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Location of the Abducent Nerve within the Cavernous Sinus

Sinus Cavernosus İçindeki Nervus Abdusens'in Lokalizasyonu

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ABSTRACT

AIM: Knowing the distance between the superior and inferior border of Parkinson's triangle and the location of the abducent nerve within the cavernous sinus is important to decrease the complications which may occur during surgery. We aimed to investigate the cavernous sinus to decrease the complications that may occur during surgery to this area.

MATERIAL and METHODS: Fifty MRIs without pituitary gland abnormality were chosen for radiological assessment of CS. These images were from 18 males and 32 females, with ages ranging from 9 to 58 years and a median age of 28 years. We evaluated structures within and on the lateral wall of the cavernous sinus (especially Parkinson's triangle) with magnetic resonance imaging. The position of the abducent nerve and its level according to the cranial nerves running close the lateral wall were examined.

RESULTS: At the level of pituitary stalk, the distance between the trochlear nerve and the ophthalmic nerve ranged from 1 to 4 mm bilaterally. The abducent nerve was located between the trochlear and the ophthalmic nerves in 30% cases bilaterally.

CONCLUSION: The knowledge of the position of the abducent nerve will provide a great benefit in minimizing the rate of complications that may occur during the resection of tumors of the cavernous sinus.

KEYWORDS: Cavernous sinus, Abducent nerve, Trochlear nerve, Ophthalmic nerve

ÖZ

AMAÇ: Parkinson üçgeninin üst ve alt kenarları arasındaki mesafeyi ve sinus cavernusus içindeki nervus abdusens'in lokalizasyonunu bilmek cerrahi sırasında ortaya çıkabilecek komplikasyonları azaltmak için önemlidir. Bu alana yapılan cerrahi sırasında görülen komplikasyonları azaltmak için sinus cavernosusu araştırmayı amaçladık.

YÖNTEM ve GEREÇLER: Hipofiz bezi anomalisi olmayan elli MR görüntüsü sinus cavernosusun radyolojik değerlendirilmesi için seçildi. Görüntüler ortalama yaşı 28 ve yaşları 9-58 arasında olan 18 erkek ve 32 kadına aitti. Sinus cavernosus'un lateral duvarı üzerinde ve içinde bulunan yapılar (özellikle Parkinson üçgeni) MR görüntüleme ile değerlendirildi. Nervus abdusens'in pozisyonu ve onun lateral duvara yakın uzanan kranyal sinirlere göre seviyesi incelendi.

BULGULAR: Hipofiz sapı seviyesinde, troklear sinir ve oftalmik sinir arasındaki mesafe iki taraflı 1 mm ila 4 mm arasında değişmektedir. Nervus abdusens vakaların %30'unda iki taraflı olarak nervus trochlearis ve oftalmicus arasında bulunur.

SONUÇ: Nervus abdusens'in posizyonunu bilmek sinus cavernosus'un tümörlerini çıkarırken ortaya çıkan komplikasyonların oranını azaltmada büyük faydalar sağlayacaktır.

ANAHTAR SÖZCÜKLER: Sinus cavernosus, Nervus abdusens, Nervus trochlearis, Nervus oftalmicus

INTRODUCTION

The cavernous sinus (CS) is a vascular channel of great importance in many branches of science (1, 6). With the increasing frequency of surgical operations to the CS, knowing the location and course of the abducent nerve (CN VI) within the CS has become necessary. The Parkinson's triangle is one of the regions used for surgical procedures to the CS (10). The inferolateral trunk of the internal carotid artery (ICA) may appear through these openings superior to the ophthalmic nerve (CN V[1]). The superior border of this triangle is formed by the lower margin of the trochlear nerve (CN IV), the inferior border by the upper rim of the CN V[1] and the posterior border by the slope of the dorsum sellae and clivus (10).

The CN VI enters the lower part of the lateral wall of the sinus and runs obliquely upward to pass through Dorello's canal of the clivus, which is situated between the petroclinoid ligament and the upper surface of the petrous apex. CN VI is the only cranial nerve to run inside the CS, lateral to the ICA. Cranial nerves V[1] and VI together are inferolateral to the ICA (11). The anatomy of CN VI is well known. Its duplication has rarely been reported in the literature (5).

The anatomy of the CS is still being investigated and different approaches to the region are given, which are of significant importance in guiding surgical intervention. In spite of these studies, some details are still unclear.

We first examined the location and dimensions of Parkinson's triangle one of the regions using for surgical procedures through the CS. Then we aimed to find the level of the abducent nerve found within cavernous sinus (CS) according to the nerves extending from the outer wall of the CS with three-dimensional constructive interference in steady state (3D CISS) MRI.

MATERIAL and METHODS

Fifty MR images without pituitary gland abnormality were chosen for radiological assessment of the CS. These images were from 18 males and 32 females, ages ranged from 9 to 58 years and a median age of 28 years. Following the T2 and T1-weighted coronal, and T1-weighted sagittal sequence we obtained postcontrast CISS and T1-weighted scans. Postcontrast coronal CISS images were obtained using the following parameters: TR/TE 11.7/5.8 ms; 180×180 matrix; 160×180 mm FOV; 0.5 mm slice thickness and two acquisitions. This sequence added extra 2-3 minutes to total examination time. For the evaluation of intracavernous segments of cranial nerves, one radiologist retrospectively evaluated a midcoronal postcontrast 3D-CISS section through the pituitary gland-stalk junction. We determined the locations of the Parkinson's triangle in MR images, and measured the distance between CN IV and CNV[1] at the level of pituitary stalk. In addition, the position of the CN VI according to the ICA and the cranial nerves running close to the lateral wall were investigated by MRI.

RESULTS

The distance between CN IV and V[1] ranged from 1 to 4 mm (average 2.40 ± 0.08) bilaterally. At the same level with MR scans, the distance of the Parkinson's triangle was 1 mm in 6 specimens (12%), 2 mm in 17 specimens (34%), 3 mm in 24 specimens (48%) and 4 mm in 3 specimens (6%) in the right side. At the left side, the distance of the Parkinson's triangle was 1 mm in 7 specimens (14.6%), 2 mm in 16 specimens (33.3%), 3 mm in 16 specimens (33.3%) and 4 mm in 9 specimens (18.7%). In 2 cases (4%), Parkinson's triangle was not identifiable (Table I).

On the right side, the CN VI was close to the lateral wall of the CS in 28 (56%) of our cases, lower to the ICA in 21 (42%) of our cases. In one case (2%), Meckel's caves were extending to the base of the cavernosus sinus, and CN VI was not visualized bilaterally. On the left side, CN VI was close to the lateral wall of the CS in 31 of our cases (62%) and lower to the ICA in 17 (34%). In one case (2%), CN VI was close to Meckel's cave formed posterolateral wall of the CS (Figure 1). Intracavernous segments of CN VI were identified on contrast-enhanced 3D CISS MRI in 48 (96%) of the 50 CS.The levels of CN VI according to the cranial nerves running the lateral wall are shown in the Table (Figure 2, 3, 4, 5).

DISCUSSION

The CS is of particular importance due to its special location, contents and connections. Many studies have been conducted on this region and its contents, but the exact nature of the CS has not yet been clearly defined (2, 3, 8, 9, 12). Although

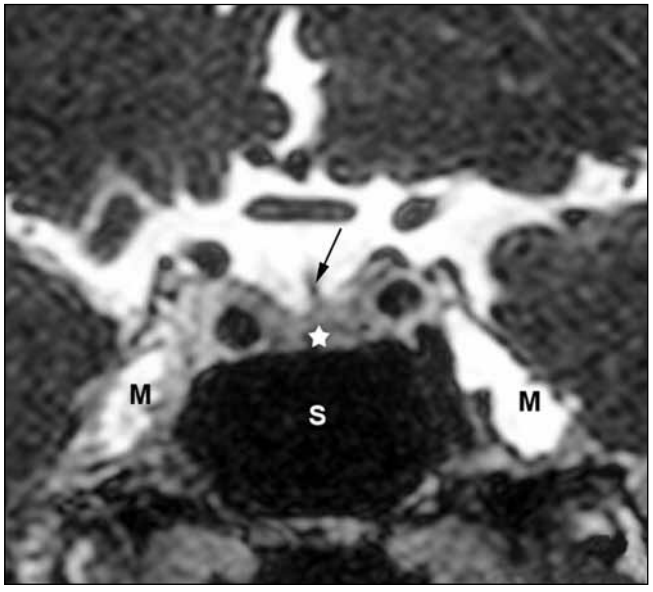

Figure 1: Coronal CISS image at the level of the pituitary gland (star) demonstrates that bilateral Meckel's caves (M) extending more anteroinferior to the cavernous sinus. Note close relationship of the Meckel's caves and and intracavernous branches of the 6th and 5th cranial nerves. The sphenoidal sinus (S), the pituitary stalk (black arrow).

Table I: This Table Shows Levels of the Abducent Nerve According to the Cranial Nerves Running the Lateral Wall of the Cavernous Sinus

	Right		Left	
Levels	**Case**	**Per cent**	**Case**	**Per cent**
Level of the CN IV	1	2%	1	2%
Between CN IV and V[1]	15	30%	15	30%
Level of the CN V[1]	4	8%	8	16%
Between CN V[1] and V[2]	25	50%	22	44%
Level of the CN V[2]	2	4%	1	2%
Lower of the CN V[2]	1	2%	1	2%
No evaluation	2	4%	2	4%

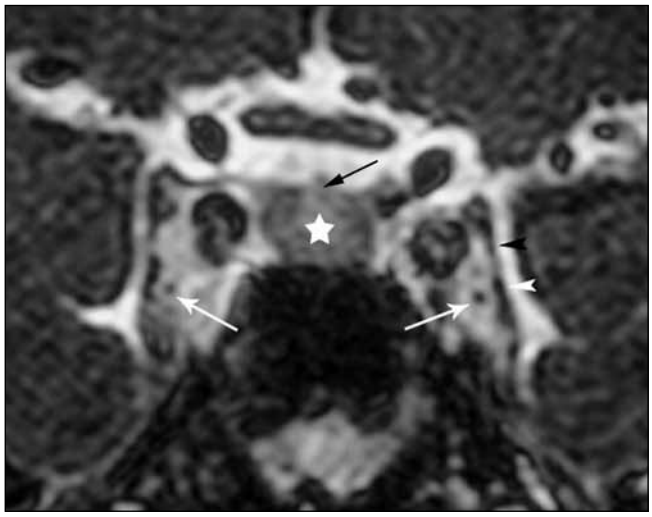

Figure 2: Coronal CISS image at the level of the pituitary gland (star) shows that 6th cranial nerves (white arrows) are seen between the first (white arrow head) and second branches of the trigeminal nerves on both sides. Fourth cranial nerve (black arrow head), the pituitary stalk (black arrow).

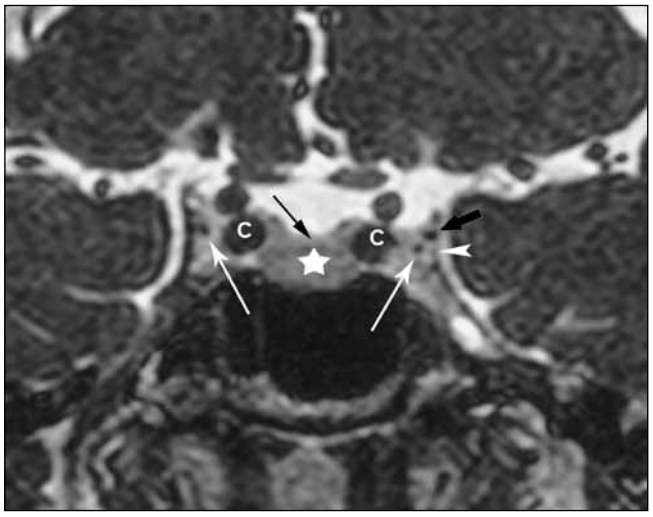

Figure 3: Coronal CISS image at the level of the pituitary gland (star) reveals that both 6th cranial nerves (white arrows) are seen lateral to the internal carotid arteries (C). Note that the left one is seen between 3th (black thick arrow) and 4th (white arrow head), and the right one is seen at the level of the 4th cranial nerve. The pituitary stalk (black thin arrow).

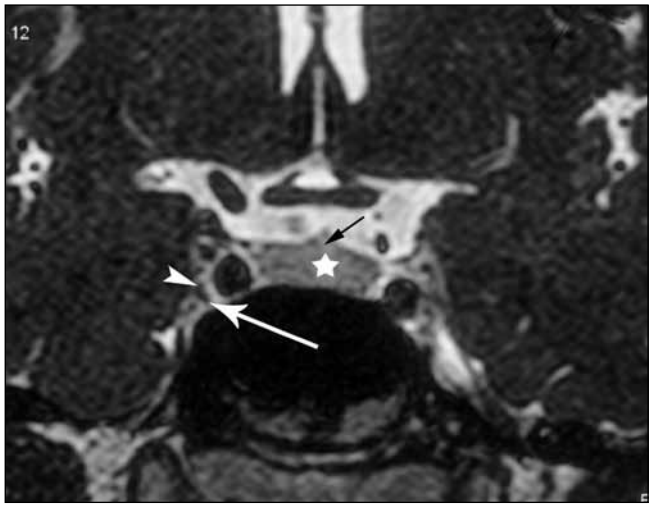

Figure 4: Coronal CISS image at the level of the pituitary gland (star) demonstrates that the right 6th cranial nerve (white arrow) is closely located to the V1 branch (arrow head) of the 5th cranial nerve. The pituitary stalk (black arrow).

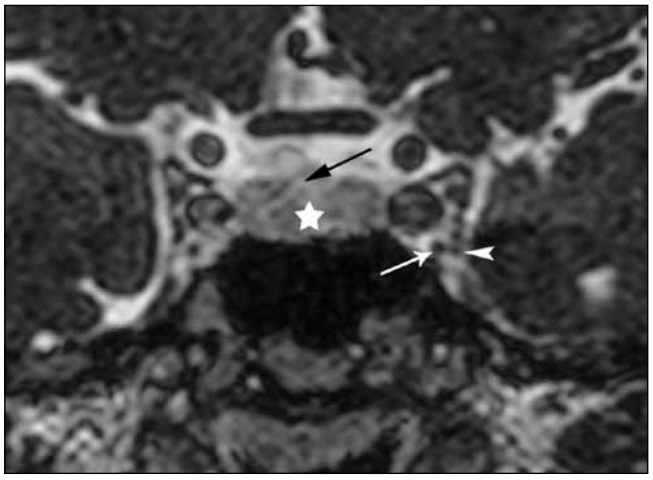

Figure 5: Coronal CISS image at the level of the pituitary gland (star) demonstrates that left 6th cranial nerve (white arrow) is close to the lateral wall of the cavernous sinus at the level of the V2 branch (arrow head) of the 5th nerve. The pituitary stalk (black arrow).

many researchers (2, 3, 8) have been examined the structures within the CS by dynamic contrast-enhanced MRI, a recently validated contrast-enhanced 3D CISS MR sequence provides clear images of each CN in the cavernous sinus (CS) (12). Therefore, we used 3D CISS MR for imaging of the CS and its boundaries.

It is possible to approach branches of the ICA via Parkinson's triangle, which is very important for the surgical procedures. Therefore, many researchers have measured the size of the cranial nerves forming the border of Parkinson's triangle (4, 7, 10). Tuccar et al. measured the superior margin averaged 16.74 mm (range: 10–22 mm), the inferior margin 17.07 mm (range: 11–20 mm), and the posterior margin 7.45 mm (range: 5–11 mm) (3). Harris and Rhoton also measured Parkinson's triangle and found the posterior border to be 3-14 mm (average 6), superior border 8-20 mm (average 13) and inferior border 5-24 mm (average 14) (4). Kayalioglu et al. measured the posterior border of Parkinson's triangle as ranging from 3.3 to 9.9 mm (average 6.41 ± 1.99), the inferior border from 9.2 to 26.1 mm (average 15.43 ± 7.68) and the superior border from 9.2 to 26.1 mm (average 15.43 ± 7.58) (7). The results of these three studies with the mean values related to the borders of Parkinson's triangle are consistent with each other.

The average distance of the posterior border of Parkinson's triangle was 6.68 mm, average distance of the inferior border was 15.96 mm and average distance of the superior border was 15.04 mm. Although the measurements of these authors were performed on cadavers, our measurements were performed on MR images. We measured the distance between CN IV and V^1 from same image level as ranging from 1 to 4 mm (average 2.40 ± 0.08) bilaterally. In our study, the distance of Parkinson's triangle was close to mean values (3 mm) in right and left sides, as 48% and 33.3%, respectively. This result shows that Parkinson's triangle is a useful and available region for surgical procedures to the CS. Tuccar et al. also observed a single CN IV (2.5%) lying very close to V^1 for its whole course on the lateral wall of the CS. In this case, there was no space between nerves CNs IV and V^1, and therefore the triangular area described by Parkinson could not be exposed surgically (10). In the MRI, in 2 (4%) of our cases, Parkinson's triangle was not identifiable. These openings are generally seen in Parkinson's triangle, as the courses of the CNs IV and V^1 often vary from one specimen to another (10). Harris and Rhoton stated that Parkinson's triangle was found in all specimens (4). However, it must be kept in mind that, although Parkinson's triangle represents a reliable surgical landmark. This and the other triangles on the lateral wall of the CS can be sometimes unrecognizable due to distortion by neoplastic and vascular lesions, but in many cases these are preferred for lateral surgical approaches.

The CS has a very complex structure and important vascular and neural contents, it is very difficult for the surgeon to reach and operate on the sinus. Understanding of the microsurgical anatomy of the region is essential for the surgeon operating in and around the CS for neoplastic and vascular lesions. Based on the meningeal architecture, we conclude that this opening, called Parkinson's triangle, is the weak point in the lateral wall. This opening can play a role in the etiology of neoplastic invasions originating from the CS. Furthermore, the venous channels appear uncovered, so neurosurgeons must be aware of this dural opening. This study and other anatomic and morphometric studies of the region still provide valuable information about this very complex structure.

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