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Surgical Importance of Neurovascular Relationships of Paranasal Sinus Region

Paranazal Sinüslerle Nörovasküler Yapıların Bağlantısının Cerrahi Önemi

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ABSTRACT

OBJECTIVE: Damage to the optic nerve and internal carotid artery is a serious complication of transsphenoidal surgery. The relationships of the sphenoid sinuses to the carotid artery and optic nerve were studied on computerized tomography and their clinical importance was discussed.

METHODS: 45 (90 sides) paranasal tomography images consisting of coronal, axial or both coronal and axial images were evaluated. Tomographic findings including bony septum extending to the optic canal or internal carotid artery and protrusions and dehiscences of the walls of the internal carotid artery and the optic nerve were investigated. The results were classified as "present" or "absent".

RESULTS: We detected 28 protrusions and 4 dehiscences of internal carotid artery and 31 protrusions and 7 dehiscences of the optic nerve. Bony septum to the internal carotid artery and optic nerve was observed in 25 and 18 cases respectively.

CONCLUSION: Detailed preoperative analysis of the anatomy of the sphenoid sinus and its neurovascular boundaries is crucial in facilitating entry to the pituitary fossa and reducing intraoperative complications. Axial and coronal images, or axial-coronal investigation obtained by direct acquisition or by reconstructions are necessary to show the positions and variations of the optic nerve and carotid artery.

KEYWORDS: Paranasal sinus, optic nerve, carotid artery, computerized tomography, transsphenoidal surgery

ÖZ

AMAÇ: Optik sinir ve internal karotid arter hasarı, transsfenoidal cerrahinin ciddi komplikasyonlarından biridir. Sfenoid sinuslerle karotid arter ve optik sinirin ilişkisi, bilgisayarlı tomografi üzerinde çalışıldı ve bu ilişkilerin klinik önemi tartışıldı.

METOD: 45 (90 taraf) paranazal tomografi görüntüsü, koronal, aksiyal ve koronal-aksiyal inceleme birlikte olacak şekilde gerçekleştirildi. Optik kanala ve internal karotid artere uzanan kemik septum, optik kanal ve internal karotid arter duvarının protrüzyon ve dehisansları tomografide araştırıldı. Sonuçlar "var" ve "yok" olarak sınıflandırıldı.

SONUÇLAR: İnternal karotid artere yönelik 28 protrüzyon ve 4 dehisans; optik sinire ait 31 protrüzyon ve 7 dehisans tespit edildi. Vakaların 25'inde internal karotid artere uzanan; 18'inde ise optik sinire uzanan kemik septum mevcuttu.

TARTIŞMA: Sfenoid sinüsün ve nörovasküler bağlantılarının anatomisinin ayrıntılı ameliyat öncesi analizi hipofizer fossaya girişi kolaylaştırmada ve intraoperatif komplikasyonları azaltmada önemlidir. Karotid arterin ve optik sinirin yerleşimini ve varyasyonlarını göstermede, direkt alınan veya rekonstrüksiyonla elde edilen aksiyal ve koronal veya aksiyal-koronal inceleme gereklidir.

ANAHTAR SÖZCÜKLER: Paranasal sinüs, optik sinir, karotid arter, bilgisayarlı tomografi, transsfenoidal cerrahi

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INTRODUCTION

Complications secondary to transsphenoidal surgery (TSS) still occur despite advanced surgical techniques and instruments (5, 6, 7, 8, 12). Furthermore, use of the transsphenoidal technique has been expanded to include other skull base lesions at the anterior skull base fossa, cavernous sinus, clivus and petroclival posterior fossa, leading to an increased risk of possible complications and necessitating additional radiological assessment. Axial and coronal images obtained by direct acquisition or reconstructions are necessary to show the position of the optic nerve and carotid artery (1, 2, 3, 9, 10, 11).

MATERIALS AND METHODS

We reviewed 45 CT (90 sides) studies of the paranasal sinuses performed by the same radiologist. The patients were investigated at the Department of Radiology and Neurosurgery of Kırıkkale University, Faculty of Medicine. The age of the patients ranged from 21 to 60 years. A SeleCT device (Marconi, Israel) was used for the tomographic study. Systematic studies of the nasal sinus region were performed in coronal and axial scans in all cases. Axial sections were performed in a plane parallel to the hard palate; section thickness was 2.5 mm and the interscan interval 1.5 mm. Coronal sections were obtained by reconstruction. Axial-coronal investigation where coronal and axial sections were assessed together was accepted as the golden standard of the study. Protrusion of internal carotid artery (ICA) and optic nerve (ON), dehiscence of the walls of ICA and ON, the site of attachment of the sphenoid sinus septum and extreme medial course of ICA were investigated. In coronal sections, protrusion is determined as the localization of a neural or vascular structure with more than 50% of its diameter in the sphenoid sinus. The results were classified as "present" or "absent".

RESULTS

The ON and ICA produced a definite bulge in the supero-lateral wall of the sinus in 31 (34.4%) and 28 (31.1%) sinuses, respectively. A definite dehiscence in the bony covering was seen in 7 (7.7%) sinuses for ON and 4 (4.4%) sinuses for ICA. Bony septa or a crest was seen in 25 (27.7%) sinuses extending to the ICA and 18 (20%) sinuses extending to the ON (Table I).

Combined axial-coronal investigations are more helpful than axial scans to detect dehiscences or protrusion of optic nerves and the coronal scan for detecting a sphenoid septum attached to the ICA.

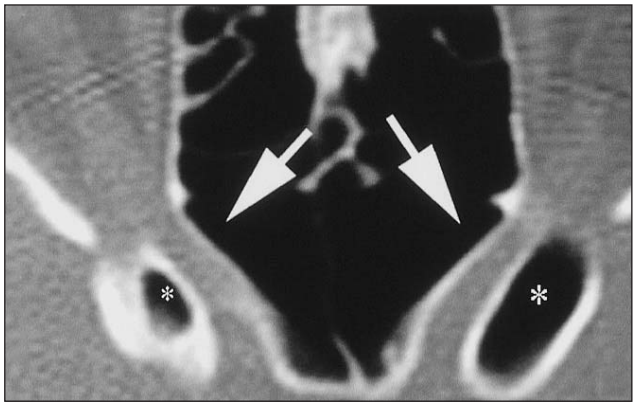

Figure 1: Axial CT images showing the protrusion of the optic nerve (short arrows). Asterixes show aerated clinoid processes.

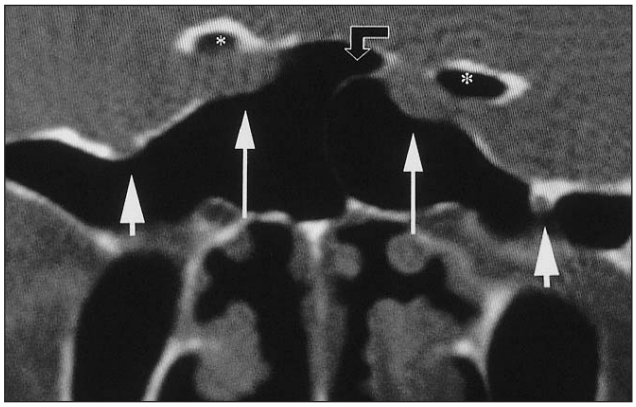

Figure 2: Coronal CT image showing the protrusion of ICA, bony septum (black arrow) extending to ICA and dehiscence of the bony canal of ICA (long white arrows). Bony dehiscense of maxillary canal bilaterally (short arrows), and protrusion of the left maxillary nerve (left short arrow) were also observed. Clinoid processes are aerated bilaterally (asterixes).

Table I. The incidence of anatomic variations in coronal-axial investigations.

	Carotid artery		Optic nerve	
Protrusion	28	(31.1%)	31	(34.4%)
Dehiscence	4	(4.4%)	7	(7.7%)
Extending bony septum	25	(27.7%)	18	(20%)

DISCUSSION

Sphenoid sinuses are the most inaccessible paranasal sinuses and are surrounded by significant anatomical structures such as the orbit and its content, cavernous sinus and ICA and the anterior cranial fossa (16). Only thin bones separate these structures from the sphenoid sinus. Anatomical landmarks vary widely from patient to patient. The surgical significance of these variations including indentations, dehiscences or more medial placement of vascular structures lies in the vulnerability of the underlying structures.

Complications of transsphenoidal surgery may lead to mortality with an incidence rate of less than 1% and serious morbidity at a relatively higher rate (7, 8, 12). Pertinent radiologic landmarks in sufficient detail are extremely helpful for the neurosurgeon to successfully extend a standard transsphenoidal approach for the treatment of lesions involving the region of the tuberculum sellae, planum sphenoidale and medial cavernous sinus.

During TSS, the surgeon may lose depth perception. Excessive bleeding, when present, may contribute to loss of visibility. Because of these hazards, it may be difficult to determine the position of surgical instruments, leading to complications. These include: loss of orientation within a capacious sinus, perforation of the carotid artery or cavernous sinus; injury to the optic nerve or ophtalmic artery; violation of the subarachnoid space with resultant pnemocephalus or cerebrospinal fluid rhinorrhea, meningitis and even brain injury resulting in death. Certain operative difficulties and complications are the result of the marked variability in the anatomy of the sphenoid sinus. If there is a lack of knowledge of the anatomy of the particular patient, as is usually the case without further radiographic evaluation, complications may be more severe. During transseptal sphenoidectomy surgery, care must be taken not to violently crack the variant septum while the septum is being detached as it may be inserted to the wall of the ICA or ON and cause damage to these structures. Uncontrollable bleeding, retrobulbar hematoma with acute proptosis, diplopia caused by extraocular muscle injury and stretching of the optic nerve resulting in blindness may occur if the intracavernous and intraorbital compartments are invaded (5), especially if punch biting forceps are used, when one is not careful about dehiscences which signify the absence of bony margins and protrusions which indicate bulging of the structures into the air space.

The preoperative radiologic evaluation plays a major role in evaluating patients considered for TSS. The existence of anatomical variations and their role during TSS have been well documented by previous studies (14, 15). However, there are only a few CT studies on the guiding points for these dangerous areas and the anatomical variations that may lead to complications (2, 3, 4, 9, 10, 13, 16). CT is more valuable for imaging the sphenoid sinus. Preoperative CT examination of the sphenoid sinus is extremely helpful in planning the safest and most direct route to the sella. CT scans also detect the anatomic variations that may place the patient at increased risk for intraoperative complications. Coronal screening sinus CT are especially useful to detect of protrusion of ON while axial images are superior for assessing septal details (4).

Great attention to detail during the surgical procedure and perfect knowledge of the radiologic anatomy of the sphenoid sinus are required to avoid an increase in related complications. Better planning before the procedure and improved familiarity with the regional anatomy should further decrease the incidence of death and morbidity resulting from this procedure.

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