The Contribution of the Micro Dissection of the Occipital Artery to Surgery

Oksipital Arterin Mikrodiseksiyonunun Cerrahiye Katkısı

Mete EDİZER, MD,[a]
Orhan MAĞDEN, MD,[b]
Nüket GÖÇMEN-MAS, MD,[c]
Çiğdem İÇKE, MD,[a]
Ali BARUTÇU, MD,[d]
Atay ATABEY, MD,[d]
Ramazan KÖYMEN,[e]
Hamit Selim KARABEKİR, MD[f]

[a]Department of Anatomy,
Ondokuz Mayıs University
Faculty of Medicine, Samsun
[b]Department of Anatomy,
[d]Department of Plastic Reconstructive and Anesthetic Surgery,
Dokuz Eylül University
Faculty of Medicine, Izmir
[c]Department of Anatomy,
[f]Department of Neurosurgery,
Kocatepe University
Faculty of Medicine, Afyonkarahisar
[e]Department of Oral and Maxillofacial Surgery,
Gülhane Medical Academy, Ankara

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Yazışma Adresi/*Correspondence:*
Nüket GÖÇMEN-MAS, MD
Kocatepe University
Faculty of Medicine,
Department of Anatomy, Afyonkarahisar,
TÜRKİYE/TURKEY
nuketmas@gmail.com

ABSTRACT Objective: The occipital artery has an important role in the vasculature of the scalp. The aim of this study was to determine the origin, location, length, size, and adjacent regions of the occipital artery. **Material and Methods:** In the present study, occipital artery types were evaluated according to the location, origin, diameter, length, and course; and in relation to the artery with hypoglossal, greater occipital and accessory nerves by bilateral meticulous anatomic microdissection under 4X loop magnification in formalin fixed 14 adult (28 cases) cadavers. **Results:** The examinations revealed that the occipital artery originated separately from the external carotid artery in 89% of cases. It originated from the posterior auricular artery as an occipitoauricular common trunk in 11% of cases. The hypoglossal nerve formed an apparent hook proximal to the origin of the artery in 52%, distal to the origin of the artery in 4% and at the origin of the artery in 44%. **Conclusion:** In this study, the anatomical data of the occipital artery will help the surgeons to elevate flaps based on the occipital artery in a safer way as well as to protect the artery during cranial and maxillofacial surgical approaches.

Key Words: Anatomy; surgical flaps; surgery, oral; neurosurgery; microdissection

ÖZET Amaç: Kafa derisi kanlanmasında arteria occipitalis'in önemli bir rolü vardır. Çalışmanın amacı oksipital arterin orijin, lokasyon, uzunluk, çapı ve yakın çevresel alanlarını araştırmaktır. **Gereç ve Yöntemler:** Bu çalışmada formol ile fikse edilmiş 14 erişkin kadavrada (28 olgu) 4X'lük lup büyütme altında, arterin tipleri, yerleşimi, orijini, çapı, uzunluğu ve seyir parametreleri bilateral anatomik mikrodiseksiyon yöntemi ile incelendi. Arterin seyri sırasında nervus hypoglossus, nervus occipitalis major ve nervus accessorius ile komşuluk ilişkisi değerlendirildi. **Bulgular:** Çalışmamızın verilerine göre arteria occipitalis olguların %89'unda direkt olarak arteria carotis externa'dan köken almaktaydı. Olguların %11'inde ise "truncus occipitoauricularis" adı altında ortak bir gövde olarak arteria auricularis posterior'dan orijin almaktaydı. Nervus hypoglossus tüm olguların %4'ünde arterin orijinine göre distalde, %44'ünde arterin tam orijininde ve %52'sinde arterin orijinine göre proksimalde, belirgin bir kanca şekli oluşturarak seyretmekteydi. **Sonuç:** Bu çalışmayla ortaya konulan arteria occipitalis'e ait anatomik veriler kullanılarak cerrahların, arteria occipitalis temelli vasküler flepleri güvenli şekilde kaldırmaları, aynı zamanda kraniyal ve maksillofasiyal cerrahi yaklaşımlar sırasında arteri korumaları için büyük oranda katkı sağlanacağı düşüncesindeyiz.

Anahtar Kelimeler: Anatomi; flap cerrahisi; maksillofasiyal cerrahi; kraniyal cerrahi; mikrodiseksiyon

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Musculocutaneous and fasciocutaneous flaps from scalp, neck, suboccipital and deltoid regions are important for wide face defect reconstruction operations.[1,2] They are widely used in the

head and neck burns or trauma contracture, benign or malign tumor excision or radiotherapy related defect repairment, alopecia and cosmetic scar reconstruction operations.[2-6] There are a few and limited studies on the role of the occipital artery in flap operations. While some studies investigated the difference between effectiveness and function of the occipital artery flap surgery methods, others examined occipital artery for postoperative tissue viability and prevention of complications.[6,7]

Additionally, preservation of the occipital artery branches or understanding the anatomic characteristics of adjacent regions are important for postoperative survival of neurosurgical posterior fossa operations such as eosinophilic granuloma of the skull with dural invasion by elevating and moving flaps safely.[8] The occipital artery is essential for microsurgical posterior circulation bypass.[9] The artery is also used in patients who undergo intracranial to extracranial pedicle bypass anastomosis to the posterior circulation.[10,11] On the other hand, variations of the occipital artery should be realized for early and efficient surgery for vasculitis, occlusion, aneurysm and embryonic vascular anomalies.[12,13] Investigators have drawn attention to the inadequate anatomical features of the occipital artery and the presence of ambiguity.[14,15]

For this reason, we aimed to examine the origin, location, length, size, adjacent regions of the occipital artery, which have a major role in scalp circulation in flap surgery.

MATERIAL AND METHODS

Dissections of 14 (12 males, 2 females; age range 55 to 82 years; 28 cases) formalin fixed cadavers were performed under 4-fold magnification with a loupe. The measurements were taken by a fine micro caliper and were expressed in millimeters and centimeters. Meticulous micro dissections of the suboccipital region of each cadaver were carried out over the entire cranium and then island flap was elevated bilaterally. The common carotid vessels were identified in the neck. The occipital arteries were seen to arise from the external carotid artery (Figure 1A). The occipital arteries and their branches were displayed bilaterally in

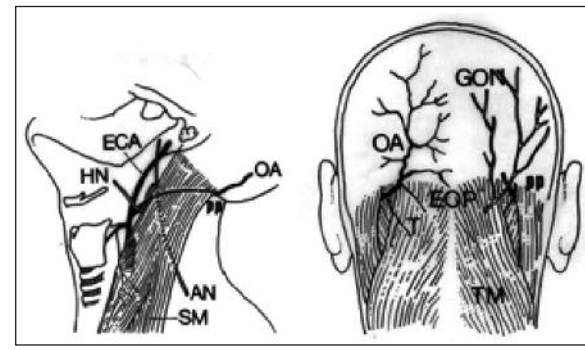

FIGURE 1A-B: Schematic appearance of the occipital artery tree (Lamberty and Cormack, 1994).
OA: Occipital artery, ECA: External carotid artery, HN: Hypoglossal nerve, AN: Accessory nerve, SM: Sternocleidomastoid muscle, GON: Greater occipital nerve, EOP: External occipital protuberance ,TM: Trapezius muscle, pp: Piercing point.

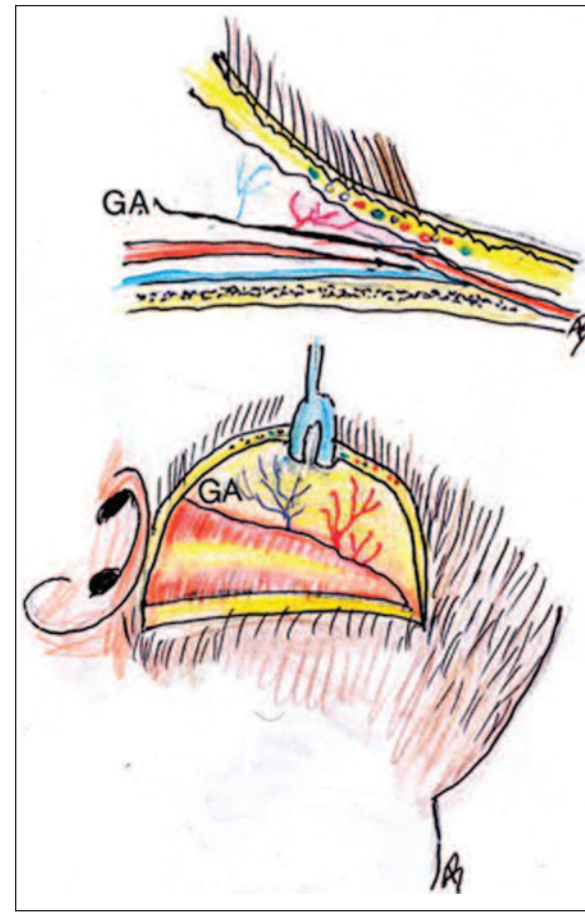

FIGURE 2: Flap design (Including occipital artery and vein).
GA: Galea aponeurotica.

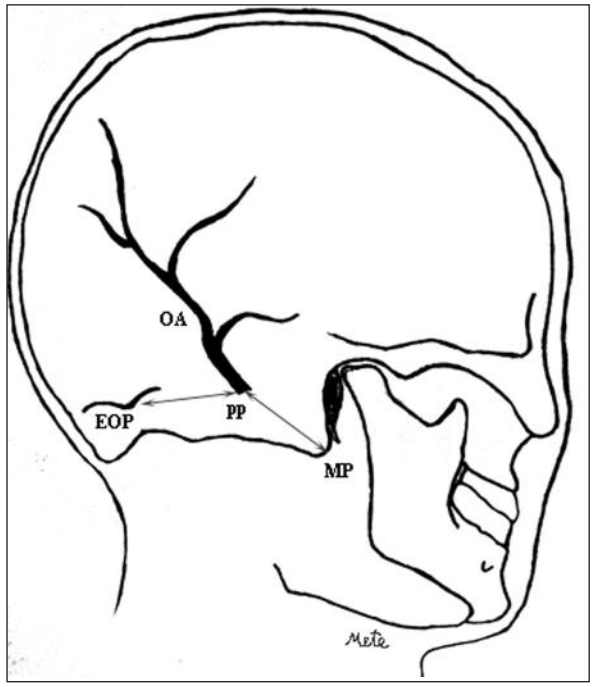

FIGURE 3: Schematic appearance of the piercing point of occipital artery.
EOP: External occipital protuberance, OA: Occipital artery, MP: Mastoid process, pp: Piercing point

each cadaver by performing tangential dissection of the hairy skin and the subcutaneous fat tissue (Figure 2).

The following parameters (Figure 1A-B, 3) regarding the occipital artery were evaluated: (1) the location (unilateral or bilateral); (2) the identification of types of the occipital artery according to the origin; (3) the diameter of the artery at its origin; (4) the length of the artery at its origin; (5) its course; (6) the distance between the origin of the artery and the mandible; (7) distance between the piercing point of the occipital artery in the sternocleidomastoid muscle and the external occipital protuberance; (8) distance between the piercing point of the occipital artery in the muscle and the mastoid process; (9) anastomoses of the occipital artery with the superficial temporal artery and (10) the posterior auricular artery; (11) the trapezius branch of the occipital artery; (12) the distan-

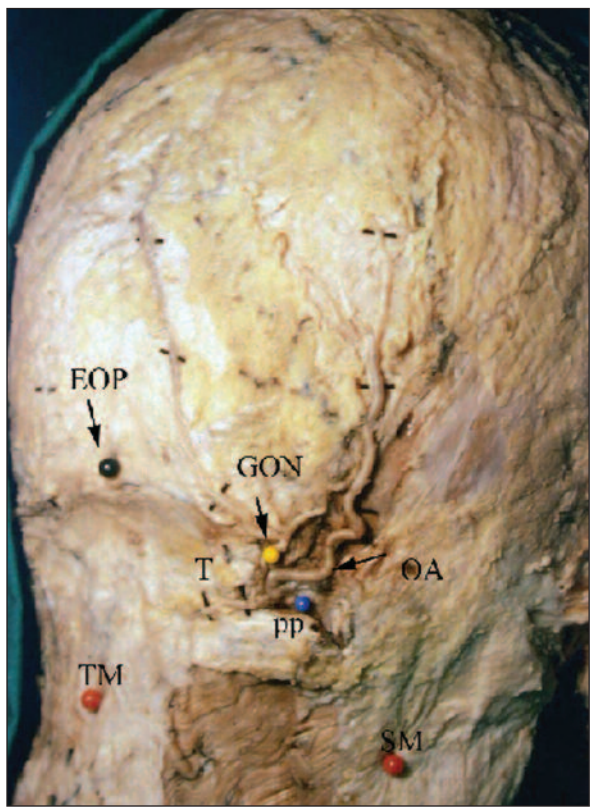

FIGURE 4: The relationship of occipital artery emerging from SM with the surrounding tissues is seen.
OA: Occipital artery, T: Trapezius branch, GON: Greater occipital nerve, TM: Trapezius muscle, SM: Sternocleidomastoid muscle, EOP: External occipital protuberance, pp: Piercing point.

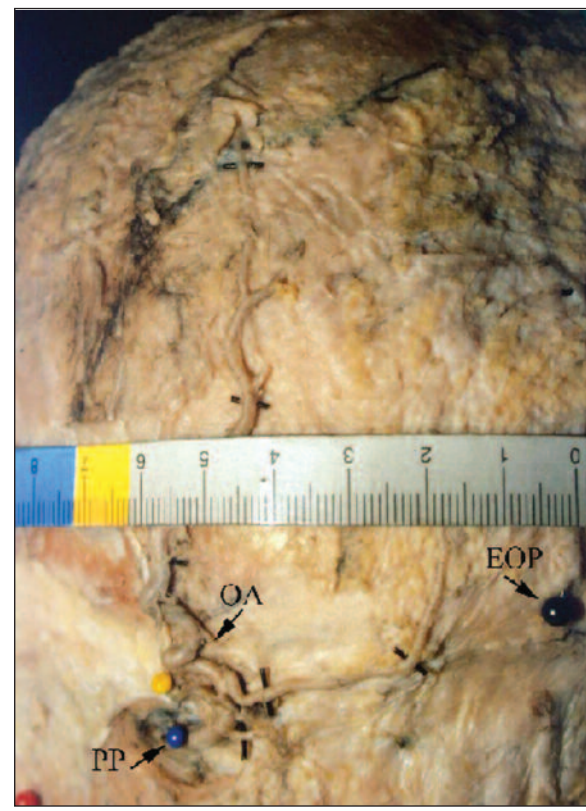

FIGURE 5: The distance between the piercing point of the occipital artery and the external occipital protuberance.
OA: Occipital artery, EOP: External occipital protuberance, pp: Piercing point.

ce between the artery piercing point of the trapezius muscle and the median size of the trapezius branches; (13) the relation of the artery with the hypoglossal nerve; (14) the greater occipital nerve; (15) the accessory nerve and (16) the sternocleidomastoid muscle.

RESULTS

The occipital artery was the main artery of the suboccipital region and had evidence in all cases. The examinations revealed that the artery originated directly from the external carotid artery in 25 cases (89%), and as a common trunk with the posterior auricular artery from the external carotid artery in 3 cases (11%).

According to the mandibular angle, the origin of the occipital artery was 5-22 mm (mean 13.4 mm) above in 8 (29%) cases, 4-32 mm (mean 17.6 mm) below in 16 (57%) cases and at the same level in 4 (14%) cases.

The occipital artery emerged from the posterior side in 22 (88%) cases, lateral side in 2 (8%) cases, and medial side in 1 (4%) case according to the location of the external carotid artery.

The mean size of the occipital artery was 1.9 mm (1.0-3.0 mm) and the mean length was 9.9 cm (3.4-12.5 cm). In the suboccipital region, the mean distance between the point of the occipital artery piercing the sternocleidomastoid muscle and the external occipital protuberance was 4.8 cm (3.9-6.5 cm) and the mean distance between the piercing point of the artery in the muscle and the lower part of the mastoid process was 5.1 cm (3.9-5.9 cm). In addition, the occipital artery emerged from the posterior side under the sternocleidomastoid muscle ended after mean1.8 cm (0.2-5.9 cm) (Figures 4, 5).

The occipital artery had anastomosis with the superficial temporal artery in 21 (75%) cases and the posterior auricular artery in 16 (57%) cases. The trapezius branch of the occipital artery was single in 18 (64%) cases and double in 10 (36%) cases. One branch was mean 1.5 cm (0.4-4.5 cm) and two branches were mean 1.4 cm (0.4-2.7 cm) far from the point of artery piercing the trapezius muscle. The mean size of the trapezius branch was measured 0.9 mm (0.6-1.1 mm) in one branch and 0.8 mm (0.4-0.9 mm) in 2 branches.

A relationship was present between the occipital artery and the hypoglossal nerve, proximal to the origination point of the artery in 14 (52%) cases, distal in 1 (4%) case and at the same level in 13 (44%) cases.

The distance between the point of the greater occipital nerve crossing the occipital artery and the external occipital protuberance was measured 4.8 cm (2.8-7.2 cm).

The distance between the occipital artery and the accessory nerve crossing the occipital artery at its origin was determined 2.7 cm (0.6-4.3 cm). In all cases, the occipital artery was covered by the sternocleidomastoid muscle. All other measurable data are listed in Table 1.

DISCUSSION

Since the occipital artery is a convenient and feasible nutrition supply for flap surgery, it is preferable in wide face and scalp defect reconstructions by maxillofacial and plastic surgeons.[6] For that reason it is important to know the anatomical features of the artery in detail for surgical success.

In our study, examinations revealed that the occipital artery originated from the external carotid artery in 98% of the cases, which is similar to normal anatomy.[16] The occipital artery is known to arise from the posterior side of the external carotid artery.[17] However, we found that the artery originated from the posterior in 88%, the lateral in 8%, and the medial in 4%.

The mean size of the artery was measured by quite a few authors.[16,18] In our study, the mean original size of the occipital artery was detected 1.9 mm, and its mean length was 9.9 mm. These results are similar to those of the other authors.

TABLE 1: Data list used in the evaluation of the occipital artery.

Parameters	Description	Mean mm	Minimum Mm	Maximum mm
1	Origin level (according to MA): Above	13.4	5	22
2	Origin level (according to MA): Below	17.6	4	32
3	Diameter (at origin)	1.9	1.0	3.0
4	Length	99	34	125
5	Distance between piercing point of sternocleidomastoid muscle and EOP	48	39	65
6	Distance between piercing point of sternocleidomastoid muscle and lower tip of MP	51	39	59
7	Distance of the artery emerged from sternocleidomastoid muscle	18	2	59
8	Distance between piercing point of trapezius muscle and 1 branch sample	15	4	45
9	Distance between piercing point of trapezius muscle and 2 branch sample	14	4	27
10	Mean size of r. trapezius in 1 branch	0.9	0.6	1.1
11	Mean size of r. trapezius in 1 branch	0.8	0.4	0.9
12	Distance of the OA junction and greater occipital nerve to EOP	48	28	72
13	Distance of the OA junction and AN to origin	27	6	43

MA: Mandibular angle, OA: Occipital artery, AN: Accessory nerve, EOP: External occipital protuberance, MP: Mastoid process.

Many vascular anastomoses between the occipital artery, the posterior auricular artery and the superficial temporal artery branches were shown by many investigations.[15,19-21] The finding in our study that the anastomoses ratio of the occipital artery with the superficial temporal artery and the posterior auricular artery was 75% and 57%, respectively seems to differ from the results of other studies. Considering our data together with the previous studies, we think that the flaps have been thought to be removed safely by their supplementary artery or anastomoses in order to increase postoperative survive.

Classically the occipital artery enters into the sternocleidomastoid muscle 1.5 to 2.0 cm to the anterior margin.[22] The point where the occipital artery enters the sternocleidomastoid muscle and then comes out to the surface up to 4.0 cm under the process is determined the reference point.[23] In our study, the artery emerged from a mean of 1.8 cm under the posterior side of the muscle. Thus, we measured the distance between the arteries coming out to the surface after piercing the muscle and the external occipital protuberance and the mastoid process to help surgeons and to determine quantitative criteria. The distances were 4.8 cm and 5.1 cm, respectively.

Studies report that the occipital artery gives the trapezius branch on the mastoid process level; the branch's piercing point of the muscle is at the beginning point of the superior nuchal line of the occipital bone. In upper trapezius musculocutaneous flap surgery, reference point determined to elevate flap borders is the superior nuchal line; it is important for flap viability to determine the arteries supplying the flap in detail and to preserve them during surgery.[23] For this reason in our study we also determined the trapezius branch of the occipital artery and the distance between the branch piercing point of the trapezius muscle and I and II branches. To help flap surgery we tried to determine the anatomical characteristics of the arteries.

Reports suggest that the greater occipital nerve crosses the occipital artery up to 4 cm lateral to the external occipital protuberance.[23] Schmidt et al suggested that the occipital artery biopsy should be performed between 4 to 5 cm lateral and 1 to 3 cm proximal side of the external occipital protuberance to avoid occipital artery damage in vasculitis.[21] In clinical trials to investigate headache etiology, anatomical relationship between the greater occipital nerve and artery course should be discussed together.[24] Surgery textbooks suggest

that flap supplying the occipital artery should be preserved carefully while elevating and removing the superior pedicle of the sternomastoid island flap.[20] The distance between the point which is the reference to the occipital protuberance and the nerve and the artery crossing point, is essential to preserve the occipital artery during operation. For this reason, we measured the distance between the point of the greater occipital nerve crossing the occipital artery and the external occipital protuberance.

The course of the occipital artery and the relationship between the artery and the hypoglossal nerve were investigated by many authors.[23,25] The hypoglossal nerve crosses the distal portion of the occipital artery at a rate of 20%.[26] There was a hook-like anatomical relation between the occipital artery and the hypoglossal nerve in all our cases. To determine the localization, the distance between the origin of the artery and the nerve and the hook-like relation was measured. The artery hooked above the origin, at the level of origin and below the origin in 52%, 44%, and 4%, respectively.

This study examined the origin, localization, length, size and adjacent region elationships of the occipital artery. We suggest that the results of this study will contribute to the surgical procedure anatomically, especially in cases with scalp and face defects, by providing easy anastomoses, normal anatomical reorganization and a safe operative period.

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