ISSN 1220-8841 (Print)
ISSN 2344-4959 (Online)

ROMANIAN
NEUROSURGERY

Vol. XXXVIII | No. 2 June 2024

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DOI: 10.33962/roneuro-2024-033

Romanian Neurosurgery (2024) XXXVIII (2): pp. 195-199
DOI: 10.33962/roneuro-2024-033
www.journals.lapub.co.uk/index.php/roneurosurgery

Variation in optic recess angle with optic chiasm position. Imaging characteristics of 140 cases

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Keywords
optic chiasm, lamina terminalis, chiasmatic recess, mri-t2 scans, suprasellar lesions

Abstract

Background: The position of the optic chiasm relative to surrounding structures is critical in planning surgical interventions for suprasellar lesions. This study explored the relationship between the angle of the optic chiasm and lamina terminalis (OC-LT) and the position of the optic chiasm.

Methods: The study comprised 140 individuals who underwent midsagittal and axial MRI-T2 scans. The position of the optic chiasm was classified into three categories: sellar, prefixed, and postfixed. The OC-LT angle was measured in the midsagittal section.

Results: The angle between OC-LT varied from 30 to 66 degrees with a mean of 46.6 degrees. The sellar position of the optic chiasm was predominant (85.2%), with smaller angles (30-39 degrees) significantly associated with a sellar chiasm location. Most cases with postfixed optic chiasm fell within a 40-49 degree angle range.

Conclusions: The OC-LT angle variability can be linked to the position of the optic chiasm. Predominantly, smaller angles correlated with a sellar position of the optic chiasm, while larger angles were associated with a postfixed optic chiasm. This information is crucial for surgical planning in the suprasellar region.

Introduction

The chiasmatic recess (CR) is a distinctive structure in the anterior region of the third ventricle. It is formed by the lamina terminalis (LT) as its anterior wall and the upper surface of the optic chiasm as its floor. Together, these adjacent surfaces create a margin that resembles an

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ISSN online 2344-4959
© Romanian Society of Neurosurgery

First published
June 2024 by
London Academic Publishing
www.lapub.co.uk

inverted U shape (11). The anatomical relationship between the lamina terminalis, hypothalamus, chiasm, sella turcica, pituitary gland, diaphragma sellae, basal cistern, and other adjacent structures is of great significance. The lamina terminalis forms the anterior wall of the third ventricle, enclosing the hypothalamus above the chiasm. Below the chiasm, the sella turcica, pituitary gland, and diaphragma sellae are situated (8). This intricate network of structures, including the lamina terminalis, hypothalamus, chiasm, sella turcica, pituitary gland, diaphragma sellae, basal cistern, and other adjacent elements, highlights the profound anatomical interplay within this region.

The optic chiasm, formed by the convergence of the optic nerves, plays a crucial role in visual perception by transmitting visual information from one side of both eyes to the occipital cortex (8). The location of the optic chiasm classified into three positions. The terms "prefixed" and "postfixed" were introduced in 1924 to describe these positions, and a subsequent study by Bergland et al. in 1968 confirmed the existence of these chiasm types. Prefixed chiasms were found above the tuberculum sellae, while postfixed chiasms were observed above the dorsum sellae (1). This classification provides valuable insights into the anatomical variations of the optic chiasm.

Suprasellar lesions, including craniopharyngiomas, gliomas, pituitary adenomas, germinomas, hamartomas, and meningiomas, have a profound impact on the optic chiasm. In addition, vascular disorders like aneurysms and arteriovenous malformations, as well as granulomatous diseases affecting the infundibulum and hypothalamus, can further complicate the situation (9). Understanding the intricate anatomy of the optic chiasm and its surrounding region is essential for effective surgical planning in these cases, enabling the development of optimal strategies and reducing the risk of complications.

The aim of this article is to investigate the anatomical variations of the angle between the optic chiasm and lamina terminalis (OC-LT), with a focus on its relationship with different positions of the optic chiasm.

Methods

The study was conducted at the Department of Neurosurgery in Baghdad, Iraq, spanning from 2021 to 2023. A diverse group of participants underwent midsagittal magnetic resonance imaging (MRI)-T2 scans for various medical reasons. Participants without abnormalities in the ventricular system were included, while scans lacking essential parameters were excluded. Measurements of the optic chiasm position and the angle between the optic chiasm and the lamina terminalis were taken using Perfect Screen Ruler 3.0 software and the accompanying drawing scale. The measurements were conducted by an experienced researcher to ensure accuracy and minimize bias. The focus was on examining the chiasmatic recess, which is a small extension located below the anterior portion of the third ventricle. The CR is characterized by the lamina terminalis serving as its anterior wall, while the upper surface of the optic chiasm forms its floor as showen in (Figure 1). Within this anatomical region, the focus was on measuring the angle between the optic chiasm and the lamina terminalis. This angle was measured and recorded according to the methodology illustrated in (Figure 2). Statistical analysis was performed using SPSS version 25 to determine frequencies and percentages of categorical variables.

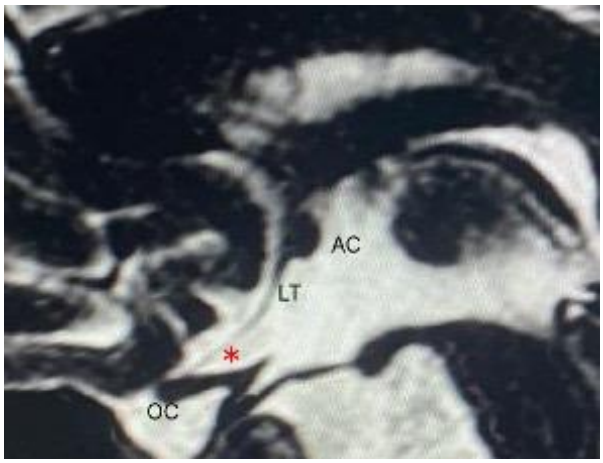

Figure 1. Mid sagittal MRI T2 shows chiasmatic recess (red star), the optic chiasm (OC), lamina terminalis (LT) and anterior commissure (AC).

Results

A group of 146 individuals participated in the study and underwent midsagittal and axial MRI-T2 scans for different reasons. The average age of the participants was 55 years, ranging from 10 to 87 years. Among the participants, 54.4% were female and 43.6% were male. Following a careful evaluation

based on predetermined criteria for inclusion and exclusion, 140 subjects were selected for comprehensive analysis out of the initial sample. Out of the 140 patients included in the study, one patient (2.9%) had a prefixed chiasm, while ten patients (7.1%) had a postfixed chiasm (Table 1).

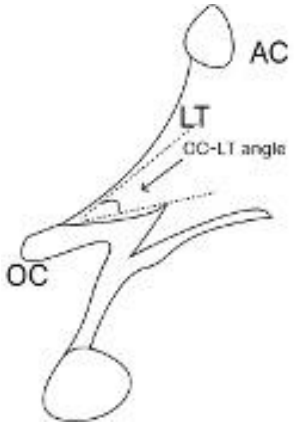

Figure 2. Schematic illustration of the OC-LT angle, the optic chiasm (OC), lamina terminalis (LT), and anterior commissure (AC).

Table 1. Optic chiasm positions

Optic chiasm position	position	No. (%)
	Sellar	*129* (*90.0%*)
	Postfixed	*10* (*7.1%*)
	Prefixed	1 (*2.9%*)
	Total	**140 (100.0%)**

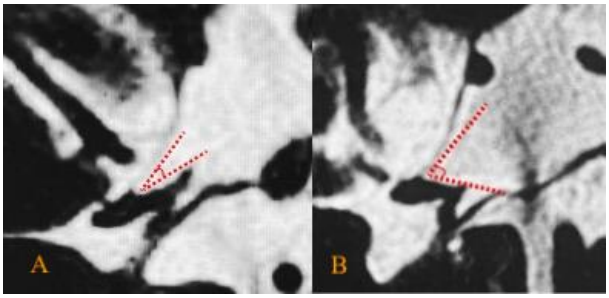

Figure 3. Mid sagittal MRI T2 shows variation in OC-LT angle ranging from 30 degrees in A to 60 degrees in B.

Table 2. OC-LT Angle ranges

OC-LT angle	Angle range	No. (%)
	30-39	*37* (*26.6%*)
	40-49	*54* (*38.5%*)
	50-59	*29* (*20.7%*)
	≥60	*20* (*14.2%*)
	Total	**140 (100%)**
Abbreviations: OC; optic chiasm, LT; lamina terminalis.		

Table 3. OC-LT angle ranges in different optic chiasm positions

Variables		OC-LT Angle range			
		30-39	**40-49**	**50-59**	**≥60**
		No. (%)	No. (%)	No. (%)	No. (%)
OC positions	Sellar	*35* (94.5%)	*46* (85.2%)	28 (96.5%)	20 (100.0%)
	Postfixed	2 (5.5%)	8 (14.8%)	0 (0.0%)	0 (0.0%)
	Prefixed	0 (0.0%)	0 (0.0%)	1 (3.5%)	0 (0.0%)
	Total	***37*** **(100.0%)**	***54*** **(100.0%)**	***29*** **(100.0%)**	**20 (100.0%)**
Abbreviations: OC; optic chiasm, LT; lamina terminalis.					

The optic chiasm and LT angle, was measured on the midsagittal sections ranged from 30 to 66 degrees (Figure 3), with a mean angle of (46.6) degree and standard deviation (SD) equal to 9.9. The largest proportion of cases (38.5%) exhibited angles between 40 and 49 degrees, followed by cases with angles between 30 and 39 degrees, accounting for 26.6% of the total (Table 2).

When considering optic chiasm positions, the analysis revealed that the sellar position was predominant, observed in 85.2% of cases. Conversely, a smaller percentage (14.8%) exhibited a postfixed optic chiasm. In cases with angles between 30 and 39 degrees, the sellar location was highly prevalent, accounting for 94.5% of cases, while a minority (5.5%) had a postfixed optic chiasm. Only one case was identified with a prefixed optic chiasm and an angle falling within the 50-59-degree range, as shown in Table 3.

Discussion

The chiasmatic recess is a distinctive structure located in the front part of the third ventricle. It is created by the anterior wall, known as the lamina terminalis (LT), and the upper surface of the optic

chiasm, which forms its floor. These adjacent surfaces come together to form a border that resembles an inverted U shape (11). The anatomical relationship between the lamina terminalis, hypothalamus, chiasm, sella turcica, pituitary gland, diaphragma sellae, basal cistern, and other nearby structures holds significant importance. The lamina terminalis acts as the front wall of the third ventricle, surrounding the hypothalamus above the chiasm. Below the chiasm, you can find the sella turcica, pituitary gland, and diaphragma sellae situated (8).

Lesions located in the suprasellar and anterior ventricular regions can have an impact on the optic chiasm. Among these lesions, craniopharyngiomas are the most commonly encountered, characterized by their benign nature and slow growth originating from remnants of squamous epithelium in Rathke's pouch. Although primarily found in children and young adults, craniopharyngiomas can also occur in adults and manifest with a range of symptoms, from growth failure to visual disturbances, depending on their size and precise location (10). Another type of lesion in this region includes chiasmatic and hypothalamic gliomas. Chiasmatic gliomas, associated with neurofibromatosis type I, are gradual-growing tumors that infiltrate the visual pathways. On the other hand, hypothalamic gliomas, predominantly observed in adults, tend to exhibit more aggressive behavior (5). Pituitary adenomas can cause hormone hypersecretion microadenomas or visual impairment and headaches in non-secreting adenomas (12). Other rare lesions include choristoma, epidermoid and dermoid tumors, Rathke's cleft cyst, suprasellar arachnoid cysts, and metastatic tumors (2,3,7).

Since the 18th century, surgeons have been exploring different approaches to the base of the skull for the management of suprasellar lesions. The evolution of trans-sphenoidal approaches, including endoscopic techniques, has revolutionized contemporary skull base surgery (6). These techniques offer advantages such as minimally invasive access, excellent visualization of the operative field, and the ability to manage various types of lesions. However, there are potential complications, including cerebrospinal fluid (CSF) leaks, bleeding, damage to critical structures like the internal carotid artery and optic nerves, meningitis, and ophthalmic complications. Preoperative radiological studies, careful planning, and a multidisciplinary approach are crucial for successful outcomes and minimizing complications in these complex surgeries (4). OC-LT angle can be utilized as assessment parameter to determine the feasibility of employing different approaches for the surgical resection of suprasellar lesions.

In our study OC-LT angle ranged from 30 to 66 degrees, with a mean angle of (46.6) degree and SD of 9.9. This mean angle is slightly higher than the mean reported by Tsutsumi S et al. (ranging from 16.5 to 62 degrees, with a mean of 34 degrees) (11). Among the cases analyzed, the largest proportion (38.5%) exhibited angles between 40 and 49 degrees, indicating that this range is the most prevalent configuration. Additionally, 26.6% of the cases fell within the range of 30 to 39 degrees, while angles ranging from 50 to 59 degrees accounted for 20.7% of the sample. Furthermore, cases with angles exceeding 60 degrees represented 14.2% of the total cases. These observations highlight the variability in the angulation of the OC-LT angle in the chiasmatic recess.

The distribution of optic chiasm positions within specific angle ranges is also noteworthy. In cases with angles between 40 and 49 degrees, the majority (85.2%) displayed an optic chiasm located at the sellar position, while a smaller proportion (14.8%) exhibited a postfixed optic chiasm. This suggests association between the angle of the optic chiasm and its anatomical position within this angle range. Similarly, in the subset of cases with angles between 30 and 39 degrees, the vast majority (94.5%) exhibited an optic chiasm positioned at the sellar location, with only a minority (5.5%) displaying a postfixed optic chiasm. These findings indicate a predominant sellar position of the optic chiasm in cases with smaller angles.

The cases with a postfixed optic chiasm were distributed across two angle categories: 30-39 degrees and 40-49 degrees. As expected, the distribution of angles in the postfixed position encompassed a wider range. However, it is important to note that the absence of cases in the wider-angle range may be attributed to the relatively small sample size utilized in this study. a single case featuring a prefixed optic chiasm with an angle ranging from 50 to 59 degrees. Surprisingly, this particular case exhibited a wider-angle range compared to the postfixed cases, which is unexpected. Several factors could contribute to this

unusual observation, such as the small sample size or the presence of unrecognized associated conditions that may have influenced the optic chiasm's positioning and angulation. Further investigation is warranted to explore the underlying reasons for this atypical occurrence. These results contribute to our understanding of the anatomical variations in optic chiasm orientation and position relative to the measured angle.

The chiasmatic recess is a distinct structure in the front part of the third ventricle, formed by the lamina terminalis and the upper surface of the optic chiasm. It has an inverted U shape and is important for the anatomical relationship with nearby structures. Lesions in the suprasellar and anterior ventricular regions, such as craniopharyngiomas, chiasmatic and hypothalamic gliomas, and pituitary adenomas, can affect the optic chiasm, resulting in various symptoms including visual disturbances, hormone hypersecretion, and headaches. Other rare lesions in this area include choristoma, epidermoid and dermoid tumors, Rathke's cleft cyst, suprasellar arachnoid cysts, and metastatic tumors. In our study, the angle between the optic chiasm and lamina terminalis ranged from 30 to 66 degrees, with a mean angle of 46.6 degrees.

This mean angle is slightly higher than the average angle reported by Tsutsumi S et al., which ranged from 16.5 to 62 degrees, with a mean of 34 degrees. Among cases with angles between 40 and 49 degrees, the majority (85.2%) had an optic chiasm located at the sellar position, while a smaller proportion (14.8%) exhibited a postfixed optic chiasm. The cases with a postfixed optic chiasm were distributed across two angle categories: 30-39 degrees and 40-49 degrees. Additionally, there was a single case with a prefixed optic chiasm and an angle ranging from 50 to 59 degrees. These findings enhance our understanding of the variations in the angle between the optic chiasm and lamina terminalis and positions of optic chiasm.

Conclusion

The angle in the chiasmatic recess is variable and the variability can be related to the position of optic chiasm. Cases with smaller angles (30-39 degrees) showed a predominant sellar position of the optic chiasm. Most postfixed optic chiasm cases displayed in a range of angles (40-49 degrees).

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