Anatomical Characteristics of the Arcuate Eminence

Arkuat Eminensin Anatomik Özellikleri

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ABSTRACT Objective: The arcuate eminence (AE) is an arc-like prominence in middle cranial fossa (MCF). Its long axis is obliquely directed anteriorly and medially. The AE is one of the anatomical landmarks for MCF approaches. However, if the AE is not prominent in MCF, it can go unnoticed and is likely that it has individual variations. The aim of this study is to define the anatomical characteristics of the AE in detail and to show its variations and their incidences. **Material and Methods:** We used 24 cranial bases (48 specimens), 38 right-side and 33 left-side temporal bones; 119 specimens overall. After assessment of the presence or absence of the AE, we grouped them as single arc, dual arc or complex arc. Cases with the complex arc shape were grouped into five subgroups for the first time in the literature. Data were then analyzed. **Results:** The overall incidence of AE was 94.1% with 64.3% single arc, and 35.7% dual or complex arc. In the group in which the variations of complex arc were remarkable, the most common ones were those with triangle-shaped origo at 36.7%. **Conclusion:** According to the hypothesis in the literature, the AE corresponds to the anterior semicircular canal (ASC), the air cells underneath, or the third temporal sulcus. Although the association between the AE and ASC has not yet been proven, the importance of the AE in MCF surgery is still valid. The data in our study will be helpful in surgery by defining the formal characteristics of the AE.

Key Words: Temporal bone; anatomy; semicircular canals

ÖZET Amaç: Arkuat eminens (AE), orta kafatası boşluğunda (OKB) bulunan kemer benzeri bir çıkıntıdır. Uzun ekseni ön iç tarafa doğru eğiktir. AE, OKB yaklaşımlarında anatomik olarak öenmli bir noktadır. Ancak, AE OKB'da belirgin değilse, faredilmez ve varyasyonlarının olması olasıdır. Bu çalışmanın amacı, AE'nin anatomik özelliklerini detaylı bir şekilde tanımlamak, şekil varyasyonlarını ve görülme sıklıklarını ortaya koymaktır. **Gereç ve Yöntemler:** Çalışmamızda 24 kafa tabanı (48 örnek), 38 sağ taraf ve 33 sol taraf temporal kemik (toplam 119 örnek) kullanılmıştır. Kemiklerde AE'nin varlığı ya da yokluğu belirlendikten sonra, AE tekli kemer, çiftli kemer ve karışık kemer olarak gruplandırıldı. Karışık kemer şekilli vakalar literaturde ilk kez beş alt gruba ayrıldı ve veriler analiz edildi. **Bulgular:** AE'nin genel olarak insidansı %94,1; tekli kemerlilerin insidansı %64.3 ve çift ve karışık kemerli vakalarınki ise %35.7'dir. Karışık kemer varyasyonuna sahip grupta en sık %36.7 ile üçgen şekilli orijinliler bulunmaktadır. **Sonuç:** Literatürlerdeki hipotezlere gore AE, anterior semicircular kanala (ASK), hava boşlukları altına veya üçüncü temporal oluğa tekabül etmektedir. AE ve ASK ilişkisi henüz ispatlanmamış olmasına rağmen, AE'nin OKB cerrahisindeki önemi açıktır. AE'nin biçimsel özelliklerini tanımlayan çalışmamızdaki veriler, cerrahi işlemler sırasında yardımcı olacaktır.

Anahtar Kelimeler: Temporal kemik; anatomi; semisirküler kanallar

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The arcuate eminence (AE) is a prominence in the middle cranial fossa (MCF) and it has an arc shape.[1] Paturet described it as a smooth rounded bulging with its long axis obliquely forwards and in-

wards, lying very close to the superior border of the petrous part of the temporal bone at the junction between the lateral third and medial two thirds.[2]

The MCF approach is important in otolaryngology and neurosurgery.[3] The lack of definitive landmarks on the superior surface of the temporal bone is a technical challenge in middle cranial fossa approaches. It is important in protecting the vital structures such as the cochlea, labyrinth, and labyrinthine facial nerve when approaching the internal auditory canal (IAC). Anatomical landmarks help to protect these vital structures.[4] Although considered as the relief of the anterior semicircular canal (ASC), the AE does not always seem to correspond to it.[2,3,5] However, if the AE does not form a prominence, it may go unnoticed and it is likely that it shows individual variations.[3] These features which hinder its systematization render the AE unable to be a constant and valid landmark.[2] AE is classified as single arc, dual arc and complex arc forms in the literature.[1,6] However no detailed subclassification of complex arc is present.

The objective of this study was to define the anatomical characteristics of the AE, which is an important landmark in MCF approaches in detail and to demonstrate its variations and their incidences.

MATERIAL AND METHODS

This study is conducted in Dokuz Eylul University Faculty of Medicine, Department of Anatomy. Twenty four cranial bases (48 specimens), 38 right and 33 left temporal bones, 119 specimens overall (62 right and 57 left) were studied. The AE, which is located on the petrous portion of the temporal bone has been classified in the literature as follows: (1) smooth surface with no remarkable arc (Absent), (2) single arc-like prominence with or without a small branch (single arc), and (3) Dual or complex arc.[1,6] In our study, after assessing the presence or absence of the AE, AEs were grouped as single-arc, dual-arc and complex-arc using the classification in the literature. Complex-arc cases were further grouped into five subgroups:

Group I: Those with geometric shape of origin: those with triangular, square, trapezoid or semi-circular origo.

Group II: Those with letter shapes: T, C, V, or L shaped.

Group III: Goosefoot shaped.

Group IV: Triangular prism shaped.

Group V: Square shaped origo, reverse-located dual arc.

The data were analyzed using Fisher's exact test and Chi-Square test.

RESULTS

The incidence of the AE in our study was 98.4% on the right and 89.5% on the left (Table 1). The incidences for single arc, dual arc and complex arc in were 60.5%, 8.4%, and 25.2%, respectively (Table 2).

The types of AE were interpreted in two groups in our study. In the first group, the distribution of single arc and the others, and in the second group the distribution of dual arc and the others were examined. In other words, AEs were grouped as 'single-dual or complex' and 'dual-single or complex'. It was found that 'single' was present on the

TABLE 1: Incidences of AE.

	AE					
	present		absent		Total	
	n	%	n	%	%	n
Right	61	98.4	1	1.6	100.0	62
Left	51	89.5	6	10.5	100.0	57
Total	112	94.1	7	5.9	100.0	119
p*	0.054					

* Fisher's exact test.

TABLE 2: The types of AE.

	Right		Left		Total	
	n	%	n	%	%	n
Single arc	58.1	36	63.2	36	60.5	72
Dual arc	11.3	7	5.3	3	8.4	10
Complex arc	29.0	18	21.1	12	25.2	30
Absent	1.6	1	10.5	6	5.9	7
Total	100	62	100	57	100	119

right-side in 59.0% of the cases in the 'single-dual or complex' group, and it was on the left-side in 70.6% of the cases. It was also found that 'single or complex' was present on the right-side in 88.5% of the cases in the 'dual-single or complex' group, and it was on the left-side in 94.1% of the cases (Table 3).

Cases with complex arc were grouped into five subgroups:

Group I: Those with geometric shaped origin: those with triangular, square, trapezoid or semi-circular origin (63.4%) (Figures 1, 2).

Group II: Those with letter shapes: T, C, V, or L shaped (13.2%) (Figure 3).

Group III: Goosefoot shaped (6.7%) (Figure 4).

Group IV: Triangular prism shaped (13.3%) (Figure 5).

TABLE 3: Assessment of the AE types according to the groups.

	AE type				AE type			
	Single		Dual or Complex		Single or Complex		Dual	
	n	%	n	%	n	%	n	%
Right	36	59.0	25	41.0	54	88.5	7	11.5
Left	36	70.6	15	29.4	48	94.1	3	5.9
Total	72	64.3	40	35.7	102	91.1	10	8.9
p	0.282*				0.342**			

* Chi-Square test, ** Fisher's exact test. AE: Arcute eminence.

FIGURE 1: The one with triangular shaped origin.

FIGURE 2: The one with semi-circular shaped origin.

FIGURE 3: The one with letter C shape.

FIGURE 4: The one with goosefoot shape.

FIGURE 5: The one with triangular prism shape.

Group V: Square shaped origin, reverse-located dual arc (3.3%)

It was noticed that Group I, complex arcs with geometric shaped origin had the highest incidence with 63.4% (Table 4).

DISCUSSION

Although it is not known what AE corresponds to, AE can be defined as a prominence in the MCF located on the superior edge of the petrous portion of the temporal bone, or as a focal osseous prominence at the midpoint of the anterior intracranial surface, or as the highest osseous prominence on the base of the MCF.[5]

Three hypotheses have been proposed: AE corresponds to (1) the ASC, (2) the subjacent air cells, or (3) the third temporal sulcus.[1,2,5,7] Faure et al. showed that these three hypotheses can be sustained and are variably associated, excluding any single theory of the origin of the AE.[2] However, recent studies support the idea that the association between the AE and ASC is not constant or reliable.[3-5] Although the relationship between the AE and ASC has not yet been proven, the importance of the AE in MCF surgery is still valid. Especially, Fisch method of localizing internal acustic meatus in middle fossa approach uses arcuate eminence as a landmark.[8] In a surgical point of view, AE is an obstacle in the routes of transpetrosal approaches.[7] The anterior and posterior (i.e., retrolabyrinthine, translabyrinthine, and transcochlear) transpetrosal approaches have been established for accessing pathologies situated in Meckel's cave or the petroclival area.[9-14] Defining the shape characteristics of the AE will be helpful in the surgical dissection process. Blunt dissection is carried out between dural-bone interface during surgery. Dissection would be more rapid and safe if the surgeon is aware of characteristics of arcuate eminence during the epidural dissection process. Transpetrosal approaches have narrow surgical corridors and arcuate eminence need to be abolished by drilling.[7] To obtain a similar exposure without drilling, the temporal lobe must be elevated more with the tentorium while avoiding damage to the vein of Labbe.

Tsunoda et al. found AE in more than 90% of cases,[6] Faure et al. and Kartush et al. found it in 85%,[2,3] Seo et al in 82.7%,[3] and Tsunoda[1] in 80% of cases. The incidence of the AE in our study (94.1%) is higher than the rates in the literature; the closest rate is that of Tsunoda et al.[6] Tsunoda reported the

TABLE 4: The subgroups of complex arc.

Subgroups		%		n	
Group I Complex arcs with geometric shaped origo	Triangular	36.7	63.4	11	19
	Square	10.0		3	
	Trapezoid	10.0		3	
	Semi-circular	6.7		2	
Group II Complex arcs with letter shapes	T	3.3	13.2	1	4
	C	3.3		1	
	V	3.3		1	
	L	3.3		1	
Group III Goosefoot shaped		6.7		2	
Group IV Triangular prism shaped		13.3		4	
Group V Square shaped origo, reverse-located dual arc		3.3		1	

types of the AE as: absence of AE in 20%, single arc in 47.6%, and dual or complex arc in 33.3%. Our rates were 5.9%, 60.5%, and 33.6%, respectively (Table 2). The rate for dual or complex arc by Tsunoda (33.3%) is consistent with the rate in our study (33.6%). However, our rate for single arc was 60.5%, whereas the rate by Tsunoda was 47.6% and the absence of the AE was 5.9% in our study while it was 20% in the study by Tsunoda.[1] We classified complex arc forms into five subgroups as geometric shaped origin (group I), letter shapes (group II), goosefoot shaped forms (group III), triangular prism shaped forms (group IV) and square shaped origin (group V), for the first time in the literature. Triangular shapes of Group I constituted majority of the complex arc forms (36.7%).

CONCLUSION

Complex arc forms were subclassified in this study. Although the incidence for the AE (94.1%) in our study increases the reliability of the AE as an anatomical landmark, it has individual variabilities. Therefore, it is important to be aware of the variations defined here and to take these into consideration during surgery. Knowing characteristics of AE may be helpful for a safer dissection.

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