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Research Article

Sphenoid Sinus; Variability of its Surrounding Neurovascular Structures

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Abstract

Introduction: The sphenoid sinus (SS) is the least accessible paranasal sinus deeply lying in the skull base and is surrounded by vital neurovascular structures. Detailed knowledge of the sphenoid sinuses and their variant anatomy and type of pneumatization is warranted prior to conducting an invasive procedure like Fess, trans-sphenoidal pituitary surgeries or endoscopic cerebrospinal fluid leak closures.

Methods: This is a retrospective observational study done with the primary aim of estimating the frequency of dehiscence and protrusion of neurovascular structures surrounding the sphenoid sinus. 100 patients who had undergone Non contrast CT scans of nose and paranasal sinuses with SOMATOM EMOTION 16 slice CT scanner were studied. Patients with history of sino-nasal surgeries, head, neck or face trauma, extensive sino-nasal polyposis or age below 18 years were excluded.

Results: The commonest pneumatization pattern seen was post sellar type (48%) and the least one was pre-sellar (7%). The most common variability noted was protrusion of maxillary nerve which was seen in 47.5% of cases. Protrusion of vidian canal was 2nd most common variability observed in 42.5% of scans. Among all dehiscence's, vidian canal dehiscence was most common, noted in 16% of scans. The protrusion of internal carotid artery and optic nerve was seen in 16% and 11% respectively.

Conclusion: The author concludes that the meticulous knowledge of anatomical variations of sinuses, particularly sphenoid sinus, is of paramount importance for any ENT or skull base surgeon and recommends every patient should undergo preoperative imaging to reduce surgical catastrophe in view of high frequency of SS anatomical variations.

Keywords: Sphenoid Sinus; Vidian Canal; Foramen Rotundum; Protrusion; Dehiscence

Introduction

The sphenoid sinus (SS) is the least accessible paranasal sinus deeply lying in the skull base and is surrounded by vital neurovascular structures. The neurovascular structures seen around the sphenoid sinus are the internal carotid artery, optic nerve, maxillary nerve and vidian nerve, which traverse through their respective foraminas. The pneumatization of SS is rarely seen at birth. It usually begins after 4 years of age and can get delayed up to 6–12 years of age [1]. The bony foramina around the SS can vary in shape and size based on pneumatization patterns. Highly pneumatized sphenoid sinus may distort the anatomic configuration and may attenuate the bone over the overlying foramina, thus placing structures like optic nerve, carotid artery, maxillary and vidian nerves at greater risk [4]. Complete Absence of bone or its thinning around these neurovascular structures makes them susceptible to iatrogenic injury [5]. The absence of more than 50% diameter of surrounding bone from any neurovascular structure within the sphenoid sinus is considered as protrusion, while anything less than that is considered as dehiscence [6]. The variations about the pneumatization types of the SS and its surrounding neurovascular structures have been studied before in detail [2,3]. The variability in the anatomy of the sphenoid sinus and its surrounding neurovascular structures are well documented in various populations [7]. Detailed knowledge of the sphenoid sinuses and their variant anatomy and type of pneumatization is warranted prior to performing any invasive procedure like Functional Endoscopic Sinus Surgery (FESS), Transsphenoidal pituitary surgeries or Endoscopic cerebrospinal fluid leak closures. The purpose of this study is to estimate the frequency of dehiscence and protrusion of neurovascular structures surrounding the sphenoid sinus and to demonstrate variability in pneumatization of Sphenoid Sinus in north Indian population.

Materials and Methods

This is a retrospective observational study. It was carried out in the department of Ent-HNS in collaboration with the department of Radiology, Hamdard institute of medical sciences and research centre New Delhi, a tertiary care hospital. The primary aim of the study was to estimate the frequency of dehiscence and protrusion of neurovascular structures surrounding the sphenoid sinus and secondary aim was to demonstrate the pneumatization variability of sphenoid sinus in north Indian population. We collected the data of 100 patients who had undergone Non contrast CT scans of nose and paranasal sinuses. Patients with history of Sino-nasal surgeries, head, neck or face trauma, Extensive Sino nasal polyposis or age below 18 years were excluded. The department of Radiology is installed with SOMATOM EMOTION 16 slice CT scanner which was used for imaging purposes. The scans were studied in detail in axial, coronal and sagittal planes in both bone and soft tissue windows. The pneumatization pattern of sphenoid sinus was noted and tabulated. Dehiscence and/or protrusion of internal carotid artery, Optic nerve, Maxillary nerve and Vidian nerve into the sphenoid sinus was looked for and noted down. Dehiscence was considered as the absence of any visible bony density separating the sinus from the course of the concerned structure. However the Presence of more than 50% diameter of any neurovascular structure within the sphenoid sinus was considered as protrusion [6]. Whenever a clear distinction between a very thin bony wall and total dehiscence was not feasible, the results were accepted as dehiscence [7]. Ethical committee clearance was not applicable as the study was retrospective and observational in nature.

Results

The current study consisted of 100 patients with male to female ratio of 1:1. All patients were above the age of 18 years. The commonest pneumatization pattern seen was post sellar type (48%) and the least one was pre-sellar (7%). The table 1 below shows the percentage type of pneumatization of sphenoid sinus.

Type of pneumatization	Number of cases	Percentage
Conchal	20	20
Pre-sellar	7	7
Sellar	25	25
Post-sellar	48	48
Total	100	100%

Table 1: Types of pneumatization of sphenoid sinus.

The figure 1A, 1B, IC, shows CT pictures of different types of pneumatization patterns of sphenoid sinus on sagittal sections.

The most common variability noted was protrusion of maxillary nerve which was seen in 47.5% of cases. In the majority of cases it was seen unilaterally being present on the left side in 29% and on the right side in 7.5% and bilaterally in 11%. Dehiscence of the maxillary nerve was seen only in 12.5% of cases. The unilateral presence was noted in majority (10 Vs 2.5%) compared to bilateral presence.

Figure 1a: Pre sellar sphenoid sinus pneumatization.

Figure 1b: Seller sphenoid sinus pneumatization.

Figure 1c: Post sellar sphenoid sinus pneumatization.

Protrusion of the vidian canal was 2nd most common variability observed in 42.5% of scans. Bilateral vidian canal protrusion was noted in 17% of cases. It was seen in 9.5% of cases on the left side and 16% on the right side.

Among all dehiscence's, vidian canal dehiscence was most common, noted in 16% of scans, figure 2 of the Coronal plane CT showing Left vidian Canal dehiscence and right rotundum prolapse.

Figure 2: Coronal plane CT showing Left vidian Canal dehiscence & right Foramen rotundum prolapse.

The protrusion of the internal carotid artery and optic nerve was seen in 16% and 11% respectively. The frequency prevalence of dehiscence was less compared to protrusions seen across all planes. Dehiscence of internal carotid artery was seen in 15% while dehiscence of optic nerve was noted in 5% of cases. Most of the cases were seen unilaterally (ICA 12 Vs 2, ON 4 Vs 1). Figure 3 shows, Brown arrows point at protrusion of ICA & Red arrow points at optic nerve dehiscence. While as figure 4 of Axial plane CT showing sphenoid septum overlying on internal carotid artery.

Figure 3: Shows, Brown arrows point at protrusion of ICA & Red arrow points at optic nerve dehiscence.

Figure 4: Of Axial plane CT showing sphenoid septum overlying on the internal carotid artery.

Discussion

The neurovascular structures including cavernous sinus, internal carotid artery, Optic nerve and vidian canals are intimately related to sphenoid sinuses. The sphenoid sinus and adjacent bony structures may show various degrees of pneumatization. The commonest pneumatization seen in the current study was post sellar type which was present in 48% of cases, followed by seller (25%) type. Pre seller (7%) pattern was the least common type of pneumatization observed Similar to our observations , Cho JH., *et al*. [1] in his study found the most frequent type of the SS pneumatization is type III (sellar) and type IV (post sellar). The variations about the pneumatization types of the SS and its surrounding neurovascular structures have been studied before in detail [2,3]. The current study observed that maxillary nerve protrusion is the most common anatomical variation, seen in 47.5% of scans. These findings are close to the findings of Kajoak., *et al*. who in his study on the Sudanese population found the prevalence of maxillary nerve protrusion to be 27.9% [8]. However much lower figures compared to our were observed by Hewaidi and Omami in their study (22.6%) [5]. These differences could be the result of categorising cases as dehiscence, wherever there was any discrepancy in differentiating protrusion dehiscences. The protrusion and dehiscence of the maxillary nerve are usually caused by the extension of sphenoid sinus pneumatization onto the greater wing of sphenoid [8]. These variations predispose maxillary branch of trigeminal nerve to iatrogenic injury during FESS or can lead to trigeminal neuralgia secondary to nerve inflammation in sphenoid sinusitis [9]. The optic nerve protrusion in our study was seen in 11% of cases while as dehiscence was seen in 5% of cases only. The reported prevalence of optic nerve protrusion into the sphenoid sinus ranges from 7% to 35% [10]. Our results lie within the above reported range. Dasar., *et al*. In his study found a statistically significant association between anterior clinoid process pneumatization and optic nerve protrusion into the sphenoid sinus [11]. The optic nerve is susceptible to injury while passing through the optic canal as the nerve is least nourished over there throughout its course. The inflammatory sinus disease can involve the protruded or dehiscent nerve and thus risking the vision. Moreover, there is a high chance of blindness in such cases as the risk of damaging the nerve is quite high intraoperatively while performing endoscopic sinus surgeries [12].

The protrusion of internal carotid artery was observed in 16% and dehiscence in 15% of cases. A direct contact of the artery with sinus mucosa secondary to cavernous sinuses involvement is quite possible if dehiscence is present. Preoperative radiological assessment and documentation of such variations is vital to reduce the chances of carotid artery injury and thus blindness or fatal haemorrhage. The prevalence of internal carotid artery dehiscence and protrusion varies widely and ranges from 2% to 23% and 5.2% to 67% respectively [13].

Our results corroborated with the findings of Kantarci., *et al*. [14] who evaluated 512 CT scans for the presence of this variation and noted the dehiscence /protrusion as 16% (bilaterally) and 7% (unilaterally) in the Turkish population. However, results quite higher (27.3% and 25.4%) than our observations were seen by Fasunla., *et al*. [15] and Kajoak., *et al*. [9] in their respective studies in Nigerian and Sudanese populations. Lower prevalence rates compared to ours was observed by Birsen., *et al*. (5.3%) [16].

Protrusion of the vidian canal was 2nd most common variability, which was observed in 42.5% of scans. Bilateral vidian canal protrusion was noted in 17% of cases. Unilaterally it was seen in 9.5% and 16% on left & right side respectively.

Among all dehiscences, vidian canal dehiscence was most common, seen in 16% of scans. The extensive pneumatization of the sphenoid sinus into the pterygoid process is responsible for the variations of the Vidian canal [8]. These variations are associated with deep nasal pain often referred to as Vidian neuralgia [17]. Turkdogan., *et al*. [18] in his study ,had similar rates of vidian canal protrusion as observed (34.25%) in the current study.

Conclusion

The author concludes that the sound knowledge of anatomical variations of sinuses particularly sphenoid sinus is of paramount importance for any ENT or skull base surgeon and recommends every patient should undergo preoperative Imaging to reduce surgical catastrophe in view of high frequency of Sphenoid Sinus pneumatization variations.

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