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Original Article

MICROSURGICAL ANATOMY OF SUPRACLINOID ICA IN NORTH WEST INDIAN POPULATION: A CADAVERIC STUDY

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ABSTRACT

Background: To study the microsurgical anatomy of supraclinoid ICA, the size and number of perforators, any anomalies in normal anatomy of ICA, its branches and surrounding structures in North West Indian population.

Materials and Methods: Twenty cadaveric brain dissections were performed under operating microscope (Carl ZeissNC31). Sylvian fissure was meticulously dissected from distal to proximal. Anterior clinoid process (ACP) was drilled intradurally using M-80 pneumatic drill. Vessels, their branches and perforators were dissected with measurement of their length, diameter and number. Supraclinoid ICA was dissected till its bifurcation into anterior and middle cerebral arteries. The length of falciform ligament was also measured.

Results: The length of ophthalmic segment was largest varying from 5.5 to 13.0 mm (average 9.75mm).The communicating segment was the shortest varying from 1.5 to 6.0 mm (average 3.2mm). The number of perforating arteries excluding the OphA, PComA and AChA arising from C4 varied from 3-10(average 6). The maximum perforators were from Cho Seg and least from Com Seg.

Conclusion: The overall anatomical details of supraclinoid ICA in North West Indian population were comparable to existing literature.

KEY WORDS: Internal Carotid Artery, Middle Cerebral Artery, Posterior Communicating Artery, Microsurgical Anatomy, North West Indians.

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INTRODUCTION

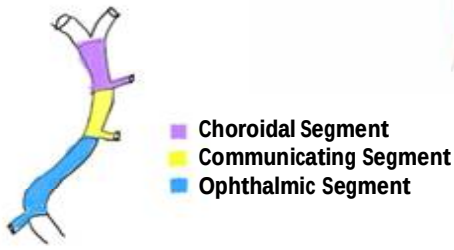
Anterior clinoid process (ACP) is a bony structure of paramount interest situated at the junction of anterior and middle cranial fossa. Internal carotid artery (ICA) and Optic Nerve (ON) run in close proximity to Anterior clinoid process (ACP). ICA runs on the under surface of ACP directed postero laterally before finally dividing between Anterior cerebral artery (ACA) and Middle cerebral artery (MCA). In different classification systems, supraclinoid ICA has been numbered differently. Supraclinoid ICA (C4) has several anatomical variation including origin of Ophthalmic Artery (OphA), superior hypophyseal artery, Posterior communicating artery (PComA) and Anterior choroidal artery (AChA). Since time immemorial, cadaveric dissection has been of

great importance for evaluation of normal anatomy and anatomical variations in different populations [1]. This study was done to evaluate pertinent anatomy of supraclinoid ICA in north-west Indian population.

Anatomy of Supraclinoid ICA (C4 segment): The ICA has been assigned several nomenclature that divides it into several segments by different authors. The first classification was published by Fischer [2] in a seminal paper in 1938, designating intracranial ICA from C1-C5. The segments were based on angiographic course of intracranial ICA rather than its anatomical compartments. Its aim was to help localize skull base lesions via their mass effect on different ICA segments. It was not designed to describe ICA aneurysms. So in 1981, Gibo, Lenkey and Rhoton [3], based on incredible supracliniod ICA dissections classified it into 4 segments — cervical, petrous, cavernous, and supraclinoid, with an alphanumeric designation of C1 through C4, in direction of blood flow. The C4 segment is subdivided into ophthalmic, communicating, and choroidal. Bouthillier [4] and colleagues proposed a "Modified Fischer Classification" in 1996. They divided ICA into seven segments in direction of blood flow. This system is based on careful microsurgical dissections and optimized for present-day aneurysm clipping.

In this study, we have followed the system described by Rhoton et.al. [7] The C4 portion of the ICA was divided into three segments based on the site of origin of the OphA, PComA, and AChA (Fig 1). The ophthalmic segment extends from the origin of ophthalmic artery to PComA. The communicating segment is the length of ICA in between origin of PComA and origin of AChA; while choroidal segment from the origin of AChA to the terminal bifurcation of the ICA.

Fig. 1: Diagram showing segments of C-$_4$ portion.



MATERIALS AND METHODS

The region of C4 segment of ICA and ACP were examined in 20 specimens obtained from 10 formalin fixed human cadaveric heads. All dissections were performed under magnification(x3 to x40) with operating microscope (Carl Zeiss, NC31). On each side, sylvian fissure was dissected from distal to proximal followed by intradural drilling of ACP. OphA was traced to ascertain its location in relation to distal dural ring. The supraclinoid ICA was dissected in its whole length from origin of OphA to its division into ACA and MCA. Vessels, their branches and perforators were dissected and their length, diameter and number recorded by using scale/ vernier calliper.

RESULTS

The Oph Seg was the longest, and the Com Seg was the shortest. While the length of the Oph Seg varied from 5.5 to 13.0 mm (average 9.75 mm) that of Com Seg varied from 1.5 to 6.0 mm (average 3.2 mm). Cho Seg measured from 2.5 to 10.0 mm (average 5.8 mm). The length, diameter of vessels and number of perforators arising from these vessels are shown in Tables 1, 3 and 5 respectively.

Ophthalmic Segment (Oph Seg): The number of perforating arteries arising from this segment ranged from 1-5 (average 3) as shown in Table 1.Of the perforating arteries found in 20 hemispheres, 40% arose from the posterior aspect of the C4 portion, 40% arose from the posteromedial aspect and 20% arose from the medial aspect (Fig 2). The arteries that arose from this segment and passed to the infundibulum of the pituitary gland are called the "superior hypophyseal arteries (Fig 3).

Fig. 2: Arrow showing perforators from Ophthalmic segment.

Fig. 3: Arrow showing Superior hypophyseal artery.

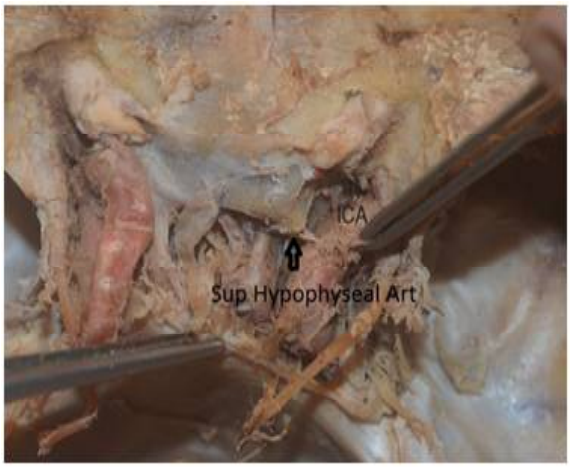


Table 1: Comparison of diameter, length and perforators of Ophthalmic Segment.

	Diameter (mm)	Length (mm)	No. of perforators	Diameter of perforators (mm) Avg
Left side	5.2 (3-5.5)	10 (8-13)	2.7 (1-5)	0.1-1 (0.2)
Right side	5.0 (3-5.0)	9.5 (5.5-12)	3.1 (0-5)	0.1-1 (0.2)
Both sides	5.1 (3-5.5)	9.75 (5.5-13)	2.9 (0-5)	0.1-1 (0.2)

Ophthalmic Artery(OphA): The OphA arose from the medial one-third of the superior surface of the C4 portion immediately adjacent to the cavernous sinus in the area below the optic nerve and medial to ACP. In this study,the Oph arteries except in two hemispheres arose from the C4 portion, outside the cavernous sinus. It arose above the medial one-third of the superior surface of the C4 portion in 80% of hemispheres and in the remaining 20% from the middle one-third of the superior surface (Fig 4). It arose 5-7 mm medial to the ACP. The average length of OphA was 4.1mm (range 3-7mm). Its average diameter was 0.93 mm (range 0.6-1.5mm) [Table 2].

Fig. 4: Arrow showing origin of Ophthalmic artery.

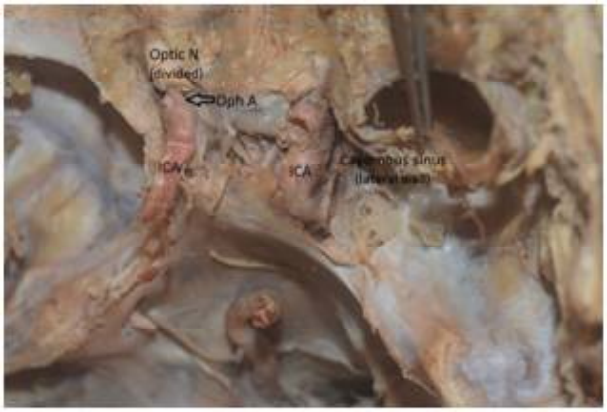


Table 2: Comparison of length & diameter of Ophthalmic Artery.

	Length (mm)	Diameter (mm)
Right side	4.1 (3-6)	0.93 (0.6-1.5)
Left side	4.1 (3-7)	0.93 (0.6-1.5)
Both sides	4.1 (3-7)	0.93 (0.6-1.5)

Communicating Segment (Com Seg): No perforating branches arose from this segment in 70% of hemispheres. One perforating branch arose from this segment in 25% of hemispheres, and two arose in 5%.These branches arose from the posterior aspect and terminated in the optic tract, the optic chiasm and the floor of the third ventricle.

Table 3: Comparison of diameter, length and perforators of Communicating Segment.

	Diameter (mm)	Length (mm)	No. of perforators	Diameter of perforators (mm) (Avg)
Left side	4.38 (2.5-5)	3.4 (2.5-6.0)	1	0.1
Right side	4.5 (2.5-5.5)	3.1 (1.5-4.5)	1	0.2
Both sides	4.4 (2.5-5.5)	3.25 (1.5-6.0)	1	0.1

Posterior Communicating Artery (PComA): The PComA arose from the posteromedial aspect of the C4 portion in 40% of hemispheres, from the posterior surface in 35%, from the posterolateral surface in 20% (Fig 5), and from the medial surface in 5%. Its length ranged from 1.5 to 6.0 mm (average 3.2mm) and diameter from 2.5 to 5.5mm (average 4.4mm) [Table 3]. Its diameter varied from 0.5 to 1.4 mm (average 0.8 mm) and its length ranged from 4.0 to 12.0 mm (average 8.2 mm) as shown in Table 4.

Fig. 5: Postero lateral origin of PComA.

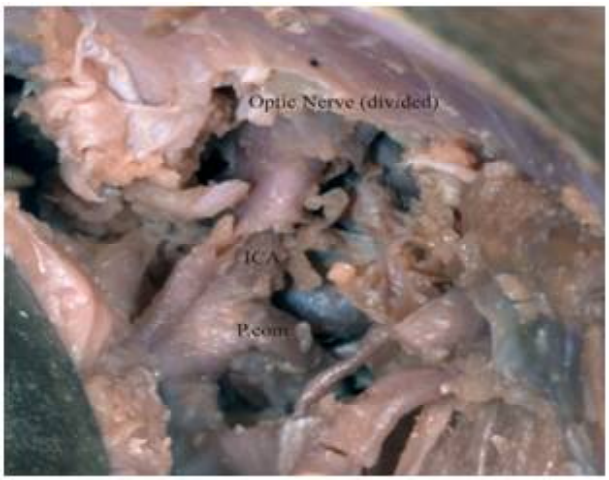
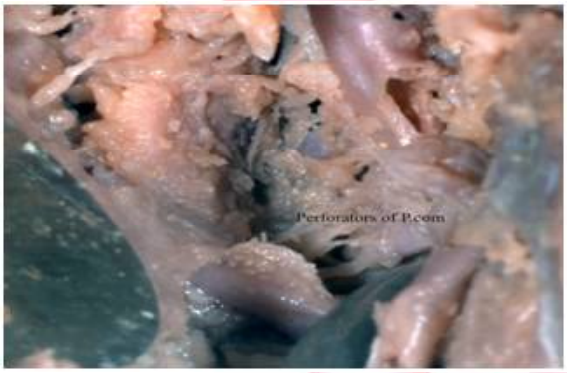


Table 4: Comparison of length & diameter of Posterior Communicating Artery.

	Length (mm)	Diameter (mm)
Right side	8.1 (5-12)	0.9 (0.5-1.4)
Left side	8 (4-12)	0.7 (0.6-1.0)
Both sides	8 (4-12)	0.85 (0.5-1.4)

The number of perforating arteries arising from the PComA ranged from two to six (average 4.3) (Fig 6). The perforator details are also shown in the Table 3. These branches coursed superiorly and terminated usually in the premamillary part of the floor of the third ventricle, the posterior perforated substance and optic chiasm. The largest branch that arose from the PComA and entered the floor of the third ventricle in front of or beside the mamillary body has been named either the "premamillary" or "anterior thalamoperforating" artery.

Fig. 6: Showing perforators arising from PcomA.



Choroidal Segment (Cho Seg): The Cho Seg was the most frequent site of perforating branches (Fig 7). The length of Cho Seg varied from 2.5-10 mm (average 5.8 mm) with mean diameter of 4.3 mm as shown in Table 5. The number of perforating branches varied from one to six (average four) (Fig 7). 70% of these perforating branches arose from the posterior aspect, 20% from the posteromedial surface and 10% arose from the posterolateral surface.

Fig. 7: Multiple perforators arising from Choroidal segment.

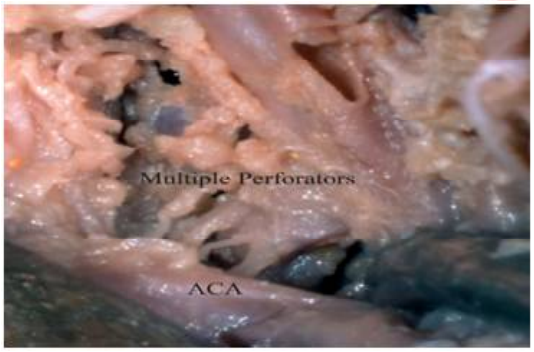


Table 5: Comparison of diameter, length and perforators of Choroidal Segment.

	Diameter (mm)	Length (mm)	No. of perforators	Diameter of perforators (mm) Avg
Left side	4.36 (2.5-5)	6 (3-10)	4 (1-5)	0.1-1 (0.2)
Right side	4.40 (2-5)	5.6 (2.5-9)	4.5 (1-6)	0.1-1 (0.2)
Both sides	4.38 (2-5)	5.8 (2.5-10)	4.25 (1-6)	0.1-1 (0.2)

Anterior Choroidal Artery (AChA): The origin was located between 2.5 and 10.0 mm (average 5.8 mm) proximal to the terminal bifurcation of the ICA (Table 5). The site of origin was on the posterolateral aspect in 60% of hemispheres, on the posterior aspect in 30%, and on the lateral side in 10% (Fig 13). The diameter of the AChA varied from 0.4 to 1.2 mm (average 0.75 mm) and length from 3 to 6.5 mm (average 4.2 mm) as shown in Table 6.

Table 6: Comparison of length & diameter of Anterior Choroidal Artery.

	Length (mm)	Diameter (mm)
Right side	4.3 (3.0-6.0)	0.8 (0.4-1.2)
Left side	4.2 (3-6.5)	0.7 (0.4-1.2)
Both sides	4.25 (3-6.5)	0.75 (0.4-1.2)

Falciform ligament: It is a dural fold extending from the base of the clinoid process over the roof of optic canal to the planum sphenoidale. The falciform ligament measured from 1 to 6mm (average 3mm) in our study. Incising the falciform ligament enables in exposure of OphA [5].

DISCUSSION

The C4 segment of the ICA and its major and perforating branches are frequently exposed in operations on tumors of the sphenoid ridge, anterior and middle cranial fossa, and the suprasellar region. The perforating branches from the C4 (Oph) segment arise from the medial wall of the C4 segment and are commonly stretched over the dome of sellar tumors. The perforating branches from the communicating and choroidal segments [6] arise from the posterior wall of the C4 portion and are frequently stretched around tumors arising behind C4 in the parasellar region or along the sphenoid ridge.

The OphA, the first C4 branch, is difficult to expose because of its short intradural length and

its location under the ON. It usually arises from the medial third of the superior surface of the Oph Seg under the ON and commonly enters the optic foramen within 1 to 2 mm of its origin [7]. The origin may be as far as 1 cm medial to the ACP. The exposure of the OphA is facilitated by removing the ACP and incising the falciform process. In this study, the OphA arose 5-7mm medial to the ACP which is comparable with the existing literature.

The PComA is better seen through opticocarotid triangle, a triangular space between the ON, the ICA and ACA than in the space posterior to the C4 portion (C4 and the oculomotor nerve). The perforating branches arising from the C4 portion, and may be an obstacle to the operative approaches through the space between C4 and the ON [7,8]. Opening the medial part of the Sylvian fissure below the anterior perforated substance facilitates the exposure of the choroidal segment. In our study, the number of perforators arising from the Oph Seg ranged from 1-5 (average 3) arising mostly from posterior or posterom edial aspect. The Cho Seg perforators ranged from 1-6 (average 4) arising predominantly from posterior aspect.

Carotico-Oph aneurysms usually have their neck on the superior wall of the C4 portion just distal to the origin of the OphA [9,10]. Exposure of the neck of this aneurysm is facilitated by the removal of the ACP, by incising the falciform process of the dura to allow mobilization of the optic nerve. This fact has been further validated in a morphometric analysis by Andaluz et al [11].The perforating branches of the Oph Seg arise from the medial and posterior side of the C4 portion.

SUMMARY AND CONCLUSION

The ophthalmic segment was the longest varying from 5.5 to 13mm (average 9.75mm) while the communicating segment was the shortest varying from 1.5 to 6.0mm (average 3.2mm). There was no statistically significant difference in the diameter and length of various segments of supraclinoid ICA on either side. An average number of perforating arteries which arose from C4 (excluding the OphA, PCom A and AChA)was 6 (range 3-10). The least number of perforators were from communicating segment and maximum were from choroidal segment. The falciform process (extending medially from the ACP) measured from 1 to 6mm (average 3mm). The ophthalmic artery arose from superior surface of ICA about 5-7mm medial to ACP which is comparable with existing literature.

The overall anatomical details of supraclinoid ICA i.e., the length and diameter of various segments and the details of their perforators were measured in North West Indian population. These were found comparable to existing literature.

ABBREVIATIONS

ICA- Internal carotid artery
ACA- Anterior cerebral artery
MCA- Middle cerebral artery
PComA- Posterior communicating artery
AChA- Anterior choroidal artery
ACP- Anterior clinoid process

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Conflicts of Interests: None

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