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Case Report

Anomalous Bilateral DeLano Type III Trans-Sphenoidal Optic Nerve Course in an Iraqi Patient

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Abstract

Anomalous trans-sphenoidal course of the optic nerve represents a rare anatomical variant with important clinical implications. Because the optic nerve may bulge into or traverse the sphenoid sinus in the setting of extensive sphenoid sinus pneumatization, such unrecognized anomalies increase the risk of optic nerve or visual pathway injuries during endoscopic or surgical procedures. Early recognition on preoperative imaging is therefore crucial. We are presenting a case study of an eighteen-year-old Iraqi male who underwent a paranasal computed tomography at Baghdad Medical City; clinical history and presenting complaint were unavailable. Imaging demonstrated marked sino-nasal asymmetry with a severe left-sided nasal septum deviation, a larger right inferior turbinate, mild left Schneiderian membrane thickening, an asymmetric multi-septate sphenoid sinus with a left lateral recess, bilateral anterior clinoid process pneumatization, and small right Onodi cells. Most notably, both optic nerves followed an anomalous DeLano type III trans-sphenoidal course, which is an uncommon but clinically significant sino-nasal anatomic variant. Careful preoperative assessment of sphenoid sinus pneumatization, septation, and optic-nerve relationships is essential to prevent iatrogenic optic-nerve injury and to guide endoscopic sinus and skull-base procedures, including functional endoscopic sinus surgery (FESS). Radiology reports should explicitly document these variants, and significant findings should prompt multidisciplinary discussion.

Keywords: Arabs; Congenital abnormalities; Functional endoscopic sinus surgery; Paranasal sinuses; Sphenoid bone; Visual pathways.

مسار شاذ ثنائي الجانب للعصب البصري عبر الجيب الوتدي، من النوع الثالث وفق تصنيف ديلانو، لدى مريض عراقي

الخلاصة

يمثل المسار الشاذ للعصب البصري عبر الجيب الوتدي متغيّرًا تشريحيًا نادرًا ذا أهمية سريرية كبيرة، إذ قد يبرز العصب البصري داخل الجيب الوتدي أو يعبره في حالات التهوية المفرطة للجيب، مما يزيد من خطر إصابة العصب البصري أو المسارات البصرية أثناء الإجراءات التنظيرية أو الجراحية في حال عدم التعرف على هذا المتغير مسبقًا؛ لذلك يُعد التعرف المبكر عليه في التصويرالشعاعي قبل الجراحة أمرًا بالغ الأهمية. هذا التقرير يمثل حالة لمريض عراقي يبلغ من العمر 18 عامًا خضع لتصوير مقطعي محوسب للجيوب الأنفية في مدينة الطب ببغداد، ولم تكن المعلومات السريرية أو الشكوى الرئيسية متوفرة. أظهرت الصور الشعاعية عدم تماثل واضح في البنى الأنفية والجيوب الأنفية مع انحراف شديد للحاجز الأنفي إلى الجهة اليسرى، وتضخم المحارة السفلية اليمنى، وتثخنًا خفيفًا في غشاء شنايدر للجيب الفكي الأيسر، إضافة إلى جيب وتدي غير متناظر متعدد الحجرات مع جيب جانبي أيسر، وتهوية ثنائية للناتئين الكلينويديين الأماميين، ووجود خلايا أونودي صغيرة في الجهة اليمنى. والأكثر أهمية أن كلا العصبين البصريين اتبعا مسارًا شاذًا عبر الجيب الوتدي من النمط الثالث حسب تصنيف ديلانو، وهو متغير تشريحي جيبي-أنفي غير شائع لكنه ذو دلالة سريرية مهمة. إن التقييم الدقيق قبل الجراحة لدرجة تهوية الجيب الوتدي، وأنماط الحواجز داخله، وعلاقات العصب البصري مع هذه البنى يُعد ضروريًا لتجنب الأذيات الغير متعمدة للعصب البصري (الناجمة عن الأخطاء الجراحية) ولتقنين الإجراءات التنظيرية للجيوب الأنفية وقاعدة الجمجمة، بما في ذلك الجراحة التنظيرية الوظيفية للجيوب الأنفية، كما ينبغي أن يوثق التصويرالشعاعي هذه المتغيرات التشريحية بوضوح وأن تستدعي النتائج نقاشًا متعدد التخصصات لضمان التخطيط العلاجي الآمن.

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INTRODUCTION

Variable sphenoid pneumatization dictates relations with the *sella turcica*, optic nerves, internal carotid arteries, and cavernous sinuses. Sphenoid hyperpneumatization into the clivus, pterygoid processes, or greater wings can alter anatomical landmarks and compromise surgical safety. Preoperative computed tomography (CT) is essential to detect these variants during trans-sphenoidal or endoscopic skull-base surgery [1]. Functional endoscopic sinus surgery (FESS) is a minimally invasive procedure that restores sinus ventilation and drainage by removing obstructing mucosa and bone. It is indicated for refractory chronic rhinosinusitis (CRS), sinonasal polyposis, and mucoceles, among others. For FESS, preoperative high-resolution CT and nasal endoscopy are crucial to identify anatomical variants (e.g., Onodi cells, sinus hyperpneumatization) to reduce surgical risks (bleeding, CSF leak, optic nerve injury) [2]. Sinonasal anatomical variants, such as concha bullosa (CB), Onodi cells (OCs), and Haller cells (HCs), among others, can impair drainage and potentiate the CRS risk; however, most relevant studies are retrospective or cross-sectional with limited causal inference. The current evidence highlights these variants as modifying, rather than primary etiologic factors in CRS, given its multifactorial nature involving inflammatory, infectious, and host mechanisms [1–3]. An uncommon but important sino-

nasal variant is the trans-sphenoidal optic nerve, in which the optic nerve indents into or traverses the sphenoid sinus. It carries clinical and surgical significance because it risks visual pathway injury during sinus disease or trans-sphenoidal procedures. The "through-sphenoid sinus" course occurs in the single-digit percent range, with higher rates for minor protrusions or indentations [4,5]. DeLano's classification categorizes optic nerve-sphenoid sinus relationships into four types, among which types II, III, and IV are clinically important due to their higher surgical risk. Type I: the optic nerve lies adjacent to the sphenoid sinus without indentation; type II: the nerve lies adjacent with indentation of the sinus wall; type III: the nerve courses within the sphenoid sinus (trans-sphenoidal); type IV: the nerve relates to both the sphenoid and posterior ethmoid air cells [5]. Key anatomic associations and surgical risk factors are (i) anterior clinoid pneumatization and optic canal bony dehiscence and (ii) sphenoid sinus hyperpneumatization and lateral recesses [5,6]. Clinical-surgical implications include (a) preoperative imaging: reviewing high-resolution CT with multiplanar reconstructions and explicitly reporting the DeLano type and associated anomalies; (b) surgical planning: identifying types II, III, and IV to modify surgical approach and limit instrumentation, while involving neurosurgery and ophthalmology experts; and (c) intraoperative risk reduction: avoiding aggressive manipulation of the lateral sphenoid sinus wall and recognizing anterior clinoid process pneumatization and lateral recesses of the sphenoid sinus, among other risk factors [4–8]. We report a unique case of an eighteen-year-old Iraqi male with bilateral trans-sphenoidal optic nerves and other sinonasal anomalies, highlighting their radiologic and surgical relevance to skull-base procedures and FESS. The current case study corresponds to Level-5 evidence per the Oxford Centre for Evidence-Based Medicine (OCEBM).

CASE PRESENTATION

An eighteen-year-old Iraqi male underwent paranasal CT at the Radiology Unit, Surgical Specialties Hospital, Baghdad Medical City. Clinical presentations and prior history were unavailable. The CT scan was acquired as part of a retrospective study assessing sinonasal anatomical variants in Iraqi patients with CRS versus controls. The paranasal sinus CT was performed with a 1-mm slice thickness. The CT images were accessed in Digital Imaging and Communications in Medicine (DICOM) format and reviewed using RadiAnt DICOM Viewer software (version 2025). 2). Orthogonal 2D multiplanar reconstructions (2D-MPRs) and 3D volume rendering (3D-VR) were used for assessment of sinonasal anatomy; all morphometric measurements were obtained from the 2D-MPRs. Using the 3D-VR imaging, the skull demonstrated a normal external appearance and no apparent skeletal defects. No radiologic features suggestive of a craniofacial syndrome were identified. Concerning the nasal cavity (Figure 1), the middle and inferior conchae were normal with no CB or paradoxical curvature; ostiomeatal units were patent bilaterally.

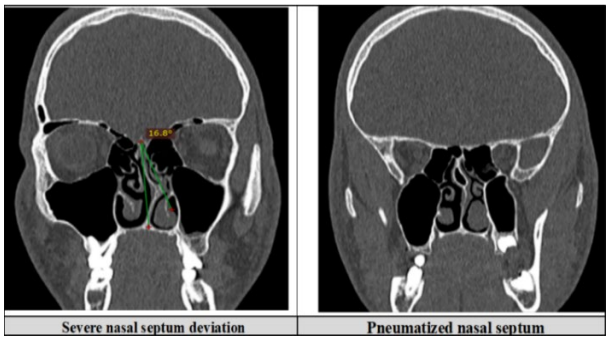

Figure 1: Coronal CT showing severe septal deviation and a pneumatized vertical ethmoidal plate.

Frontal and maxillary sinuses were normal, though bilateral intraluminal septa existed for both of the maxillary sinuses, with mild left maxillary Schneiderian thickening (<2.5 mm). Severe left-sided nasal septal deviation (NSD) of 16.8° (Figure 1) existed per the severity thresholds (normal 0–2°, mild 2–9°, moderate 9–15°, severe ≥15°) [9]. The ethmoidal perpendicular plate showed focal pneumatization (coronal area 0.41 cm²; width 4.76 mm; length 11.52 mm). The most striking anomaly involved the sphenoid sinus, which was markedly asymmetric and multi-septate. A left lateral recess extended toward the pterygoid process (coronal area 1.96 cm²; length 16.89 mm; width 12.61 mm) (Figure 2).

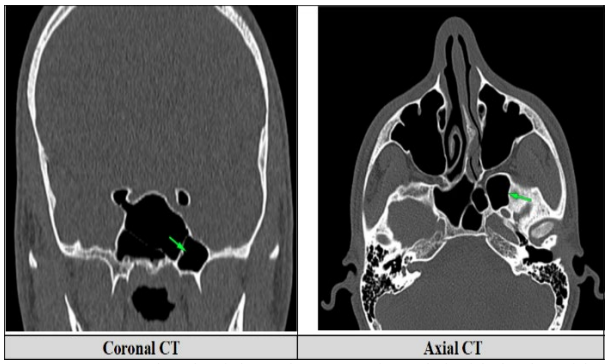

Figure 2: Coronal and axial CT demonstrating a left-sided sphenoid sinus lateral recess. *Green arrow (left-sided lateral recess).

Bilateral pneumatization of the anterior clinoid processes and a relatively small right OC were also identified (Figure 3).

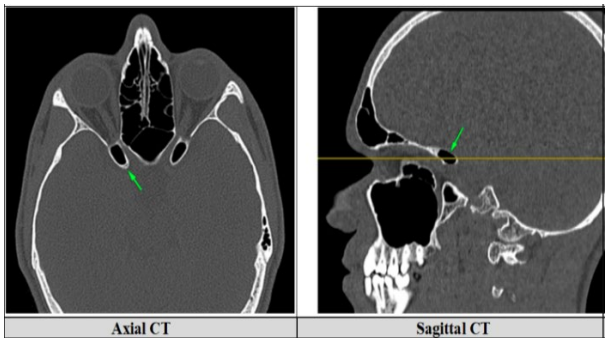

Figure 3: Axial and sagittal CT demonstrating bilateral anterior clinoid process pneumatization. *Green arrow (pneumatized clinoid process); horizontal yellow line (axial/sagittal cross-reference line).

Concerning the anomalous trans-sphenoidal course of the optic nerves, both passed through the sphenoid sinus while being encased by cortical bone and traceable in all planes from the orbital apex to the middle cranial fossa (Figure 4). The intraluminal sphenoid sinus course measured approximately 12 mm on the left and was slightly shorter on the right. The full trans-sphenoidal course is traceable on 2D-MPRs available in the Zenodo dataset (Data Availability statement). In the coronal plane, the optic nerves were roughly symmetric (mean area 0.21 cm²; mean diameter 4.96 mm).

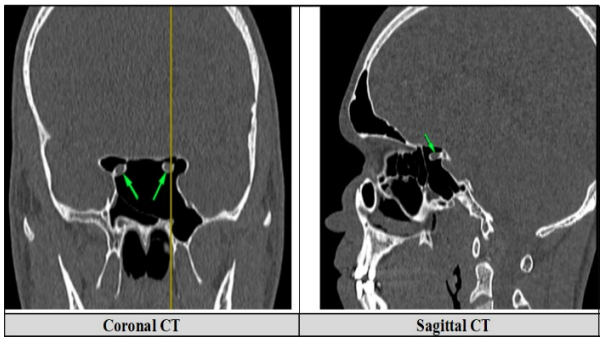

Figure 4: Bilateral trans-sphenoid sinus course of the optic nerves. *Green arrow (optic nerve); vertical yellow line (coronal/sagittal cross-reference line).

DISCUSSION

In the current case report, an incidental but clinically important finding in a young Iraqi male was the bilateral anomalous DeLano type III trans-sphenoidal course of the optic nerves. External craniofacial anatomy showed no dysmorphic features, yet the nasal cavity demonstrated severe left-sided NSD, multiple intraluminal septa in both maxillary sinuses, and minor left maxillary mucosal thickening. Further, the hyperpneumatized sphenoid sinus was markedly asymmetric and multi-septate with a left lateral recess, while the anterior clinoid process of the sphenoid bone was pneumatized bilaterally. These unusual relationships have important implications for radiologic interpretation and for planning sino-nasal procedures, including FESS. As introduced earlier, the CT images were obtained retrospectively from a case-control study investigating sinonasal anatomical variants among Iraqis. The study employed convenience sampling, and the observed frequency of the DeLano type III variant was approximately 1.41%, which is lower than DeLano's reported prevalence (6%). Several associated anomalies were recognized, including a multiseptated hyperpneumatized sphenoid sinus, bilateral pneumatization of the anterior clinoid process, and a possible association with right-sided OCs. The present case is particularly distinctive due to the co-existence of multiple anomalies involving the sphenoid, ethmoid, and maxillary sinuses. Notably, it demonstrates the concurrent presence of two rare anatomical variants: a unilateral OC and a DeLano type III variant. The reported prevalence of OCs varies widely, with estimates as low as 1.6% [10], while the DeLano type III configuration accounted for approximately 6% in DeLano's original study [5]. The co-existence of these two variants may represent an exceptionally rare anatomical constellation. The estimated joint probability is 0.096% (1:1,042 cases). When combined with additional anomalies, including sphenoid sinus hyperpneumatization with a lateral recess, intra-maxillary sinus septa, and bilateral anterior clinoid process pneumatization, the overall prevalence could be even lower. Additional anomalies involving the maxillary sinus were also identified, including multiseptated maxillary sinuses and mild focal thickening of the Schneiderian membrane; however, there was no radiological evidence of maxillary sinusitis. In a systematic review and meta-analysis, Valenzuela-Fuenzalida *et al*. (2023) analyzed 26 studies comprising 12,969 subjects [11]; they reported intra-sinus maxillary septa in 39% of cases, ranking among the three most common maxillary sinus variants, alongside CB (36%) and HCs (30%). Regarding OCs, although they may not directly cause sinusitis, their close anatomical relationship to the sphenoid sinus may impair sinus drainage and predispose to sphenoid sinusitis. In the current case, however, no radiological evidence of ethmoid or sphenoid sinusitis was identified, despite the presence of a combined spheno-ethmoidal anatomical anomaly.

Limitations and recommendations

A key limitation is the missing clinical context, which prevents clinical-radiological correlation. Possible indications for imaging include nonspecific headache, recurrent rhinosinusitis, preoperative sinus assessment, or visual manifestations. Symptoms may stem from adjacent pituitary or cavernous-sinus pathology, including endocrine disturbance or neurovascular/cranial nerve (III, IV, V_1/V_2, VI) manifestations. Three-dimensional reconstruction of the middle cranial fossa as a physical cast, 3D-printed model (Data Availability statement), or using virtual or augmented reality would clarify spatial relations among the optic nerves, chiasma, sella, pituitary, and cavernous sinuses. Detailed 3D mapping of the optic nerve from the orbital apex to the optic chiasma can improve interpretation, prognosis, surgical planning, and educational or simulation use. The optic nerve traversing through an aerated sphenoid sinus or being enclosed by an aberrant cortical bone may jeopardize arterial supply or venous outflow, causing ischemia and ipsilateral visual loss. Further, due to retinal fibers' decussation at the nearby chiasma, stereopsis may also be affected. A focused ophthalmic workup is therefore essential, including best-corrected visual acuity, color vision, pupillary responses, automated perimetry, dilated fundoscopy, optical coherence tomography (OCT), and visual evoked potentials (VEP). Fundoscopy should specifically assess for papilledema, as bony confinement may predispose the optic nerve to raised intracranial pressure. Using MRI is an essential complement to high-resolution CT in DeLano optic nerve variants, particularly types II, III, and IV. It offers superior assessment of soft tissues, including the entire visual pathway, and allows

evaluation of the sphenoid and posterior ethmoidal sinus mucosa. Histopathologic studies may also be needed to assess associated tumors or aberrant osseous tunnels, while suspected syndromes may benefit from next-generation sequencing to explore genetic and inter-ethnic associations.

Ethical statement

The relevant committee of the Department of Anatomy, College of Medicine, University of Baghdad, reviewed this case report and determined that formal ethical approval was not required. All patient data were fully anonymized, and no identifiable personal information was included. The requirement for written informed consent was waived because the study was retrospective in nature and the case was identified from the radiology unit database.

Conclusion

The presented case represents an unusually complex sino-nasal anatomy in a young adult Iraqi male with bilateral DeLano type III trans optic nerves traversing a hyperpneumatized sphenoid sinus. In such cases, early multidisciplinary input and focused preoperative radiologic evaluation are pivotal for planning skull-base surgeries or endoscopic procedures to reduce iatrogenic optic nerve injury. The retrospective nature, lack of clinical correlation, and level-5 evidence constrain causal inference. Prospective imaging of clinical cohorts is needed to define anomaly prevalence and operative risk and refine reporting standards.

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Conflict of interests

The authors declared no conflict of interest.

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Data sharing statement

The data of anonymized study are available from the corresponding author on reasonable request. Anonymized CT images and standard tessellation language (STL) file are deposited in the Zenodo repository at https://doi.org/10.5281/zenodo.18317996 and are publicly accessible. The STL file is provided in standard format suitable for 3D printing and computer-aided design.

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