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Original Article

The intraorbital course of ophthalmic artery and its relationship with the optic nerve

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Necdet KOCABIYIK ✦
Fatih YAZAR
Hasan OZAN

Department of Anatomy, Gulhane Military Medical Academy, Ankara, TURKEY.

✦ Dr. Necdet Kocabiyik,
Department of Anatomy, Gulhane Military Medical Academy, Etlik Ankara, TURKEY.
☎ +90 (312) 304 3508
+90 (312) 304 2150
nkocabiyik@gata.edu.tr

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ABSTRACT

In this study, we aimed to investigate some features of the ophthalmic artery (OA), which supplies the internal structures of the orbit. We evaluated the origin, branches and the relationships of the OA with the optic nerve and carried out morphometric analyses.

Our study was conducted on 60 human orbits. We evaluated the OA divided into three parts. The first part of OA usually runs along the infero-lateral aspect of the optic nerve. The second part of the OA passed over the optic nerve in most of the specimens and under the optic nerve in the other specimens. The third part of the OA ran medial to the optic nerve. Diameter of the OA was 1.45 ± 0.23 mm on the right and 1.42 ± 0.3 mm on the left. Diameter of the optic nerve was 4.1 ± 0.57 mm on the right and 4.2 ± 0.63 mm on the left. The mean intra-orbital length of the central retinal artery was 8.2 ± 1.6 mm on the right and 8.5 ± 2.03 mm on the left. The topographical relationships of the OA should be clinically important in surgical approaches to the orbit. © **Neuroanatomy. 2009; 8: 36–38.**

Key words [ophthalmic artery] [central retinal artery] [optic nerve] [orbit]

Introduction

Most intraorbital structures are supplied by branches of the ophthalmic artery (OA) which is the first branch of the internal carotid artery after it exits from the cavernous sinus.

OA, proceeds in optic canal embedded in dura mater of the optic nerve [1]. Within OA's branches, there are pial vessels and central retinal artery, a main intraneural branch. In addition to these, there is a strong anastomosis networks between branches of external carotid artery and orbital arteries. The OA can be sacrificed during aneurysm clipping without loss of vision in many cases, most likely because of adequate collateral filling from the external carotid artery [2]. Therefore, while the obstruction of central retinal artery leads to a sudden blindness (amaurosus fugax), OA obstructions may be asymptomatic.

Optic nerve is 50 mm in length from its originating point at sclera to optic chiasm and it consists of four parts: 1) intraocular, 2) intracanalicular, 3) intraorbital and 4) intracranial. The intracranial part of the optic nerve is supplied by internal carotid artery, anterior cerebral artery, anterior communicating artery and OA. Transition of OA branches from dural sheaths enveloping the optic nerve and their entrance to the nerves are clinically important [3,4].

At the orbital surgery, awareness of the relationship ophthalmic artery with optic nerve may be important for reduce surgical damage. The course of OA is important because it indicates the relationship between the optic nerve and the surrounding structures from the topographic and morphometric viewpoints and reduces such complications mentioned above. For this reason, we evaluated the origin, branches and the relationship of the OA with the optic nerve. We made the morphometric analysis of these structures.

Material and Methods

This study was undertaken in intact eyes of 30 (17 male, 13 female) embalmed white-race Turkish adult cadavers whose age range from 33 to 74. After scalp and calvaria were removed, brain and its meninges were released and removed. Orbit's roof was removed by extracting lesser wing of sphenoid bone and anterior clinoid process. Periorbital layer was folded towards lateral side by extending from the point corresponding to upper edge of lateral rectus muscle, in front to the eyeball, behind the apex of orbit.

The OA was exposed and filled with latex at its point of origin. Afterwards, origin point of central retinal artery and its penetration point of the optic nerve were found. Diameters of the OA and optic nerve, intra-orbital length of the central retinal artery (distance between the origin point from OA to the penetration point of the optic nerve by the central retinal artery) were measured with a graduated caliper. Diameter of the OA and the optic nerve were measured at its origin point from internal

carotid artery and at its midpoint between the common tendineous ring and eyeball, respectively.

Data were analyzed with SPSS 10.0 (SPSS Inc., Chicago, IL, USA) software. Data were tested for normality (Graphical analysis, skewness and kurtosis analysis). According to normality tests results we used 'Paired samples t test' or 'Wilcoxon Signed Rank Test' for left side and right side parameter values. Mann-Whitney U test was used to compare male and female values. Relations among the parameters were investigated with Pearson coefficient of correlation. P values less than or equal to 0.05 were evaluated as statistically significant.

Results

We examined the intra-orbital course of the OA in three parts. The first part extends from the point of entrance of the OA into the orbit to the point where the artery bends to become the second part. The second part crosses over or under the optic nerve running in a medial direction from the infero-lateral to the supero-medial aspect of the nerve. The third part extends from the point at which the second part bends at the supero-medial aspect of the optic nerve to its termination.

The first part of the OA ran along the infero-lateral aspect of the optic nerve in 54 specimens.

In two specimens it ran forwards and upwards on the lateral side of the optic nerve. In four specimens it entered the orbit at the infero-medial aspect of the optic nerve. The second part of the OA passed over the optic nerve in most of the specimens and under the optic nerve in the other specimens. The third part of the OA ran forwards above the medial rectus and under the superior oblique muscle to reach the medial wall of the orbit.

The mean diameter of the OA was 1.45 ± 0.23 mm on the right and 1.42 ± 0.3 mm on the left. The mean diameter of the optic nerve was 4.1 ± 0.57 mm on the right and 4.2 ± 0.63 mm on the left. The difference between the right and the left side was statistically significant ($p < 0.002$).

Central retinal artery arose from the OA as the first branch in 93.3% of the cases. The mean intra-orbital length of the central retinal artery was 8.2 ± 1.6 mm on the right and 8.5 ± 2.03 mm on the left (Figure 1).

But, the difference between the right and the left side was no statistically significant. We observed that there was no significant difference in all of the parameters in the aspect of gender variable.

Discussion

Embryological development of vascular structures of the eyeball and the orbit is very gradual and complicated. Temporary vascular canals oriented towards the need of embryonic eyeball develop from internal carotid artery surrounding the optic vesicle. Dorsal and ventral primitive ophthalmic arteries bud from internal carotid artery and form a loose network surrounding the vesicle. Dorsal primitive OA forms true OA, while ventral primitive OA is almost completely regressed. Hyaloid artery, a branch of dorsal primitive OA, goes forward within the optic stalk. It gives off long posterior ciliary arteries, short posterior ciliary arteries and central retinal artery [5].

At the apex of the orbit the OA lay under the lateral (55 specimens), central (1 specimen) or medial (4 specimens) part of the optic nerve in 61 specimens [6]. The incidence of the OA passing in the orbit medially under the optic nerve was 18.6% [7]. The first part of OA starts at optic canal and ends at the place where it curves towards laterally. The second part is the division next to the optic nerve. The last part is localized on the medial wall of the orbit [1]. In our study, the first part of OA lay under the lateral (56 specimens) or medial (4 specimens) part of the optic nerve in 60 specimens. The second part ran closely round the optic nerve, but it was only loosely attached to the dural sheath. The third part was usually the only part of the OA, which showed marked tortuosity in the majority of our specimens.

Intra-orbital part of the OA usually shows curved course. Especially, this curve is more prominent near the dural sheat. It was described by Wybar that the intra-orbital part of the OA surrounds the optic nerve, lies free within the extra-orbital fat and slightly adheres to the optic nerve sheath [8]. In our study, the first part of the OA usually lay in very close relationship with the optic nerve, free in the fat of the orbit and attached to the nerve only by fat and very loose connective tissue.

Lang described the diameter of the OA (2 mm from the origin) 1.54 ± 0.04 mm (male) and 1.31 ± 0.05 mm (female) in seventy-one Caucasian orbits (36 right, 35 left). In their study, there were no significant differences in vessel diameter between the right and left sides. But, differences in vessel diameter between males and females were more commonly observed in the arteries which leave the orbit (extraorbital group), the individual vessels having a larger diameter in males [7]. In our study, the mean diameter of the OA was 1.45 ± 0.23 mm on the right and 1.42 ± 0.3 mm on the left. There was no significant difference in vessel diameter between males and females.

Wybar described central retinal artery as the first branch of the OA [8]. Sudakevitch reported that this artery most

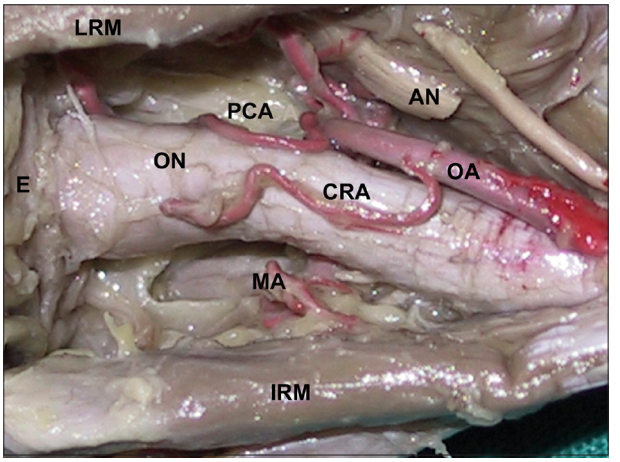

Figure 1. Course of the intra-orbital part of central retinal artery (left orbit-inferior aspect). *(**OA:** ophthalmic artery; **CRA:** central retinal artery; **ON:** optic nerve; **AN:** abducens nerve; **LRM:** lateral rectus muscle; **IRM:** inferior rectus muscle; **MA:** muscular arteries; **PCA:** posterior ciliary artery; **E:** eyeball)*

commonly originated from the first angulation point of the OA (57.69%), but he also stated that it could arise from any place in the first part of the OA and rarely from the distal part of the OA (22.12%) and even from the second part of the OA, though very rarely [9]. However, like the other researchers, we also did not encounter the last three origins that he had stated. Hayreh and Dass reported central retinal artery arose from the OA as first branch 77.45%, second branch 18.63% and third branch 3.92% [10]. In our study, central retinal artery arose from the OA as the first branch in 93.3% of the cases. This was consistent with the findings of Wybar and Sudakevitch [8,9].

The mean diameter of the optic nerve was 4 mm according to Williams et al, Snell and Lemp, Delashaw, and Duanne [11–14]. In our cases, the mean diameter of the optic nerve was 4.1 ± 0.57 mm on the right and 4.2 ± 0.63 mm on the left. The difference between the right and the left side was statistically significant. These values were consistent with literature [11].

Hayreh and Dass described the distance between the origination point of the central retinal artery from the OA and its penetration point to the nerve as intra-orbital part of the central retinal artery (10). But, he did not determine this value. In our study, this value was 8.2 ± 1.6 mm on the right and 8.5 ± 2.03 mm on the left.

Large or giant internal carotid artery-OA aneurysms can cause visual deficits, penetration and schism of the optic nerve [15].

To sum up, we believe that it is necessary for ophthalmologists and other physicians who are specialized in branches close to this field should know the origin, the course, branching and the topographic variations of the OA during their approach to orbit.

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