Angiosome territories of intracranial course of oculomotor nerve (III)

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Abstract

Introduction: Angiosome is depicted as a region of a nerve supplied by an artery. The concept of the angiosome was originated from the Plastic and Reconstructive surgical fields to enhance the knowledge regarding the vascular anatomy of human body.

Aim & objectives: To demonstrate Neurovascular supply of oculomotor nerve from brain stem till superior orbital fissure.

Material & methods: The study procured forty-five adult human brains and their base of the heads from the Department of anatomy, Mamata medical college, Khammam.

Results: The proximal part of the oculomotor nerve was supplied by the central branches of the Posterior Cerebral Artery, whereas the distal part was supplied by the cavernous part of the internal carotid artery.

Conclusion: Although functioning of peripheral nerves is influenced by their vascular supply, cessation of the arterial supply to any part of a nerve affects the passage of nerve impulses and will ultimately induce a complete nerve block. This anatomical study may help in reducing the post surgical morbidity rates after surgery.

Keywords: Angiosome, oculomotor nerve, posterior cerebral artery, internal carotid artery

Introduction

Angiosome word is represented as a vascular access of an artery in a particular area of a nerve. In 1987, Taylor and Palmer, in the plastic reconstructive surgical field introduced the word [1]. Angiosome which delineates the body into three-dimensional vascular territories supplied by a specific source of arteries and drained by specific veins[2]. The passage of nerve impulses is affected by cessation of arterial supply of any part of a nerve resulting in induction of a complete nerve block[3].

Furthermore, from an anatomical point of view, the cranial nerves lie freely in the cerebrospinal fluid throughout their length. Not surprisingly, they are only fixed at the exit point from brain stem and at the exit point of the skull with no surrounding tissue in close contact with cranial nerves, the direct vascularization of the vessels that supply lie in pia mater[4].

Embryology:

Cephalic continuation of anterior horn cells forms motor neurons called somatic efferent columns. With all the voluntary muscles in head region emerging from somitomeres 1 & 2 (preoccipital myotomes), the pattern of muscle formation in head region are directed by connective elements derived from the neural crest cells[5].

Microscopic structure of cranial nerves:

Schematically, cranial nerves lack epineurium and perineurium unlike somatic nerves. They are enveloped in a single or double layer of flattened cells. Collagen content is much less than that of peripheral nerves. Moreover, there is no microscopical fascicular organization nor inter fascicular connective tissue that separate fibers into branches[6]. Arterial supply for lower limb nerves were attempted by several authors but very few studies were there on cranial nerves. In our study we attempted arterial supply of oculomotor nerve by dissection and microscopic structure.

Aim & Objectives:

To illustrate the arterial supply of different segment of oculomotor nerve by dissection & histological methods.

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Material & Methods:

The present work was carried out in accordance with the institutional ethical committee of Mamata medical college, Khammam and the material for this study comprises of human cadaveric head & neck specimens collected for teaching purpose of undergraduate and postgraduate students .

Duration: Three years

1. Dissection Method-45 brains were used
2. Histological Method

Dissection Method: To begin with, the skull cap was removed by an incision from nasion to inion & circular incision from one pinna to opposite pinna, along the superior orbital margi. Subsequently, after exposing meninges, the right half of cerebral hemisphere was enhanced by detaching the falx cerebri from crista galli to internal occipital protuberance.

- Oculomotor nerve: -Fronto-temporal lobectomy was done at base of the brain to conceal the proximal part oculomotor nerve with capillaries at level of posterior perforated substance.
- Further exposure can be obtained by drilling the anterior clinoid process, dorsum selle for tracing the distal part of oculomotor nerve with in the cavernous sinus.
- All the above-mentioned events were captured with a digital camera

Histology Method

- Collection of nerve samples along with capillaries were fixed in 10% buffered formalin solution and the obtained samples were processed for histological study. The slides were observed under the student advance research microscope, to measure the length of capillary.
- Chi-square test was applied to variables.

Results

Gross study: Precise dissections were carried out on 45 cadavers (90 specimens including right, left sides). Arterial supply of oculomotor nerves was observed and results were tabulated.

Table.No.1. Arterial supply of different segments of oculomotor nerves

No. of specimens	Cisternal segment	Cavernous segment	Orbital segment
Right-45	35 specimens only –PCA 1 specimen-PCA + PCOA 5 specimens –PCA + SCA 1 specimen- plexus formed by PCA + SCA + PCOA + ICA 1specimen-Intracranial part of ICA	25 specimens- ICA 5 specimens - ILT	39 specimens - OA
Left-45	31 specimens only- PCA 1 specimen- PCA + PCOA 1 specimen-plexus formed by PCA + SCA + PCOA + ICA	24 specimens -.ICA 5 specimens - ILT	37 specimens - OA

PCA-Posterior cerebral artery; PCoA -Posterior communicating artery; SCA-Superior cerebellar artery, ICA-Internal carotid artery; ILT- Infero lateral trunk; OA -Opthalmic artery

In present study, cisternal segment was supplied by branches of posterior cerebral artery in 35 specimens on right side while 31 specimens on left side. In addition to PCA, branches of posterior communicating artery supplied on the right side in one specimen, while on the left side in another specimen. SCA supplied 5 specimens on the right side. It was observed that the capillary plexus formed by PCA, SCA, PCOA, ICA supplied one specimen on each side. One specimen was supplied by the intracranial part of the internal carotid artery on the right side as shown in table. No.1and figure. No.1

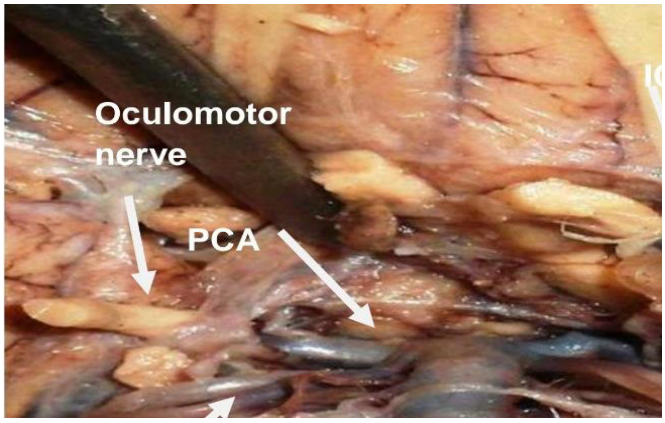

Fig.no.1. The proximal part of the oculomotor nerve is supplied by P1 segment of posterior cerebral artery (PCA)

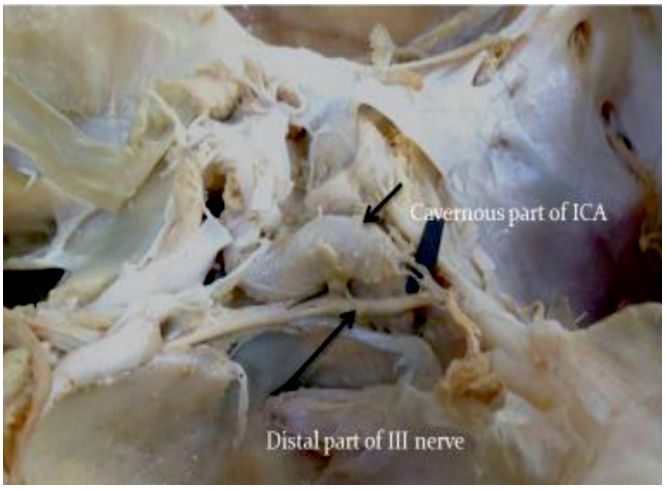

Figure.no.2 Cavernous part of the internal carotid artery supplies the distal part of the oculomotor nerve

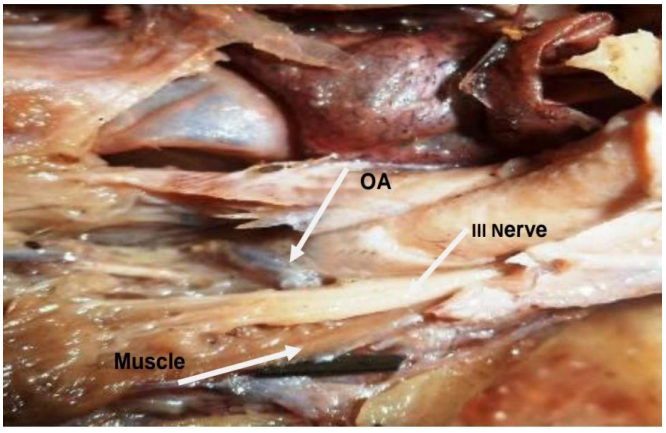

Fig.no.3 Orbital segment of oculomotor nerve with ophthalmic artery

Table.No.2 Microscopic study of capillaries oculomotor nerve

Segments	Average longitudinal measurement	Average transverse measurement
Cisternal segment	695.43µm	215.4 µm
Cavernous segment	363.20 µm	153.18 µm
Orbital segment	69.14 µm	24.56 µm

Proximal (cisternal) segment: - Length of capillary section varies from 616.14µm to 763.11 µm with a mean of 695.43µm. The width of the capillary section varies from 229.12 µm to182.10 µm with a mean of 215.4 µm.

Cavernous segment: - The length of the` lumen of capillary varies from 352.11 µm to 369.04 µm with a mean of 362.20 µm, width of lumen of capillary varies from 151.02 µm to 159.12 µm with a mean of 153.18

Orbital segment: - The length of capillary lumen varies from 62.14 µm to75.55 µm with an average of 69.14 µm. The width of capillary lumen varies from 21.01 µm to 27.40 µm with an average of 24.56 µm.

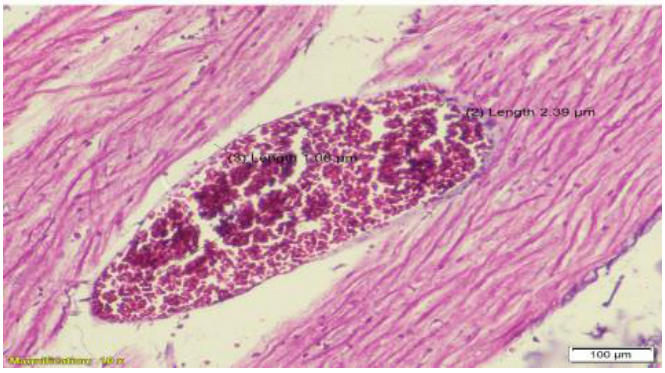

Fig.no.4 Longitudinal section of proximal part of oculomotor nerve with capillary , Observe the compact bundle of nerve fibres

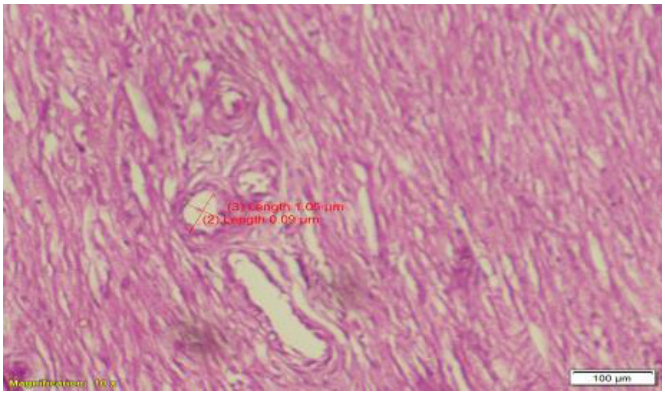

Fig.no.5 Longitudinal section of cavernous part of oculomotor nerve with capillary, observe the individual nerve fibres

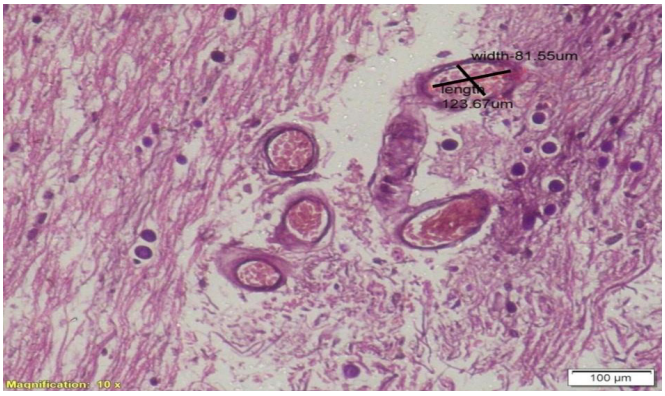

Fig.no.6 Showing ciliary ganglion and orbital segment of oculomotor nerve fibres with capillary

Table.no.3: The association between arterial supply of different segments of oculomotor (III) nerve

Oculomotor nerve	Traced	Not Traced	Total	P-value
Proximal segment	76	14	90	0.002
Cisternal segment	59	31	90	
Orbital segment	76	14	90	
Total	211	59	270	

There is significant association between arterial supply of different segments of oculomotor (III) nerve

Discussion

According to Mark chill 1996, the proximal part of intracranial oculomotor nerve received extra neural nutrient arterioles from thalamo perforating arteries which are branches of posterior cerebral artery[7]. MC Connell in 1958 instigated that relationship between the arterial supply to the pituitary gland and intra cavernous oculomotor nerve, were supplied by branches of inferior hypophyseal arteries, one of the three branches of the meningo hypophyseal trunk[8]. Pedroza (1969) outlined that in 71% of specimens dissected non-specific perforating vessels vascularised the proximal part of the intracranial oculomotor nerve[9].

In the present study, proximal part of the oculomotor nerve is supplied by central branches of the posterior cerebral artery whereas the distal part is supplied by the cavernous part of the internal carotid artery.

Krisht described that the oculomotor nerve gets its arterial supply from the tentorial branch of the intra cavernous part of ICA (or) branches coming from inferolateral trunk[10]. Our findings are similar to the above author where intra cavernous part of ICA gave tentorial branch, which supplied oculomotor nerve and also branches arise from ILT.

Practical implementation was made by Aysun.et.al to evaluate and to establish the relationship of the posterior cerebral artery and its branches by carrying out research on 15 cadavers[11]. Subsequently, they observed that the oculomotor nerve was perforated by various arteries in different portions. These arteries were the thalamo perforating arteries in 10% of the hemispheres, collicular arteries in 16% and the short circumferential arteries in 11%. It was then concluded that the dorsal portion of the cisternal segment of the oculomotor nerve has a close relationship with the branches arising from the P_1 and P_2 segments of the posterior cerebral artery which renders supply to the cisternal segment of the oculomotor nerve.

In present study, out of 90 specimens thalamo perforating branches were observed in 76 specimens. However, collicular and short circumferential arteries were not observed. Consequently, Erdogmus et.al emphasized the arterial supply of extra ocular muscles on its significance for orbital approach in 19 human male orbits[12]. In all the cases, ophthalmic artery supplied blood to muscles via its branches. They are inferolateral muscular trunk (43.36%), Infero medial muscular trunk (84.5%), lacrimal artery (89.47%), artery of superior orbital fissure (36.84%) and the distal end of ophthalmic artery (62.4%).

In the current study, comprehensive analysis of the branching pattern of the ophthalmic artery was not done, However, all the muscles received arterial supply from various branches of the ophthalmic artery in 69 specimens.

Conti. et. a demonstrated inferolateral trunk and meningo hypophyseal trunk from intra cavernous part of ICA[13]. In their study, artery of superior orbital fissure originated more often from inferolateral trunk and supplied III, IV and VI and ophthalmic division of trigeminal at their entry in fissure. In the present study, cavernous segment of oculomotor nerve received branches from inferolateral trunk in 10 specimens and cavernous part of ICA in 49 specimens. The artery of superior orbital fissure could not be traced in our study.

Ring like nerve fibres with myelinated axons were observed by Melling.et.al in their study on oculomotor nerve through atomic force microscopy (AFM)[14]. In current study, sections of 30 oculomotor nerves were extracted from all three different segments. The Cisternal segment and cavernous segment along with arteries and orbital segment along with muscle, arterioles supplying the nerve were taken. All the segments nerve fibres with capillaries and arterioles were identified. Intra neural capillary plexus was also observed.

Conclusion:

This study provides an insight for interventional radiologists, neuro-ophthalmologists for performing safer incisions techniques. Furthermore, the vascular supply is influenced by the functioning of peripheral nerves. Eventually, the post-surgery morbidity rates may be significantly reduced and optimal healing is achieved by this anatomical study. Therefore, extensive knowledge of the macroscopical and microscopical anatomy of the oculomotor nerve is indispensable and mandatory to prevent postoperative complications for clinicians in during surgical procedures.

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