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Original Article

Variation In Internal Carotid Artery Protrusion And Dehiscence In A Subset Of Karachi Population

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Abstract

Objective: To find out the frequency of protrusion of the Internal Carotid artery in the sphenoid sinus and dehiscence of the carotid canal in a subset of the Karachi population.

Study design: This was a cross-sectional study conducted at the Radiology Department of Ziauddin University.

Methodology: We analyzed 270 head and neck CT scans 270 Head and neck CT scans (540 sides) were analyzed. CT was performed on a 16-slice Toshiba Alexion at Ziauddin Hospital, Karachi. SPSS version 20 was used for data analysis.

Results: Out of 270 CT scans analyzed, 28 (10.3) scans showed protrusion of ICA in the sphenoid sinus. Out of 45 (16.6) of the subjects showed dehiscence of the carotid canal. Out of total dehiscence, present unilateral cases were more frequent as compared to bilateral. The unilateral protrusion was also more common as compared to the bilateral protrusion of the ICA.

Conclusion: Knowledge of dehiscence and protrusion related to ICA and sphenoid sinus anatomy is essential to avoid complications in endoscopic sinus surgery.

Keywords: Internal carotid artery, Karachi, dehiscence, protrusion, sphenoid sinus.

Introduction

Paranasal sinuses (PNS) are bilaterally located structures that surround the nasal cavity. These are a group of air-filled spaces. There are four bilateral paranasal sinuses namely, maxillary, sphenoidal, ethmoidal, and frontal sinuses. They are housed within the bones of the same name. They have various functions which include lightening the weight of the head, humidifying & heating inhaled air, increasing the resonance of voice & serving as a crumple zone to protect vital structures in event of facial trauma. It has become increasingly important to recognize the clinical and surgical significance of these variations because the success of ESS depends on adequate knowledge of the complicated anatomy of paranasal sinuses, which is variable. The size and shape of the sinus are irregular and a variable degree of pneumatization can be present, ranging from minimal to extensive. The proximity of sinonasal region to important structures such as the anterior cranial fossa, the orbit, and neurovascular structures, can have hazardous consequences. The relationship of the sinonasal region to neurovascular structures is subject to several anatomic variations Therefore, the surgeon should be aware of sinonasal anatomy and associated variations. When the sphenoid sinus becomes highly pneumatized, it distorts the anatomic configuration of the sphenoid sinus. The bone over its lateral wall becomes attenuated thus placing the optic nerve and internal carotid artery at risk.

For the surgical treatment of chronic rhinosinusitis which occurs due to obstruction and impaired mucociliary drainage of paranasal sinuses, Endoscopic sinus surgery (ESS) is the treatment of choice.[1] ESS is extensively used for the treatment of many diseases. These diseases include mucocele, sellar and parasellar tumors, nasal polyposis, and also for decompression of the optic nerve. It is also considered one of the best options for treating chronic rhinosinusitis which does not respond to medical treatment. When the sphenoid sinus becomes highly pneumatized, it distorts the anatomic configuration of the sphenoid sinus due to which the bone on the lateral wall becomes attenuated thus putting the optic nerve and internal carotid artery at risk.[2]

Therefore, with the purpose of avoiding possible complications of ESS, it is crucial to have a sound knowledge of the anatomy of paranasal sinuses and its variations.[3] Thus with the introduction of ESS, a proper understanding of paranasal sinus anatomy has become increasingly important. Studies documenting the anatomical variations of paranasal sinuses in the Pakistani population are scarce.

Sphenoidal sinuses are paired cavities that are irregular in shape. They are present posterior to the upper part of the nasal cavity and lie within the body of the sphenoid bone. Being the posterior-most among all other paranasal sinuses, they can't be easily accessed by surgeons. Its pneumatization varies and ranges from minimal to extensive.[4] The sinuses are minute cavities at birth, and their main development occurs after puberty.[5] A septum usually separates the sinus which deviates from the midline in about 75% of individuals and therefore, they become unequal in both size and form.[6] Bony accessory septa are also present in the cavity of sphenoid sinuses which may further partially divide their cavity into smaller ones. Bony ridges may project into the sinuses from their lateral walls which are produced by the ICA, pterygoid canal, and maxillary branch of the trigeminal nerve.[7] Additionally, the projection of the Optic Nerve (ON) may also be observed in about 15% of individuals.

The optic nerve, internal carotid artery, and vidian nerve are all closely related to the sphenoid sinus. As the cavity grows, these structures, which were present before sinus development, cause indentations in the sinus walls. Thus finally, a thin bony plate remains that separates the sinus from neighboring structures in well-pneumatized cavities. Pneumatization is not restricted to the sphenoid bone's body, it extends into the other parts of the sphenoid bone namely the greater wing and the pterygoid process. There is an increased likelihood of the protrusion of nearby neurovascular structures into the sinus due to normally extended pneumatization.[8]

In the lateral wall of the sphenoid sinus, runs the internal carotid artery thereby increasing the chance of injury during surgical procedures. The internal carotid artery impression may be hardly noticeable or highly evident depending on the sphenoid bone's pneumatization.[9] In some individuals, very thin bone which covers the internal carotid artery becomes dehiscent due to which the artery lies exposed in the sinus cavity. Now if the surgeon is unaware of such arterial protrusion, fatal hemorrhages may occur and then it becomes impossible to control the bleeding of such a great injured internal carotid artery within the sphenoid sinus.[10] Therefore, those surgeons operating

in the areas of sphenoid sinus should be well informed by the radiologist about variations occurring in this region of skull in order to avoid complications during surgery.[11-13]

Materials and Methods

In this study 270 participants aged between 21 to 60 years (both genders) without having chronic rhinosinusitis, sinonasal tumor, facial fractures along with nasal polyposis, prior sinus surgery and congenital craniofacial anomalies were included in cross sectional study. Duration of study was five months starting from Jan- May 2017. It was conducted at Department of Radiology, Ziauddin University, after the approval from ethics review committee.[14] Patients without any sphenoid sinus abnormality or adjacent structures coming for brain and head CT scan were part of this study. 16 slice Toshiba Alexion CT scanner was used to perform the scans. The scanner's X-ray beam rotated around the patient's head creating images from different angles. Volume data was created after gaining sequential axial images. Multiplanar reconstructions were made in different places such as sagittal, axial and coronal from volume data. Construction of 3D volume rendered images were constructed in bone algorithm. Evaluation of images were carried out in both axial and coronal planes. We reported the results in the data sheet after viewing the CT scans in coronal views and analyzing them in bony windows.

The internal carotid artery was classified as whether it was protruding into the cavity of sphenoid sinus or bony wall adjacent to the internal carotid artery was dehiscent. Localization of a neurovascular structure was used as the determination criteria of protrusion. If more than 50% of the structure's diameter was found to be within the sphenoid sinus, it was considered as protrusion.[9]

The deficiency of apparent bone density separating the sinus from the course of the concerned structure is referred to as dehiscence.([15]) When it was impossible to make a clear distinction between a very thin bone wall and entire dehiscence, the data were considered as dehiscence.

The findings on CT scan observations about protrusion and dehiscence were further classified into unilateral and bilateral.

Data was analyzed on SPSS version 20. Frequencies and percentages were taken out for
categorical variables.

Results

Internal carotid artery was assessed, and the results were categorized as either unilateral protrusion or dehiscence or bilateral protrusion or dehiscence. Out of 270 CT scans, protrusion of ICA was observed in 28 subjects out of which 17 showed unilateral protrusion and 11 subjects showed bilateral protrusion. Dehiscence was found in 45 subjects out of which 28 showed unilateral dehiscence and 17 showed bilateral dehiscence. Table 1

Dehiscence was found to be comparatively more frequently present (45 subjects) as compared to ICA protrusion (28 subjects). Dehiscence and protrusion were more common unilaterally than bilaterally (Figure 1).

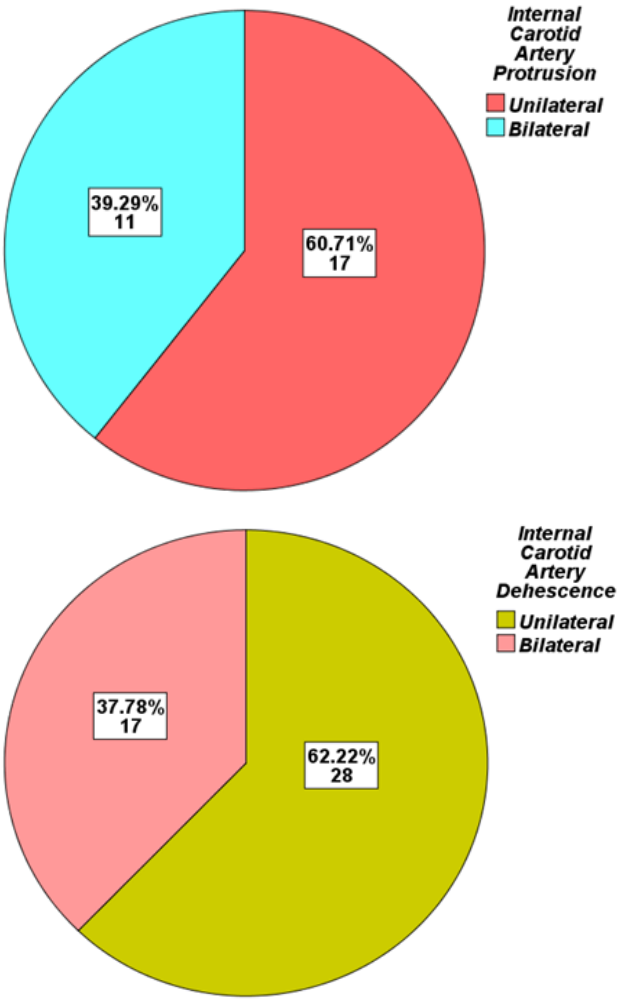

Figure 1: Pie chart showing the frequency of unilateral and bilateral protrusion and dehiscence of internal carotid artery.

Table-1 Frequency of internal carotid artery protrusion and dehiscence

Characteristics	*Unilateral N (%)*	*Bilateral N (%)*	*Total N (%)*
Protrusion	17 (6.29)	11 (4.07)	28 (10.3)
Dehiscence	28 (10.37)	17 (6.29)	45 (16.6)

Discussion

Arteries like internal carotid (ICA) and nerves such as vidian and optic nerve (ON) are present before sinus formation is complete, they cause irregularities in the sinus walls as the cavity develops.[10]

ICA protrusion into the sphenoid sinus shows wide variation among diverse populations showing a wide range of 3.9 and 41.0%. [16] Our sample shows a lower frequency which is 10.3% of ICA protrusion into the sphenoid sinus. This is similar to that reported in Turkish population by Halil Arsalan et al who reported a frequency of 8%.[17] Higher frequencies were stated by Rahmati et al (38.8%) and Hewaidi et al (41%) in Iranian and Libyan populations.[13]

The variations of internal carotid arteries have been documented in many studies. In a study done by Fatihoglu et al in 2021 on Turkish population, unilateral protrusion of internal carotid artery was present in 7%, bilateral protrusion in 24.7%, unilateral dehiscence in 6.8% and bilateral dehiscence in 15.1%. [18] In research conducted in India, Sravya et al concluded that protrusion was observed in 27% individuals out of which bilateral protrusion was present in 19% cases & 8% cases had unilateral protrusion. In the same study, unilateral and bilateral dehiscence was observed in 5% and 8% individuals respectively. [19]

Bony wall dehiscence around the internal carotid artery is also observed to show wide variation and is not conclusive. Hewaidi et al conducted a study on Libyan population and found the dehiscence to be 30%. [20] Siricki et al conducted a study in Turkey on 92 paranasal sinuses and reported a frequency of dehiscence within the same range that is 22%. [21] Priyadarshini et al also reports a frequency of dehiscence to be on higher side that is 33%. [22] It has been observed that the dehiscent varied from 5% to 48%.[23] The frequency of dehiscence according to our study is 16.6% which is in accordance with the frequency quoted by Kajoak et al from Sudan which is 12.4%. [12]

The frequent protrusion and dehiscence around the internal carotid artery wall are observed to exhibit extensive variations which may frequently come across on routine CT examination. Reporting of such variation should be made by the radiologist. Such reporting's become more relevant in the area of the sphenoid sinus, where pneumatization of the skull base bones can cause the anatomic configuration to be distorted. The radiologist's recognition of these variations before surgery is important in determining the dissection limits. Detailed study by a radiologist prior to any surgery in the sphenoid sinus area along with axial and coronal CT sections should always be obtained. [24]

Conclusion

The occurrence of protrusion of internal carotid artery was found to be 10.3% whereas dehiscence of bony wall around the internal carotid artery was observed to be 16.6% which indicates a low risk of injury to this vital structure during endoscopic sinus surgery in our population.

Limitations:

- The data was collected from only one tertiary care hospital which did not cater to a wide range of the population.
- Non-probability consecutive sampling technique was used.

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