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Original Article *Özgün Araştırma*

MASTOID PROCESS MORPHOMETRY ON DRY SKULLS

Kuru Kafalarda Processus Mastoideus Morfometrisi

Selma ÇALIŞKAN[1] Sinem AKKAŞOĞLU[2], Mustafa Fevzi SARGON[3], Mehmet Deniz DEMİRYÜREK[4]

[1,2] Ankara Yıldırım Beyazıt Üniversitesi Tıp Fakültesi Anatomi Anabilim Dalı Bilkent, ANKARA, TÜRKİYE
[3] Atılım Üniversitesi Tıp Fakültesi Anatomi Anabilim Dalı İncek, ANKARA, TÜRKİYE
[4] Hacettepe Üniversitesi Tıp Fakültesi Anatomi Anabilim Dalı Sıhhıye, ANKARA, TÜRKİYE

ABSTRACT

Objective: Mastoid process is the downward projection from the mastoid part of the temporal bone located posteroinferior to external auditory meatus. Mastoid process is a palpable bony structure which enables to determine the location of asterion. The aim of this study is to define details of mastoid process anatomy to enlighten surgeons, anatomists, anthropologists and forensic experts.

Material and Methods: Present study was conducted on 20 skulls (20 left + 20 right=40) and 18 hemi skulls of unknown sex. All measurements were taken by two observers simultaneously by using digital caliper. Of the 58 mastoid processes 30 were right sided and 28 were left sided.

Results: Mean and standard deviation of all measurements were reported on each mastoid process. The difference between right A line (distance between right asterion and right apex of mastoid process) and left A line was statistically significant (p=0.022). The difference between right D line (Vertical distance between imaginary plane from the superior border of right external auditory meatus to right apex of mastoid process) and left D line was statistically significant (p<0.001).

Conclusion: Mastoid process morphology and its anatomical relations are important for anatomists, neurosurgeons, anthropologists and forensic experts. As it is common centre of interest for multidisciplines, morphometry of this feature should be well defined.

Keywords: Mastoid process, dry skull, morphometry

ÖZ

Amaç: Çalışmamızda processus mastoideus anatomisinin detaylarını tanımlamak ve cerrahlar, anatomistler, antropologlar ve adli bilimler ile ilgilenenlere ışık tutmak amaçlanmıştır

Gereç ve Yöntemler: Processus mastoideus temporal kemikte meatus acusticus externus'un postero-inferioru'ndan aşağı doğru uzanan bir yapıdır. Çalışmamız cinsiyeti bilinmeyen 20 kafa iskeletinin bütünü (20 sağ + 20 sol= 40) ve 18 yarım kafatasında gerçekleştirildi. Bütün ölçümler digital kumpas kullanılarak iki araştırmacı tarafından eş zamanlı olarak yapıldı.

Bulgular: Ellisekiz processus mastoideus'un 30'u sağ ve 28'i sol tarafa aitti. Her processus mastoideus için tüm ölçümlerin ortalama ve standart sapması rapor edildi. Sağ ve sol A çizgileri (asterion-processus mastoideus'un apex'i) arasındaki fark istatistiksel olarak anlamlıydı (p = 0.022). Sağ ve sol D çizgileri (meatus acusticus externus'un üst sınırından çizilen düzlem ile processus mastoideus'un apex'i arasındaki vertikal uzaklık) arasındaki fark istatistiksel olarak anlamlıydı (p<0.001).

Sonuç: Processus mastoideus morfolojisi ve anatomik komşulukları anatomistler, beyin cerrahları, antropologlar ve adli tıp uzmanları için önemlidir. Pek çok disiplin için ortak ilgi alanı olduğu için, bu yapının morfometrisi iyi tanımlanmalıdır.

Anahtar Kelimeler: Processus mastoideus, kuru kafa, morfometri

Correspondence / Yazışma Adresi: **Dr. Sinem AKKAŞOĞLU**
Ankara Yıldırım Beyazıt Üniversitesi Tıp Fakültesi Anatomi Anabilim Dalı Bilkent-ANKARA, TÜRKİYE
Phone / Tel: +905534776785 **E-mail /** E-posta: snm222@hotmail.com
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ORCID NO: [1]0000-0002-5839-3172, [2]0000-0002-3371-4734 [3]0000-0001-6360-6008, [4]0000-0001-8781-1719

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INTRODUCTION

Mastoid process is the downward projection from the mastoid part of the temporal bone located posteroinferior to external auditory meatus. It is the least prone site to be damaged due to its inferolateral location on the skull. Moreover it is the most dimorphic bony feature of the skull. Due to its dimorphism it is a favourable point for sex discrimination (1-4). It is larger in males than in females (1). Not only the size of mastoid process but also shape is a statistically significant gender indicator (5).

Mastoid process is the attachment site for posterior belly of digastric muscle, clavicular head of sternocleidomastoid muscle, splenius capitis muscle and longissimus capitis muscle (6,7). There are studies in the literature indicating variations of muscles attaching to mastoid process and causing cervical pain. Mastoid process and muscle variations must be kept in mind when evaluating patients with cervical dystonia, torticollis, shoulder pain and neck pain (8). Location and dimensions of the mastoid process are of great importance because of surrounding anatomical structure for anatomists, neurosurgeons, neurotologists.

Asterion is the junction of lambdoid, parietomastoid and the occipitomastoid sutures on the lateral aspect of the skull. It overlies the junction of transverse and sigmoid sinuses. Asterion is a landmark commonly used by neurosurgeons in cerebellopontine trigone surgery, transmastoid cisternoscopy, mastoid antrum surgery and venous sinus surgery. However, its location has population spesific variations. Mastoid process is a palpable bony structure which enables to determine the location of asterion. Distance between apex of mastoid process and asterion is a valuable parameter for proper craniotomy (9).

In the present study we aimed to define details of mastoid process anatomy to enlighten surgeons, anatomists, antropologists and forensic experts.

MATERIALS AND METHODS

Present study was conducted on 20 skulls and 18 hemi skulls of unknown sex in Anatomy Department of Hacettepe University. Fifth-eight mastoid processes were evaluated. Adult skulls with morphologic deformities, variations and skulls with Wormian bones were not involved in the study for proper determination of landmarks used in measurements. All measurements were taken by two observers simultaneously by using digital caliper.

Landmark points and measurements taken on mastoid process are:

- X point: Asterion
- Y point: Apex of mastoid process
- Z point: Suprameatal spine
- A line: Distance between X and Y points
- B line: Distance between X and Z points
- C line: Distance between Y and Z points
- D line: Vertical distance between imaginary plane from the superior border of external auditory meatus to Y point (Figure 1).

Statistical Analysis

Paired t-test was used to evaluate the difference between two measurements as the difference between left and right measures were normally distributed. Type-I error rate was taken as 0.05 to test statistical hypotheses. SPSS 20.0 was used to run statistical analyses (IBM Corp. Released 2011. IBM SPSS Statistics for Windows, Version 20.0. Armonk, NY: IBM Corp.).

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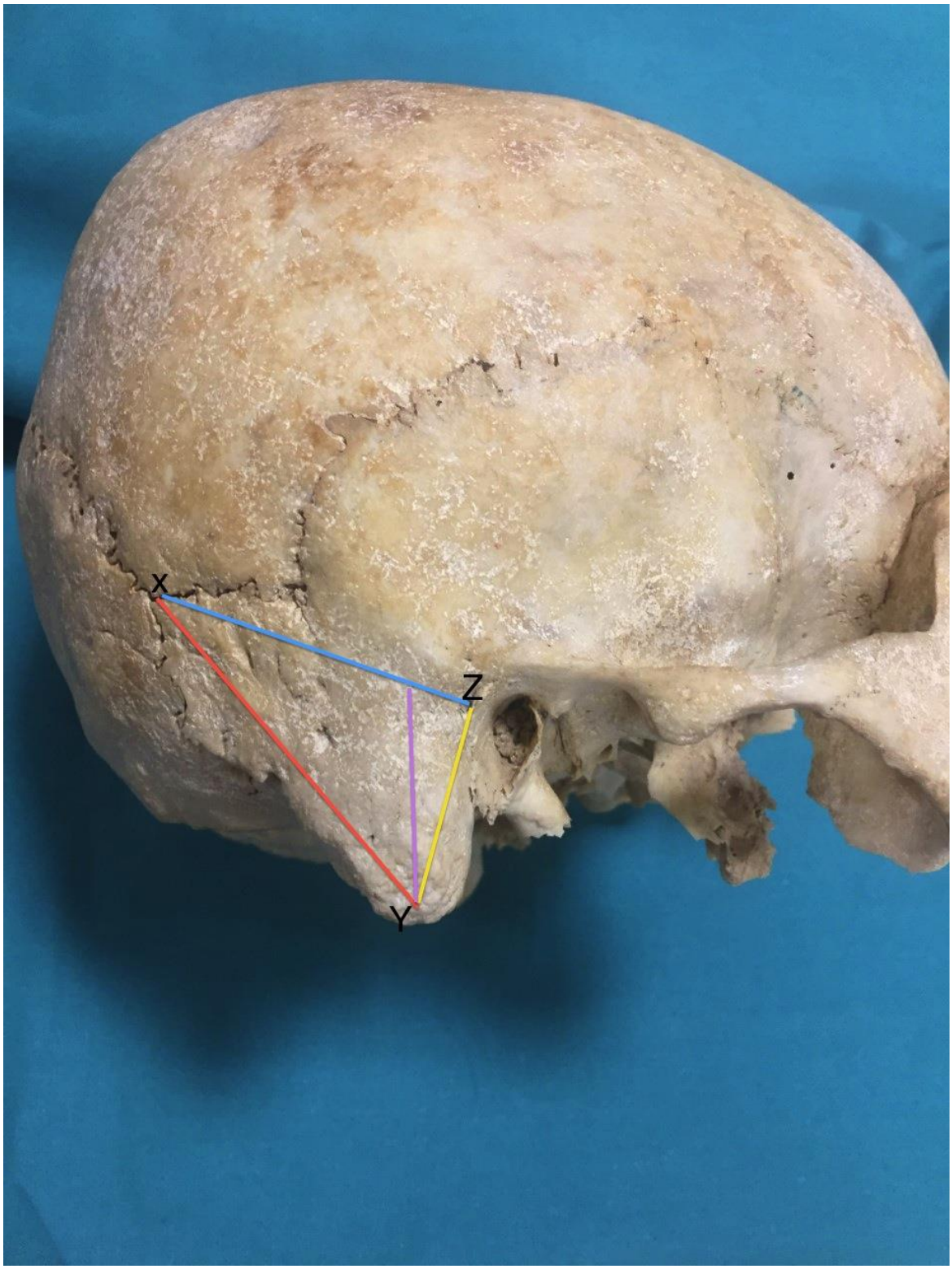

Figure 1:

- A line: Distance between X (Asterion) and Y (Apex of mastoid process) points
- B line: Distance between X and Z (Suprameatal spine) points
- C line: Distance between Y and Z points
- D line: Vertical distance between imaginary plane from the superior border of external auditory meatus to Y point

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RESULTS

A total of 58 mastoid processes of 18 hemi skulls and 20 skulls were evaluated. Of the 58 mastoid processes 30 were right sided and 28 were left sided. Mean and standard deviation of all measurements were reported on each mastoid process (Table 1 and 2).

Mean value of the A line was 5.02±0.58 mm on the right side and 4.87±0.56 mm on the left side. Mean value of the B line was 4.39±0.43 mm on the right side and 4.45±0.42 mm on the left side. Mean value of the C line was 2.84±0.41 mm on the right side and 2.78±0.39 mm on the left side. Mean value of the D line was 3.43±0.56 mm on the right side and 3.04±0.50 mm on the left side (Table1).

Measures were compared between right and left sides only on 20 skulls in terms of statistical significance. The difference between right A line and left A line was statistically significant (p=0.022). There was no statistical difference between right and left B lines (p=0.857). There was no statistical difference between right and left C lines (p=0.371). The difference between right D line and left D line was statistically significant (p<0.001) (Table 2).

Table 1: Descriptive statistics

	n	**mean±SD**
Right A	30	5.02±0.58
Right B	30	4.39±0.43
Right C	30	2.84±0.41
Right D	30	3.43±0.56
Left A	28	4.87±0.56
Left B	28	4.45±0.42
Left C	28	2.78±0.39
Left D	28	3.04±0.50

Table 2: Pairwise comparisons of right and left sides

	n	**mean±SD**	***p***
Right A	20	5.00±0.65	0.022
Left A	20	4.79±0.53	
Right B	20	4.43±0.47	0.857
Left B	20	4.45±0.47	
Right C	20	2.87±0.47	0.371
Left C	20	2.79±0.39	
Right D	20	3.43±0.58	< 0.001
Left D	20	3.02±0.54	

DISCUSSION

Mastoid process is of great interest for scientists because of its location and relations. Its location carries it to a critical point in posterolateral cranial surgery and its relations are crucial to prevent complications. Initial key hole formation before craniotomy is the first step for proper surgery. Reference point for key hole formation is the asterion. Underlying in proximity of asterion is the junction of transverse and sigmoid sinuses. Close relation of asterion and venous sinuses lead to complications such as lacerations. Asterion is the unique reference point in these types of operations but unfortunately it can not be palpated (10,11). Bony landmarks on lateral aspect of skull help to indicate position of asterion. In our opinion the most reliable landmark is the mastoid process because of its palpable mass. That's why mastoid process is one of the most commonly studied points by researchers. There are studies in the literature presenting distance between apex of mastoid process and asterion. Yılmaz et al. presented distance between mastoid apex and asterion and compared the difference between right and left sides. They found no statistically significant difference (12). In the present study, distance between asterion and mastoid apex of right side was greater than of left side and the difference between sides was statistically

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significant. Our result was not consistent with the result of Yılmaz et al. Different from our study Yılmaz et al. studied on computed tomography images. In our opinion, direct measurements on skulls are more valuable than radiologic images. Malpositioning of patients or radiologic artefacts may lead to dubious measurements. This is an additional value of studies such as ours but future studies with larger case number are required to support our opinion. Difference of length between sides should be kept in mind by neurosurgeons.

Posterior belly of digastric muscle, clavicular head of sternocleidomastoid muscle, splenius capitis muscle and longissimus capitis muscle attach to mastoid process (6,7). Mastoid process may present as an abnormal attachment site for unexpected muscles. Chotai et al. reported an unusual levator scapula muscle attaching to mastoid process (8). Sonne et al. reported omohyoid muscle attaching to mastoid process instead of hyoid bone (13). Kim et al. showed hypertrophy of mastoid process in patients with thickened and thigthened sternocleidomastoid muscle (6). This abnormality may cause musculoskeletal asymetry, craniofacial asymetry, craniovertebral abnormalities, cervical and thoracolumbar scoliosis. Mastoid asymmetry may be sign of muscular variations causing musculoskeletal dysfunctions and chronic pain. In the present study, we measured vertical length of mastoid process and found that it is greater on the right sight. Acceptable lenght difference in normal limits between right and left sides should be known to evaluate pathological mastoid asymetry. We think our study will be a base for the future radiologic studies evaluating mastoid asymetry in living populations.

Surgical resection of the advanced parotid cancer requries detailed anatomical knowledge of mastoid process and neighbouring structures. Mastoidectomy is an important part of parotid cancer surgery which leads to clear exposure of facial nerve to prevent facial paralysis. Muscles attaching to mastoid process are detached from the mastoid process before resection (14). In our opinion, knowledge of mastoid process dimensions is valuable in such operations.

Rahne et al. concluded that mastoid volume reaches the size of adult mastoid by the age of 19 in females and 18.9 years in males. Chronic otitis media, mastoiditis and cholesteatoma history result in smaller mastoid volume. Mastoid pneumatization accompanies expansion of mastoid size by age. Patients suffering from conductive hearing loss can be treated with transdermal hearing implants. Mastoid size may be a limiting factor when fitting implant into mastoid. Rahne et al. studied morphologic changes of mastoid by age and reported dimensions by aging (15). In the present study, we studied on adult skulls and did not evaluate age related morphology of mastoid process. This is a limitation of our study.

CONCLUSION

Mastoid process morphology and its anatomical relations are important for anatomists, neurosurgeons, anthropologists and forensic experts. As it is common centre of interest for multidisciplines, morphometry of this feature should be well defined.

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