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Review Article

Microsurgical Anatomy of the Cavernous Sinus: A Neurosurgical Perspective

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ABSTRACT

Background: The cavernous sinus (CS) is a complex anatomical structure that poses significant challenges to neurosurgeons performing surgical interventions in this region. A comprehensive understanding of the anatomy of the CS, including its relevant landmarks and structures, is crucial for successful surgical outcomes.

Objective: This review aimed to provide a comprehensive overview of the anatomy of the CS, including relevant anatomical landmarks and structures, as well as surgical approaches for neurosurgeons.

Methods: A literature search was conducted in electronic databases, including PubMed, Embase, and Scopus, using the keywords "cavernous sinus," "neuroanatomy," and "neurosurgery." Inclusion criteria included all articles published in the English language. Two independent reviewers screened the titles and abstracts, and relevant data was extracted from the included articles and synthesized for narrative synthesis.

Results: A thorough comprehension of the eleven triangles in the parasellar region, medial fossa, and paraclival region is imperative for neurosurgeons to navigate complex anatomical structures during surgical approaches to the CS. These structures' anatomical relationships and spatial organization were summarized, along with an overview of relevant surgical approaches.

Conclusion: The anatomy of the CS is complex and requires a thorough comprehension of the relevant anatomical landmarks and structures and surgical approaches. Neurosurgeons must comprehensively understand the eleven triangles in the parasellar region, medial fossa, and paraclival region to navigate the complex anatomical structures during surgical interventions effectively. This knowledge can enhance surgical precision and reduce the risk of complications, ultimately improving patient outcomes.

KEY WORDS: Microsurgical Anatomy, Cavernous Sinus, Neurosurgical, Surgical Interventions.

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INTRODUCTION

According to Fukushima and Dolenc [1,3], the cavernous sinus (CS) is a truncated cone-shaped space located on both sides of the sella turcica, where the anterior fossa, middle fossa, sphenoid, and petroclival border converge. The contents of the CS are enclosed within a membranous structure that, in its inferior and medial aspect, is composed of periosteum contiguous with the periosteal hard layer lining the middle fossa and sella turcica. The superior and lateral portion of this "external cavernous membrane" is continued by the connective tissue sheaths of cranial nerves III, IV, and V1, which form the outer boundary of the CS and lie within it [4].

Inside the CS is a dense venous plexus that connects the ophthalmic veins, the pterygoid plexus, the superior and inferior petrosal plexus, the basilar venous plexus, and the middle and inferior cerebral veins [4]. The internal carotid artery, its branches, and its sympathetic nerve plexus pass through the CS, as does the VI cranial nerve on its way to the superior orbital fissure, inferior to the ophthalmic division of the V cranial nerve. These structures are contained within connective tissue sheaths that envelop them and connect with the external cavernous membrane, mainly in its inferior aspect [5].

The CS can be divided into three venous spaces (figure 1): the medial compartment, which is the space between the internal carotid artery and the sella turcica; the anteroinferior compartment, which is the space anterior to the internal carotid within the space created by the posterior knee of the artery; and the posterosuperior compartment, which is bounded by the internal carotid and the posterior portion of the roof of the CS. The VI cranial nerve crosses the floor of this space to cross the internal carotid artery [6].

It is crucial for the neurosurgeon to understand the multiple routes of entry to the region, which were gathered in a single geometric construction by Fukushima in 1988 [7]. Fukushima and Dolenc took up the original work of Parkinson and Ramsay in 1963, describing 9 triangles of the middle fossa limited by bony structures, dural folds, vascular structures, cranial nerves, and imaginary lines [8]. Through these triangles, a safe approach to the CS can be achieved. One of these triangles has been further subdivided into bony and tentorial portions. These eleven triangles have been grouped into three subregions: parasellar, middle cranial fossa, and paraclival.

Conceptually, the two-dimensional triangles can be expanded into three-dimensional spatial figures to form a series of eleven tetrahedrons, each containing specific structures (6). However, for the sake of simplicity, the term “triangle” will be retained throughout this review to include the three-dimensional extent of each triangle.

This study aims to provide an overview of the most clinically important triangles present in and around the CS, to enhance the neurosurgeon’s knowledge of the neurosurgical anatomy of the CS.

METHODS

Literature search: A comprehensive literature search was conducted to identify all relevant articles on the anatomy of the CS. Electronic databases, including PubMed, Embase, and Scopus, were searched without time restrictions. The following keywords were used: cavernous sinus, neuroanatomy, and neurosurgery.

Inclusion criteria: All articles published in English were considered for inclusion in this review.

Study selection: Two independent reviewers screened the titles and abstracts of all articles identified by the literature search. Full-text articles were retrieved for further evaluation if they met the inclusion criteria or if there was uncertainty about their eligibility.

Data extraction: The relevant data about anatomical landmarks and findings related to the anatomy of the CS were extracted from the included articles. This extracted data was subsequently organized and synthesized to facilitate a comprehensive review of the current literature.

Data analysis: A narrative synthesis was performed to summarize the findings of the included studies. The synthesis involved a descriptive analysis of the anatomical landmarks and structures relevant to the CS and an overview of the relevant surgical approaches.

RESULTS AND DISCUSSION

Paraselar subregion

Anterolateral medial triangle: The anterolateral medial triangle is a well-defined anatomical area that was first described by Dolenc [4]. It is delimited by three structures: the lateral border of the intra-canalicular optic nerve, the medial border of the dura of the superior orbital fissure, and the external or tertiary membranous ring, which is formed by two dural folds. The lateral dural fold corresponds to the impression made by the third pair up to the superior orbital fissure, and the medial dural fold is formed by the expansion between the III cranial nerve and the entrance of the II cranial nerve into the optic canal. These two edges converge at an angle, constituting the last carotid annulus. The epidural space enclosed by this triangle contains the subclinoid segment of the internal carotid artery (Figure 2).

To dissect the anterolateral medial triangle, anterior clino-dectomy is required from its buttress of insertion with the sphenoid planum [9] The structures located within this triangle are: (a) the distal horizontal segment of the intracavernous carotid artery, specifically the anterior loop of the internal carotid artery; (b) the trabecular venous canals of the antero-inferior portion of the CS; and (c) a thin layer of connective tissue. A thin layer of continuous fibrous connective tissue with the same periadventitial sheath as the anterior loop of the internal carotid artery forms the proximal dural ring of this artery [5].

Overall, the anterolateral medial triangle encompasses the extradural space occupied by the anterior clinoid process, as well as the medial portion of the CS. These two adjacent regions are separated by the connective tissue of the proximal dural ring, which extends toward the posterior clinoid process parallel to the lateral aspect of the sella turcica [4].

Medial triangle: In 1988, Fukushima [10] defined the antero-lateral medial triangle as the region bounded by the angle formed by the subclinoid segment of the internal carotid artery, the posterior clinoid process, and the porus oculomotorius (entrance of the third cranial nerve into the CS). The dura delimits this triangle folds extending between the anterior and posterior clinoid processes, with its medial side constituted by the interclinoid ligament and its lateral side by the medial limit of the lesser circumference of the tent of the cerebellum. The lateral boundary of this triangle contains the entry points of the third and fourth cranial nerves into the lateral wall of the CS. The antero-lateral medial triangle is located posterior to the bases of the paramedian and paramedial triangles and in the antero-lateral aspect of the medial trigone. The internal carotid artery's knee tip and the medial region of its horizontal segment pass through this triangle (Figure 3) [11].

Superior or paramedian triangle: The superior triangle is located between the III and IV cranial nerve trunks as they travel along the lateral wall of the CS. Its posterior margin is the tentorial border between the porus oculomotorius and the porus trochlearis, as described by Fukushima. It should be noted that immediately posterior to the superior orbital fissure, the trochlear nerve curves over the lateral and superior aspects of the oculomotor nerve before both enter the fissure. Therefore, the anterior angle of the superior triangle is formed by the point at which the IV cranial nerve crosses externally over the III cranial nerve (Figure 4). The following structures are located in this triangle: a) the horizontal segment of the intracavernous internal carotid artery; b) the arms of the lateral intimal trunk; c) the trabecular venous canals of the postero-superior compartment of the CS; d) the sympathetic fibers; e) the dural roof of the CS; f) the meningohypophyseal trunk; g) the proximal intracavernous segment of the VI cranial nerve; and, in some cases, h) the anterior knee of the internal carotid (medial loop) [12].

Lateral or Parkinson's triangle: The triangle described by Parkinson in 1965 [13] is comprised between the IV cranial nerve, the ophthalmic division of the V, and the dura between these two nerves. This area provides good access to the C3 horizontal segment of the intracavernous internal carotid, the lateral intimal trunk, the anterior knee, the meningohypophyseal trunk, the anterior inferior compartment of the CS, the proximal and middle cavernous segments of the VI cranial nerve, the sympathetic fibers, and the dura forming the superior portion of the lateral wall of the CS. It should be noted that the dura region of the CS over the paramedian and Parkinson's triangles corresponds to the incomplete and frequently absent internal reticular layer between nerves III and V1. However, the different neural elements (III, IV, and V1) contained within the lateral wall of the CS do not constitute an impassable nerve wall [14].

The lateral wall of the CS consists of two layers, a free one formed by the dura mater, and a deep fibroconnective tissue layer that envelops the nerves mentioned above. The deep layer is less defined than the superficial one and is formed by the meningeal sheaths accompanying the nerves. These are separated by a conjunctival reticular membrane, which can be complete in 60% of the cases or incomplete/dehiscent in the remaining 40%. According to some authors, this fenestration is located between nerves IV and V1. Parkinson described a triangular space that allows access to the superior half of segment C5, the origin of segment C4, and the C3 segment of the intracavernous internal carotid artery (Figure 5) [15].

Parkinson's triangle measures, on average, 15mm at its inferior border, 16mm at its superior border, and 6mm at the posterior border that coincides with the anterior and lateral border of the dorsal and lateral border of the selar dorsum and clivus (which is synonymous with the length of the posterior petroclinoid ligament of Gruber). It should be noted that Gasser's ganglion is frequently located over the superior border of the ophthalmic nerve. However, a safe approach to the internal carotid artery through this triangle would require a minimum of 4mm of amplitude between the ophthalmic nerve and the trochlear nerve to avoid injury to adjacent structures. Only 24% (left side) to 35% (right side) of specimens meet these requirements. Additionally, the VI cranial nerve runs lateral to the internal carotid and is the first structure encountered before the vascular one. The VI cranial nerve can even pass over the superior pole of the trigeminal ganglion, thus, through the surgical approach route to the carotid artery. This happens in 16% of cases on the right side and in 23% of cases on the left side. In 13.5% of specimens, the IV, V1, and VI nerves are located so close to each other that it seems impossible to reach the internal carotid. It should be noted that the position of the cranial nerves can be altered in the presence of an arteriovenous shunt or by an aneurysm in the CS [16].

The intracavernous internal carotid artery in its c3 portion emits two to six small arteries, including the meningo-hypophyseal trunk, which originates from the posterior knee and originates branches in the hypophyseal direction. This trunk can be visualized through Parkinson's triangle [17].

Middle cranial fossa sub-region

Anterolateral triangle: The triangle in question is situated between the ophthalmic and maxillary divisions of the fifth cranial nerve and extends anteriorly to a line drawn from the superior orbital fissure to the round foramen. This anatomical region provides access to several structures, including the lateral inferior aspect of the distal horizontal portion of the intracavernous internal carotid artery, the dura and the anterior bony floor of the middle cranial fossa, the trabecular venous canals of the anterior inferior compartment of the CS, and the dura forming the inferior portion of the lateral wall of the CS. Notably, the distal intracavernous portion of the sixth cranial nerve lies infero-lateral to V1, as the abducens curves antero-inferiorly toward the superior orbital fissure. Please refer to Figure 6 for a visual representation of this triangle and its contents (Figure 6) [18].

Extreme lateral triangle: The triangle is located between the maxillary and mandibular divisions of the V cranial nerve, with its medial anterior border being the lateral edge of V2 and its posterior border being the anterior edge of V3. The lateral wall is formed by the dural fold between the foramen ovale and the teres major. In some cases, the triangle may contain the emissary vein of Vesalius, which connects the CS with the pterygoid venous plexus [19].

This triangle provides access to several structures, including the anterior and lateral aspect of the posterior knee of the internal carotid artery intracavernous and pericarotid sympathetic fibers. Due to the short course of V3 and the proximity of Gasser's ganglion, a slight retraction of V3 and V2 is possible without affecting their function. The lateral triangle is smaller than the anterolateral triangle and is filled with venous blood upon inspection. After removing the venous blood, retracting the dura towards Gasser's node, and extending the craniotomy laterally, the posterior knee of the intracavernous internal carotid artery can be accessed safely (Figure 7) [11].

Postero-lateral or Glasscok's triangle: The Glasscock triangle was first described by Glasscock [20] in 1969 and is defined by the posterior border of the foramen ovale, the spinous foramen, the posterior border of the mandibular division of the V cranial nerve, and the cochlear apex or helicotrema. In the middle fossa, the arcuate eminence represents the cochlear apex. Removing the bone in this triangle will expose the horizontal portion of the petrous internal carotid artery. Additionally, in this trigone, the posterior knee of the internal carotid artery is visible in its proximal portion, along with the labyrinthine arm of the middle meningeal artery, which runs parallel to the superficial greater petrosal nerve. The lesser petrosal nerves and the tensor muscle of the tympanic membrane, and therefore the Eustachian tube, are also located in this region. It is important to note that the Eustachian tube is separated from the internal carotid artery intra petrosal by a thin bony lamina that is 1 to 2mm thick (figure 8) [21] .

Posteromedial or Kawase triangle: The triangle described by Kawase et al in 1985 [22] is bounded by the porus trigeminus, the cochlea, and the posterior border of the mandibular division of the V cranial nerve, extending to the posterior apex of the posterolateral triangle. It can also be defined as a triangle with the posterior border of the ganglion of Gasser as its anterior border, the sphenopetrosal fissure with the superficial greater petrosal nerve as its lateral border, and a line connecting the hiatus of fallopian to the posterior aspect of V3 as its posterior border. This trigone includes the dura mater and petrosal apex bone and a portion of the superior petrosal sinus. By accessing the posterior fossa behind Gasser's node through an anterior petrosectomy, the clivus can be reached and the medial aspect of the posterior knee of the intracavernous internal carotid artery can be visualized (Figure 9) [23].

Paraclival subregion

Posteroinferior triangle: Delimited by the entrance of the VI cranial nerve at the foramen of Dorello´s canal, the posterior clinoid, and the trigeminal porus (24), this region can be divided into two sub-triangles:

The medial inferomedial triangle is formed by the tip of the posterior clinoid process (medial tip), the dural entry point of the IV cranial nerve (latero-superior tip), and the dural entry point of the VI cranial nerve in Dorello's canal (lateroinferior tip). In this triangle, you can find the lateral venous plexus, the dura forming the posterior wall of the CS, the posterior petroclinoid ligament of Gruber, the segment of the VI cranial nerve inside Dorello's canal and passing under the posterior petroclinoid ligament of Gruber, and the dorsal meningeal arm of the meningohypophysial trunk (Figure 10) [24].

The lateral infero-lateral (trigeminal) triangle is constituted by the dural entry point of the IV cranial nerve in the tentorium (superoanterior tip), the dural entry point of the VI cranial nerve in Dorello's canal (inferomedial tip), and the entry point of the petrosal vein (superior cerebellar vein) in the superior petrosal sinus (superior petrosal sinus) (Figure 11) [25]. It can be subdivided into two more triangles:

1. The bony portion is formed by the dural entry point of the VI cranial nerve to Dorello's canal (medial infero-medial tip), the anterior border of the trigeminal nerve at its entry to the into Meckel's cavum (anterosuperior tip), and the dural entry of the petrous vein (postero-superior tip). In this triangle, the dura supra lies to the posterior aspect of the petrosal apex and is the extension into the posterior fossa of the posteromedial triangle of Kawase (projecting through the medial petrosal apex) [25].

The tentorial portion is defined by the dural entrance of the IV cranial nerve to the tentorium (supero-medial tip), the anterior edge of the trigeminal nerve at the point where it enters into Meckel's cavum (inferomedial tip), and the dural entry point of the petrous vein (posterior tip). It contains a portion of the superior petrosal sinus and the tentorial arm of the meningohypophyseal trunk, and the portion of the tentorium that is posterosuperior to Meckel's cavum [25].

Fig. 1: CS and the position of the cranial nerves. 1- Optic chiasm 2- Pituitary stalk 3- Left posterior clinoid process 4-Right anterior clinoid process 5- Right internal carotid artery.

Fig. 2: Anterolateral medial triangle.

Fig. 3: Medial triangle.

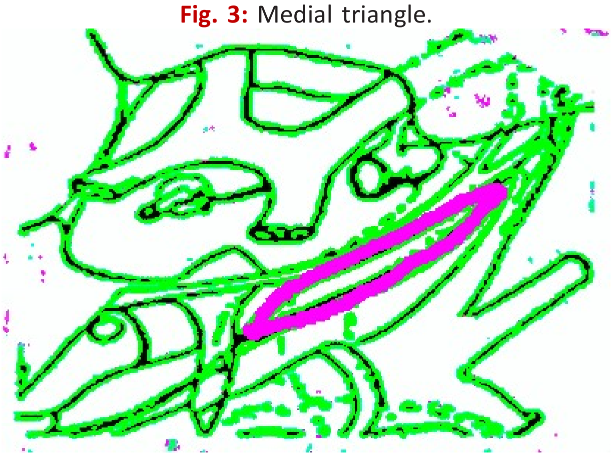

Fig. 4: Superior or paramedian triangle.

Fig. 5: Lateral or parkinson's triangle.

Fig. 6: Anterolateral triangle.

Fig. 7: Extreme lateral triangle.

Fig. 8: Postero-lateral or Glasscock's triangle.

Fig. 9: Posteromedial or kawase triangle.

Fig. 10: Medial inferomedial triangle.

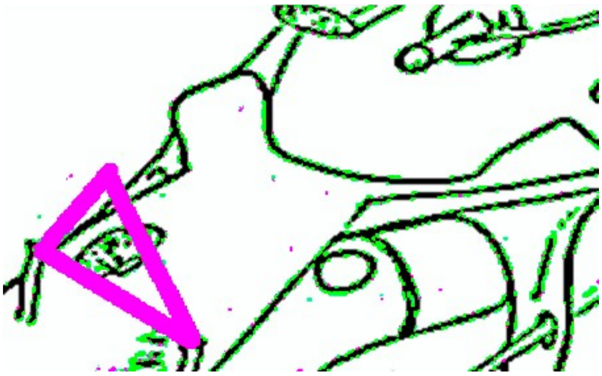

Fig. 11: Infero-lateral Triangle.

CONCLUSION

A comprehensive understanding of the intricate anatomy of the eleven triangles presents in the parasellar region, medial fossa, and paraclival region is imperative for neurosurgeons to effectively recognize and navigate through the complex anatomical structures during surgical approaches to the CS. A thorough comprehension of the anatomical relationships and spatial organization of these structures may enhance surgical precision and reduce the risk of complications. Therefore, a meticulous comprehension of the anatomy of these triangles is paramount for optimal patient outcomes and successful surgical interventions in the CS region.

Competing interests: The authors declare no competing interests.

Authors' contributions

Juan Armando Mejia and Maximiliano Paez Nova] conceptualized and designed the study. [Juan Armando Mejia and Maximiliano Paez Nova] conducted the literature search and data extraction. [Luis Garcia Rairan] contributed to the data analysis and synthesis. [Luis Garcia Rairan] drafted the manuscript. All authors reviewed and approved the final version of the manuscript.

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Luis Garcia Rairan: NA

REFERENCES

[1]. B. López Álvarez. Anatomia endoscópica del seno cavernoso con finalidad quirúrgica. Jun. 2014. doi: 10.14201/GREDOS.125444.

[2]. T. Fukushima. Management of Cavernous Sinus Lesions. Practical Handbook of Neurosurgery 2009;pp. 629–654. doi: 10.1007/978-3-211-84820-3_39.

[3]. D. Parkinson. A Surgical Approach to the Cavernous Portion of the Carotid Artery: Anatomical Studies and Case Report. J Neurosurg 1965;23(5):474–483. doi: 10.3171/JNS.1965.23.5.0474.

[4]. A. A. Bakan et al., Cavernous Sinus: A Comprehensive Review of its Anatomy, Pathologic Conditions, and Imaging Features. Clin Neuroradiol 2015;25(2):109–125. doi: 10.1007/S00062-014-0360-0/TABLES/1.

[5]. H. Q. Truong, S. Lieber, E. Najera, J. T. Alves-Belo, P. A. Gardner, and J. C. Fernandez-Miranda. The medial wall of the cavernous sinus. Part 1: Surgical anatomy, ligaments, and surgical technique for its mobilization and/or resection. J Neurosurg. 2018;131(1):122–130. doi: 10.3171/2018.3 .JN S18596.

[6]. J. C. Fernandez-Miranda et al., Cavernous sinus compartments from the endoscopic endonasal approach: anatomical considerations and surgical relevance to adenoma surgery. J Neurosurg, 2017;129(2):430–441. doi: 10.3171/2017.2.JNS162214.

[7]. J. Diaz Day, T. Fukushima, and S. L. Giannotta. Cranial base approaches to posterior circulation aneurysms. J Neurosurg, 1997;87(4):544–554. doi: 10.3171/JNS.1997.87.4.0544.

[8]. A. M. Korchi, V. Cuvinciuc, J. Caetano, M. Becker, K. O. Lovblad, and M. I. Vargas. Imaging of the cavernous sinus lesions," Diagn Interv Imaging. 2014;95(9):849–859. doi: 10.1016/J.DIII.2013. 04.013.

[9]. Z. H. Qian, X. Feng, Y. Li, and K. Tang. Virtual Reality Model of the Three-Dimensional Anatomy of the Cavernous Sinus Based on a Cadaveric Image and Dissection. Journal of Craniofacial Surgery. 2018;29(1):163–166. doi: 10.1097/SCS.0000000000004046.

[10]. G. R. Isolan, N. Krayenbühl, E. de Oliveira, and O. Al-Mefty. Microsurgical anatomy of the cavernous sinus: Measurements of the triangles in and around it. Skull Base 2007;17(6):357–368. doi: 10.1055/S-2007-985194/ID/40.

[11]. B. S. Chung, Y. H. Ahn, and J. S. Park. Ten Triangles around Cavernous Sinus for Surgical Approach, Described by Schematic Diagram and Three Dimensional Models with the Sectioned Images. J Korean Med Sci. 2016; 31(9):1455–1463. doi: 10.3346/JKMS.2016.31.9.1455.

[12]. V. R. Chavez-Herrera et al. Microsurgical and illustrative anatomy of the cavernous sinus, middle fossa, and paraclival triangles: a straightforward, comprehensive review. Surgical and Radiologic Anatomy 2023;1(1–12). doi: 10.1007/S00276-023-03105-Y/FIGURES/12.

[13]. R. V. Alves, L. C. Sousa, J. P. A. Rodrigues, and K. A. C. Laube. Revisiting Parkinson: After six decades, his triangle remains useful," Surg Neurol Int 2022;13(483). doi: 10.25259/SNI_764_2022.

[14]. P. Zhang, H. Xi, and W. Li, "The Clinical Anatomy of the Cavernous Sinus. Forensic Med Anat Res 2015;03(02):66–75. doi: 10.4236/FMAR.2015.32012.

[15]. V. Volovici and R. Dammers. How I do it: proximal control in parkinson's triangle for a very large paraclinoid aneurysm. Acta Neurochir (Wien) 2021;163(11):2967–2971. doi: 10.1007/S00701-021-04961-6/FIGURES/4.

[16]. H. Kýna, A. Ayran, and Ý. Demirtaþ. Microsurgical anatomy of the cavernous sinus and limitations of surgical approaches: a cadaveric study. Folia Morphol (Warsz), Dec. 2022, doi: 10.5603/FM.A2022.0106.

[17]. F. Chowdhury et al., Transcranial microsurgical and endoscopic endonasal cavernous sinus (CS) anatomy: A cadaveric study. J Neurol Surg A Cent Eur Neurosurg 2012;73(5):296–306, Sep. 2012, doi: 10.1055/S-0032-1322519/ID/JR110495OA-37.

[18]. D. Drazin et al., Intracranial Anatomical Triangles: A Comprehensive Illustrated Review. Cureus, 2017;9(10). doi: 10.7759/CUREUS.1741.

[19]. A. Demerdash and R. Shane Tubbs. The Cavernous Sinus, Anatomy, Imaging and Surgery of the Intracranial Dural Venous Sinuses 2020;pp. 135–148. doi: 10.1016/B978-0-323-65377-0.00015-5.

[20]. A. U. Siddiqui, R. Gurudiwan, A. T. Siddiqui, N. Chaudhary, M. R. John, and P. Gupta. Morphometry of glasscock's triangle pertinent to the exposure of horizontal intrapetrosal segment of the internal carotid artery," National Journal of Clinical Anatomy. 2019;8(3):93. doi: 10.1055/S-0039-1697882.

[21]. M. Labib, A. Samy Y. The Cavernous Sinus: Surgical Approaches—Endoscopic and Open. Contemporary Skull Base Surgery, 2022;pp. 331–346. doi: 10.1007/978-3-030-99321-4_22.

[22]. M. Tripathi et al., Quantitative analysis of the Kawase versus the modified Dolenc-Kawase approach for middle cranial fossa lesions with variable anteroposterior extension. J Neurosurg, 2015;123(1):14–22. doi: 10.3171/2015.2.JNS132876.

[23]. H. Borghei-Razavi et al.. Anterior petrosal approach: The safety of Kawase triangle as an anatomical landmark for anterior petrosectomy in petroclival meningiomas. Clin Neurol Neurosurg 2015;139:282–287. doi: 10.1016/J.CLINEURO.2015.10.032.

[24]. G. Wysiadecki et al. Microsurgical Anatomy of the Inferomedial Paraclival Triangle: Contents, Topographical Relationships and Anatomical Variations. Brain Sciences 2021;11(5):596. doi: 10.3390/BRAINSCI11050596.

[25]. V. R. Chavez-Herrera et al. Microsurgical and illustrative anatomy of the cavernous sinus, middle fossa, and paraclival triangles: a straightforward, comprehensive review. Surgical and Radiologic Anatomy 2023;1:1–12. doi: 10.1007/S00276-023-03105-Y/FIGURES/12.

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