific results may be beneficial for anthropologists, forensic scientists and also for reconstructive surgeons.

**Key words:** Mandible, coronoid process, morphometric, byzantine, maxillofacial surgery, graft.

Received August 27, 2013; Accepted September 20, 2013

### Introduction

The mandible is a major part of the viscerocranium, articulating with the rest of the cranium via temporomandibular joint. There are two processes of the ramus of the mandible. Coronoid process is a thin, flat, triangular eminence and can be different both in its shape and size. This structure provides insertion point for powerful muscles, which are capable of generating great force in relationship to biting and chewing<sup>(1,2)</sup>. Coronoid process is rather important to oral and maxillofacial surgeons for treatments of the most orthopaedic conditions, injuries and defects related to the head and neck regions. Another important anatomical part of the human mandible is the condyloid process that is thicker than the coronoid, and consists of two portions: the condyle, and the neck.

One of the most important issues in adults regarding the mandible is fracture of this bone.

Mandibular fractures can result from the traffic accidents, sports injuries, accidents at work and increasingly as a result of the interpersonal violence. Fractures of this bone occur most commonly at the neck of its condyle, parasymphyseal region or the body. Most often, mandible fractures occur at least at two of these sites and isolated fractures are relatively unusual<sup>(2)</sup>. The condylar fractures occur usually by the transmission of force following a blow to the front of the mandible or to the contralateral body. The zygomatic arches are important structures, which can block to advance fractures of condyle by direct distress. Most reported condylar fractures are not intracapsular and generally occurs at the neck of mandible<sup>(2)</sup>. It is important to identify quantitative and particular anatomical features of this relatively prominent bony structure.

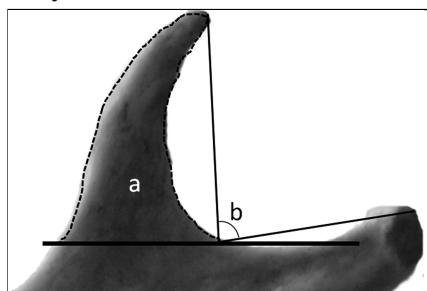
Population specific morphometric studies provide useful information for the anthropological researches and forensic investigations. In this

regard we aimed to examine morphological types of the coronoid process, the angle between coronoid process and condylar process and the area of the coronoid processes of mandibles from two different time periods (Contemporary and Byzantine).

**Material and methods**

The present study was undertaken on totally 97 dry human mandibles, which are from two different time periods (Contemporary period, n=66 and Byzantine period, n=31), which are preserved at the Department of Anatomy, Medical School, Uludag University. We investigated morphological types of the coronoid process, the angle between coronoid process and condylar process and the area of the coronoid processes by morphometric approach. Byzantine mandibles (13th century) used in this study achieved from the skeletons of earlier excavations at Nicea in Turkey.

Area measurements of the coronoid processes obtained by the aid of the Scion Image software (ver. 4.02). Briefly, a parallel line was drawn digitally from the deepest point of the mandibular notch and then upper area of the coronoid process was digitally measured. Calibration procedures have executed before the measurements, with millimetric papers placed and photographed with mandibles, which are at the same plane of the processes (Figure 1, dashed area depicted by “a”). Angular measurements, also done with aid of the Scion Image software, have been obtained calculating the angle between most upper point of two processes and deepest point of the mandibular notch (Figure 1, depicted by “b”).

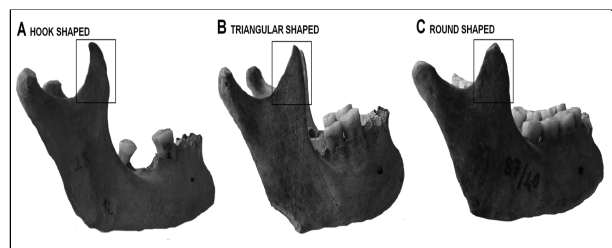


**Figure 1:** Area measurements of the coronoid processes (“a”) and angular measurements between two processes (“b”).

For the statistical analysis of the morphometric data, the mean values and standard deviations were first estimated and then unpaired t-Test was used to compare groups. A probability of  $p < 0.05$  considered significant for all statistical comparisons (Sigma-Stat, ver.3.0; SPSS, ver.11.0).

**Results**

Three types of coronoid process of the mandibles were found in this study for both groups (hook, triangular and rounded types, Figure 2A-C), of Anatolian inhabitants of two different time periods.



**Figure 2:** Three types of coronoid process (hook (A), triangular (B) and rounded (C)).

We found that the mandibles from contemporary period have hook shaped coronoid processes at the ratio of 60%, triangular shaped coronoid processes at 20 % and round shaped coronoid processes at 20% in descending order at the right side; and hook shaped coronoid processes at the ratio of 64.2%, triangular shaped coronoid processes at 21.4 %, round shaped coronoid processes ratio 14.28% in descending order at the left side. Bilaterality ratio of this period were found totally 74.2% and mean area of coronoid process were estimated  $1.9 \pm 0.5 \text{ cm}^2$  and  $2.2 \pm 0.4 \text{ cm}^2$  at the right and left sides respectively in the contemporary period. We found significantly difference between two sides ( $p < 0.05$ ) for area measurements in contemporary period. The means of the angles between two process of the mandible, coronoid and condylar processes were  $99.1 \pm 10.5^\circ$  and  $94.9 \pm 7.6^\circ$  at the right and left sides respectively for contemporary period (Table 1).

Type	Right side (%)	Left side (%)	Bilaterality (%) (74.2 % of total)
Hook	60	64.2	65.2
Triangular	20	21.4	21.8
Rounded	20	14.28	13
	Right side	Left side	
Mean area of coronoid processes (cm <sup>2</sup> )	$1.9 \pm 0.5$	$2.2 \pm 0.4$	
The means of the angle between coronoid and condylar processes	$99.1 \pm 10.5^\circ$	$94.9 \pm 7.6^\circ$	

**Table 1:** Types, bilaterality, mean areas of the coronoid processes and angular measurements of the mandibles of the Contemporary period.

Byzantine period mandibles have hook shaped coronoid processes at the ratio of 66.6%, triangular shaped coronoid processes at 17.9%, round shaped coronoid processes at 15.4% at the right side in descending order; and in the left side, the hook shaped coronoid processes ratio was 61.4%, triangular shaped coronoid processes ratio was 13.6%, round shaped coronoid processes ratio was 25% in descending order. Bilaterality ratio of this period were found totally 21.2% and the mean area of the coronoid process were estimated  $2.0 \pm 1.0 \text{ cm}^2$  and  $2.2 \pm 0.6 \text{ cm}^2$  at the right and left sides respectively in the Byzantine period. Significantly difference found between two sides ( $p < 0.05$ ) for area measurements. The means of the angles between two processes of the mandible, coronoid and condylar processes, were  $101.1 \pm 9.2^\circ$  and  $98.9 \pm 8.5^\circ$  at the right and left sides for Byzantine period, respectively (Table 2).

Type	Right side (%)	Left side (%)	Bilaterality (%) (21.2 % of total)
Hook	66.6	61.4	64.3
Triangular	17.9	13.6	21.4
Rounded	15.4	25	14.3
	Right side	Left side	
Mean area of coronoid processes ( $\text{cm}^2$ )	$2.0 \pm 1.0$	$2.2 \pm 0.6$	
The means of the angle between coronoid and condylar processes	$101.1 \pm 9.2^\circ$	$98.9 \pm 8.5^\circ$	

**Table 2:** Types, bilaterality, mean areas of the coronoid processes and angular measurements of the mandibles of the Byzantine period.

## Discussion

Studies of the human skeletal features between and within populations are valuable for both clinical applications and determinations of racial characteristics of the different populations. Use of bone and bone fragments is also important for forensic sciences and the race, sex, gender and weight of the body related estimations. In the present study, the types of the coronoid processes were found similar to both time periods. But bilaterality has been found higher in the contemporary period than the Byzantine one (74.2%, 21.2 %, respectively).

When compared with the results of previous studies, the results obtained in the present study suggest that differences of the features such as shape of the coronoid process of the mandible may not only exist between populations of different geographic environment but also within the inhabitants of the same geography in different time periods. In the previous studies, shape of the coronoid process was reported as three various types. The most common type was found to be triangular shaped type in the Indian population<sup>(3-6)</sup>. We unexpectedly found that the hook type of the coronoid process as the most common type for each two periods of Anatolian population. Second and third types were triangular and rounded types, respectively (Table 3).

	Hook Type (%)	Triangular Type (%)	Rounded type (%)
Isaac B et al., 2001	27.4	49	23.6
Prajapati VP et al., 2011	21.25	54.17	24.58
Nirmale VK et al., 2012	28	65	7
Tanveer AKHS et al., 2011	30	67	3
Present Study Contemporary Group	62.1	20.7	17.4
Present study Byzantian Group	64	15.7	20.2

**Table 3:** Comparison of recent studies of the coronoid process of the mandible in the literature.

Autologous, allograft or synthetic bone grafts can be obtained by different approaches. An autologous bone graft is taken from a part of the patient's body and can be used in another part of same person. In this way, complications such as infection, bleeding, and tissue damage is lower than allografts and so this method is preferred by surgeons. Graft bone is usually harvested from iliac crest, rib or calvarium. If injured area is small, the coronoid process can be used as a graft material. The coronoid process graft has some advantages. It can be removed via intra-oral route and no scar need be on the skin. Another advantage is that it can be harvested very easily and safely and its harvesting time is very short. Previously, the coronoid process graft was successfully performed for paranasal augmentation because of its morphology and dimensions that closely suits the paranasal area<sup>(7)</sup>. Coronoid process grafts can be used for reconstruction of

orbital floor deformities, midface or alveolar defects and other repairing procedures in the cranio-maxillofacial surgery<sup>(8-10)</sup>. It is valuable to know that available dimensions of issued bone are adequate before the grafting operations.

Morphometric features are slightly variable especially for upper parts of the mandible between different populations and these differences may come into question in fracture surgeries. Mandibular fractures are usually related to other facial region injuries and often arise from a trauma. Mandibular fractures have been reported to account for 36-70% of all maxillofacial fractures<sup>(11-14)</sup>. There is a variety of classifications of mandibular fractures depending on condition of teeth, fracture orientation and anatomical location. When mandibular fractures are evaluated according to anatomic location, large portion of fractures occur in the condylar region (36%), small portion of the fractures occur in other regions such as ramus (3%), mandibular angle (25%) and coronoid process (2%)<sup>(13)</sup>. In patients with mandible fractures, 53% of patients had unilateral fractures, 37% of the patients had two fractures and 9% had three or more fractures<sup>(12)</sup>. Unfavourable displaced mandibular fractures can require a reduction by open technique. During this application, usually two mini plates, which are parallel to each other, are screwed on the displaced bone ends.

### Conclusions

In our study, we found that the means of the angle between two processes of the mandible were 99.14° and 94.1° at the right and left sides for contemporary period. It is important that this angle between two processes may change among different populations, and it should keep in the mind those placements of mini plates in mandibular ramus fractures should be carefully placed on the ramus of the mandible and the angle between these materials are very important. More suitable grafts which are mimic normal anatomical morphology may reduce healing time and rate of the malocclusion of the teeth after surgery. Morphologic type, total area of the coronoid process and angular differences between sides and among human subjects may also be important for various specific maxillofacial operations.

### References

- 1) Moore KL. *Clinically Oriented Anatomy*, Sixth Edition, Baltimore 2010; 824.
- 2) Standring S. *Gray's Anatomy*, 39th Ed. London 2008; 489-490.
- 3) Isaac B, Holla SJ. *Variations in the shape of the coronoid process in the adult human mandible*. Journal Anat. Soc. India 2001; 50(2): 137-139.
- 4) Nirmale VK, Mane UW, Sukre SB, Diwan CV. *Morphological features of human mandible*. IJRTSAT 2012; 3: 38-43.
- 5) Prajapati VP, Malukar OJ, Nagar SK. *Variations in the morphological appearance of the coronoid process of human mandible*. Natl J of Med Res 2011; 1: 64-66.
- 6) Tanveer AKHS, Sharieff JH. *Observation on morphological features of human mandibles in 200 south indian subjects*. Anatomica Karnataka 2011; 5(1): 44-49.
- 7) Choung PH, Kim SG. *The coronoid process for paranasal augmentation in the correction of mid-facial concavity*. Oral Surg Oral Med Oral Pathol Oral Radiol Endod 2001; 91: 28-33.
- 8) Gungormus M, Yavuz MS. *The ascending ramus of the mandible as a donor site in maxillofacial bone grafting*. J Oral Maxillofac Surg 2002; 60: 1316-1318.
- 9) Honig JF. *The coronoid process as a new donor source for autogenous bone grafts for reconstructing orbital and midface defects*. Bull Group Int Rech Sci Stomatol Odontol 1996; 39: 49-55.
- 10) Mintz SM, Ettinger A, Schmakel T, Gleason MJ. *Contralateral coronoid process bone grafts for orbital floor reconstruction: an anatomic and clinical study*. J Oral Maxillofac Surg 1998; 56: 1140-1144.
- 11) Brook IM, Wood NA. *Etiology and incidence of facial fractures in adults*. Int J Oral Surg 1983; (5): 293-298.
- 12) Fridrich KL, Pena-Velasco G, Olson RAJ. *Changing trends with mandibular fractures: A review of 1067 cases*. J Oral Maxillofac Surg 1985; 59: 120.
- 13) Olson RA, Fonseca RJ, Zeitler DL, Osbon DB. *Fractures of the mandible: a review of 580 cases*. J Oral Maxillofac Surg 1982; 40: 23-28.
- 14) Sojot AJ, Meisami T, Sandor GK, Clokie CM. *The epidemiology of mandibular fractures treated at the Toronto general hospital: A review of 246 cases*. J Can Dent Assoc 2001; 67(11): 640-644.

Request reprints from:

İLKER MUSTAFA KAFA, MD

Department of Anatomy, Faculty of Medicine

Uludag University, Bursa

(Turkey)