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The Sellar Region as Seen from Transcranial and Endonasal Perspectives: Exploring Bony Landmarks Through New Surface Photorealistic Three-Dimensional Model Reconstruction for Neurosurgical Anatomy Training

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■ BACKGROUND: **Virtual reality–based learning of neuroanatomy is a new feasible method to explore, visualize, and dissect interactively complex anatomic regions. We provide a new interactive photorealistic three-dimensional (3D) model of sellar region microsurgical anatomy that allows side-by-side views of exocranial and endocranial surfaces to be explored, with the aim of assisting young neurosurgery residents in learning microsurgical anatomy of this complex region.**

■ METHODS: **Four head specimens underwent an endoscopic endonasal approach extended to the anterior and posterior skull base to expose the main bony anatomic landmarks of the sellar region. The same bony structures were exposed from a transcranial perspective. By using a photogrammetry method, multiple photographs from both endocranial and exocranial perspectives, different for angulations and depth, were captured, fused, and processed through dedicated software.**

■ RESULTS: **All relevant bony structures were clearly distinguishable in the 3D model reconstruction, which provides several benefits in neuroanatomy learning: first, it replicates bony structures with high degrees of realism, accuracy, and fidelity; in addition, it provides realistic spatial perception of the depth of the visualized structures and their anatomic relationships; again, the 3D model is interactive and allows a 360° self-guided tour of the reconstructed object, so that the learner can read the bones and their anatomic relationship from all desired points of view.**

■ CONCLUSIONS: **Detailed knowledge of key surgical landmarks representing keyholes and/or anatomic structures to not violate is mandatory for safer surgery, especially for a complex region such as the skull base. Highly accurate virtual and functional neurosurgical models, such as photogrammetry, can generate a realistic appearance to further improve surgical simulators and learn neuroanatomy.**

Key words
- Anatomy
- Endoscopic endonasal approach
- Neurosurgical training
- Photogrammetry
- Sellar region
- Skull base anatomy

Abbreviations and Acronyms
2D: Two-dimensional
3D: Three-dimensional
CPs: Protuberance of parasellar segment of internal carotid artery
CR: Clival recess
CS: Carotid sulcus
EEA: Endoscopic endonasal approach
ICA: Internal carotid artery
LOCR: Lateral optic-carotid recess
MCP: Middle clinoid process
MOCR: Medial optic-carotid recess
OC: Optic canal
OP: Optic nerve protuberance
OS: Optic strut
PC: Posterior clinoid
SF: Sellar floor
SSN: Suprasellar notch
TS: Tuberculum sellae

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INTRODUCTION

Detailed knowledge of microsurgical neuroanatomy combined with skill in surgical technique represent prerequisites for a neurosurgeon to perform safe and successful surgery. In this setting, a cadaver-based microneurosurgical laboratory represents an optimal environment for developing, improving, and refining these aspects through fine dissections and simulating neurosurgical operative procedures.[1] This laboratory-based training model has led, over the years, to the progressive discovery of new surgical corridors and to the development of increasingly minimally invasive approaches, allowing us to perform even more tailored surgical procedures and decrease mortality and morbidity, accordingly. These concepts are valid, especially in diseases affecting the skull base, which is a deep-seated, complex, and irregular bony surface, hidden by the inferior surface of the cerebral hemispheres and cerebellum, covered by a bony protuberance, grooves, and foramina, which convey vital and highly functional neurovascular structures, and understanding the anatomy of which represents simultaneously a challenge but is mandatory for avoiding/reducing intraoperative and postoperative life-threatening complications.

Over the last years, many technological tools have been proposed as alternative or complementary methods to cadaveric dissections for anatomy learning, such as digital teaching,[2] three-dimensional (3D) printing,[3-5] virtual augmented reality,[6] and surgical simulation,[7] each of which carries its own pros and cons. In this context, more recently, photogrammetry[8-10] fits; this technology, initially developed for use in surveying and mapping, because of its capability of accurately measuring distances between landmarks, and then introduced as a medical imaging technique in the mid-1990s,[11] consists of the reconstruction of highly realistic 3D model of an object starting from two-dimensional (2D) images through overlapping photographs using computer software. Several applications in neuroanatomy, both in research and in the clinical setting, have already been tested[9,10,12-16]; in addition, because of its peculiar advantages[8] (relatively inexpensive creation of authentic, digital, and virtually interactive anatomic models), it is useful for neuroanatomy education.

The aim of the present laboratory anatomic study was to design, starting from cadaveric dissections, a new photorealistic 3D model of virtual specimens to display the anatomy of both exocranial and endocranial surfaces of the sellar region fused in a unique interactive model and to discuss its role in the educational setting. This educational approach is especially useful for understanding the complex anatomy of the so-called mirror structures of the sellar region, anatomic landmarks that appear and are named differently from endoscopic endonasal and transcranial perspectives (i.e., suprasellar notch [SSN] versus tuberculum sellae [TS],[17] lateral optic-carotid recess [LOCR] versus optic strut [OS], medial optic-carotid recess [MOCR] versus middle clinoid process [MCP],[18] protuberance of parasellar segment of internal carotid artery [CPs] versus carotid sulcus [CS], optic nerve protuberance [OP] versus optic canal [OC], clival recess [CR] versus posterior clinoid [PC] and sellar floor [SF]) (Table 1). Furthermore, by simultaneously simulating both transcranial and endonasal perspectives, the trainee can easily recognize the mirror structures as seen from both viewpoints. This dual perspective approach greatly enhances the training.

METHODS

Anatomic Dissections

Four head specimens (2 dry skulls and 2 frozen embalmed and injected) underwent stepwise dissections.

An extended endoscopic endonasal transsphenoidal approach to the planum sphenoidale and clivus was performed as reported in the pertinent literature[19,20] to expose key bony anatomic landmarks of the posterior wall of the sphenoid sinus, consisting of bony protuberances and depressions (i.e., SSN, SF, MOCR and LOCR bilaterally, CPs and OP bilaterally, clivus-covering vulnerable neurovascular structures and configuring the so-called fetus face[21]) (Figure 1A).

At that point, the entire calvarium, dura mater, and cerebral hemispheres with neurovascular structures were removed, and the intracranial surface of the sellar region was exposed to clearly identify its transcranial bony landmarks (i.e., TS, ChS, SF, OC bilaterally, OS bilaterally, ACP and MCP bilaterally, CS and PC) (Figure 1B).

At the end of each dissection procedure, multiple images of the exposed areas of interest were captured through mobile telephone (Apple iPhone 14 [Apple Inc., Cupertino, California], camera 12 MP, optic zoom 2×).

Photorealistic 3D Model Creation: Technical Procedure

The first step consisted of acquisition of images. A telephone-based photogrammetry protocol was used to photograph the exposed areas after dissections.[22] Diffuse light over the specimen was enough to provide adequate illumination for sharp photographs. The camera was manually moved and more than 100 photographs (we considered 100 photos the minimum number necessary for a good reconstruction) were taken from as many different angles and depths as possible so that there were no blind spots remaining (Figure 2).

Photographs were then transferred to a dedicated photogrammetry telephone-based application, namely Metascan (Abound Labs Inc., New York, New York, USA), in which the data were cloud processed and later exported into Blender software 3.4.1 (Blender Foundation, Amsterdam, Holland), in which the primary 3D model was processed (optimization for Web sharing). The final 3D model was uploaded to an online 3D viewer platform (Sketchfab [Sketchfab Inc, New York, New York, USA]) for anatomic annotation of the structures of interest.

RESULTS

3D Model Reconstruction

The original texture and color of the sellar region were preserved in the 3D model, such that all the relevant bony structures were clearly distinguishable. In addition, although the sphenoidal sinus is an internal cavity, a relative depth was conferred: more shallow spaces appeared lighter and less shadowed; deeper negative spaces appeared darker.

Table 1. Key Anatomic Landmarks of Sellar Region at Mirror: Exocranial and Endocranial Perspectives

	Exocranial Perspective	Endocranial Perspective
Landmarks	Suprasellar notch	Tuberculum sellae
	—	Chiasmatic sulcus
	Lateral optic-carotid recess	Optic strut
	Medial optic-carotid recess	Middle clinoid process
	Carotid protuberance	Carotid sulcus
	Optic nerve protuberance	Optic canal
	Clival recess	Posterior clinoid
	Sellar floor	Sellar floor

Anatomic Bony Landmarks at Mirror: Depressions versus Prominences

The extended endoscopic endonasal transsphenoidal approach to the anterior and posterior skull base provides exposure of ventral median key bony anatomic landmarks, in the form of bony prominences and depressions, some even and symmetric, others uneven in the midline, which represent both keyholes for accessing deep lesions or structures hosting highly functional and/or vital neurovascular structures, detailed tridimensional anatomy knowledge of which is crucial for safer surgery.

SSN versus TS. SSN,[17] the deep angle resulting from the convergence of the planum sphenoidale and SF, exposed via an endonasal route is an uneven midline landmark that was clearly identifiable for its entire depth in the 3D model (Figures 3A and 4A). This wide shallow depression, bounded superiorly by a line joining the 2 LOCRs, inferiorly by a line crossing just above the superior margin of the sella, and laterally by the medial aspect of the parasellar segment of the internal carotid arteries, corresponds to the bony prominence, rectangular, namely TS exposed through transcranial route,[23] and forming the anterior wall of sellar turcica (Figures 3 and 4B–D).

Chiasmatic Sulcus. The chiasmatic sulcus is a shallow groove from the endocranial perspective in which is located the optic chiasm (Figures 3 and 4B and D); it is bounded by the optic foramina bilaterally, the TS posteriorly, and the planum sphenoidale anteriorly. It has no exocranial intrasphenoid counterpart.

OP versus OC. The OP appeared from an endonasal perspective as symmetric channels running from distal to proximal, from medial to lateral, in divergent courses (Figures 3 and 4A). On the intracranial surface, the OC can be identified at the junction of the lesser wing with the sphenoid bone body, bounded by the

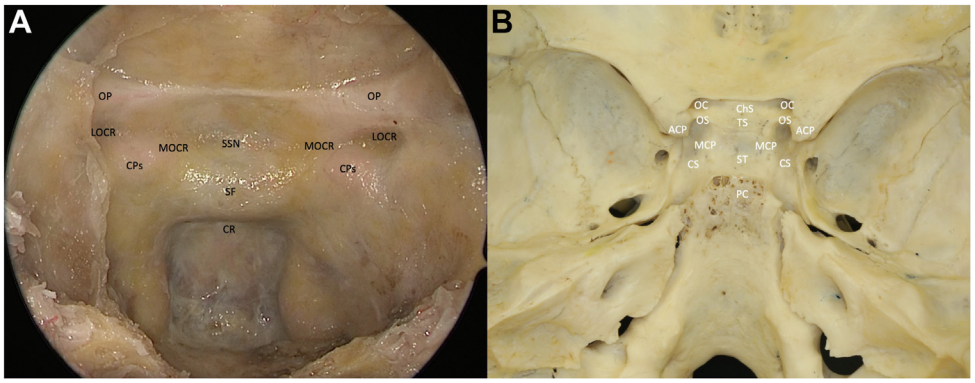

Figure 1. Key bony anatomic landmarks of the sellar region. (**A**) The posterior wall of the sphenoid sinus (so-called fetus face): forehead corresponds to the sphenoid planum, the eyes to the 2 lateral optic-carotid recesses (LOCRs), the eyebrows to the 2 optic nerve protuberances (OPs), the nose to the sellar floor (SF), the mouth to the clivus, the cheeks to the protuberance of the parasellar segment of the internal carotid artery (CPs) from an endoscopic endonasal perspective. (**B**) Intracranial surface. MOCR, medial optic carotid recess; SSN, suprasellar notch; CR, clival recess; ACP, anterior clinoid process; MCP, middle clinoid process; OS, optic strut; OC, optic canal; ChS, chiasmatic sulcus; TS, tuberculum sellae; CS, carotid sulcus; ST, sella turcica; PC, posterior clinoid.

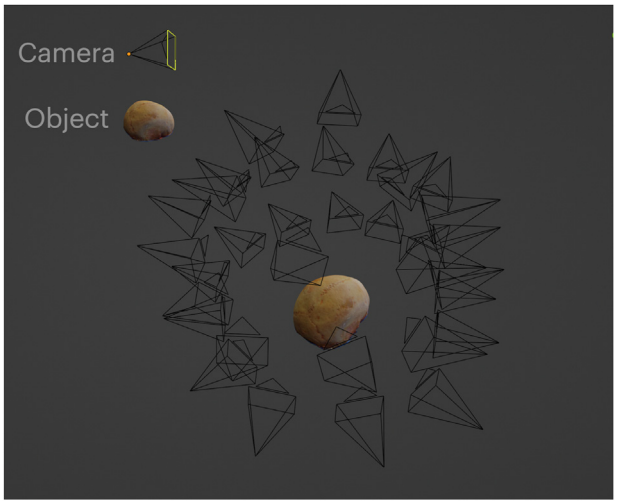

Figure 2. Photorealistic three-dimensional model reconstruction: virtual model of images capture making photos from different angles and distances but at 360° around the object to reconstruct.

OS laterally and situated medially to the anterior clinoid process and OS. The upper, medial, lower, and lateral margins of the OC, formed by the anterior root of the lesser sphenoid wing, body of the sphenoid bone, and OS, respectively, are also clearly identifiable (Figure 3 and 4B–D).

LOCR versus OS. An indentation, lateral to the junction between the optic and internal carotid artery (ICA) prominences, bilaterally, exposed through an endoscopic endonasal corridor, namely the LOCR, was detailed appreciably in the 3D reconstructed model (Figures 3 and 4A). This structure corresponds to the OS, also known as the posterior root of the lesser sphenoid wing exposed via transcranial approaches, a bony ridge that separates the OC (medially) and superior orbital fissure (laterally), forming with its superior surface the floor of the OC and with its inferior surface the medial wall of the superior orbital fissure, respectively. The OS blends superolaterally into the base of the anterior clinoid process and inferomedially into the body of the sphenoid bone (Figures 3 and 4B–D).

MOCR versus MCP. The MOCR is a shallow bony depression identifiable at the confluence of the sella (medially), TS (anteriorly), carotid protuberance (laterally), OC (anterolaterally), and planum sphenoidale through an endonasal route (Figures 3 and 4A). Its intracranial counterpart corresponds to the MCP, a small bony prominence projecting upward from the medial surface of the terminal part of the CS and medially to the tip of the anterior clinoid process (Figures 3 and 4B–D).

CPs versus CS. A curved bony protuberance hosting the distal parasellar segment of ICA runs from lateral to medial, from deep to superficial, with inferolateral convexity, limited by the MOCR and LOCR medially and laterally, respectively, from an endonasal perspective (Figures 3 and 4A). It corresponds on the intracranial surface to the anterior third of the CS, which is a shallow groove on the lateral surface of the sphenoid bone body hosting the horizontal tract and the ascending distal segment of the cavernous ICA. The CS originates inferolaterally to the dorsum sellae where the carotid canal ends, then continues forward to groove the sphenoid bone body laterally to the SF and ends

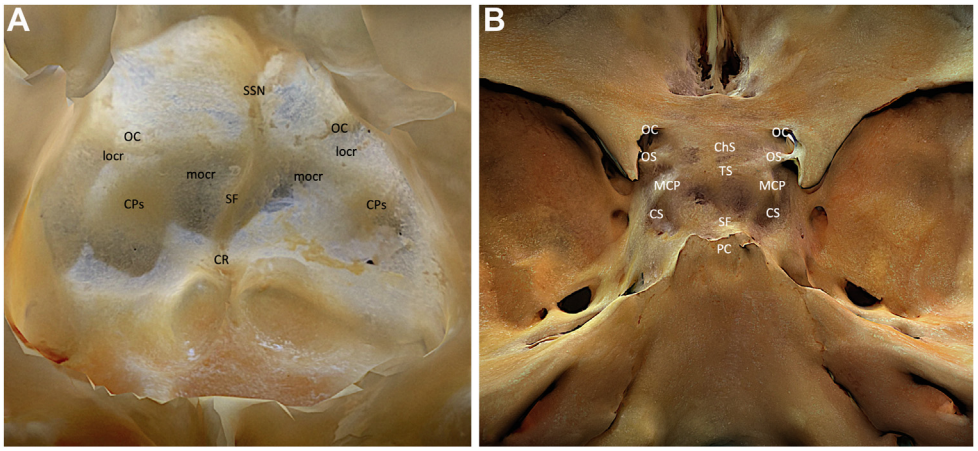

Figure 3. Photorealistic three-dimensional model reconstruction showing main bony landmarks of posterior wall of sphenoid sinus from an endonasal perspective (**A**), namely suprasellar notch (SSN), optic nerve protuberance (OP), medial (mocr) and lateral (locr) optic-carotid recesses, sellar floor (SF), carotid sulcus (CS) and posterior clinoid (PC) corresponding to tuberculum sellae (TS), optic canal (OC), middle clinoid process (MCP) and optic strut (OS), sellar floor (SF), parasellar segment of carotid protuberance (CPs) and clival recess (CR) from transcranial perspective (**B**). Chiasmatic sulcus (ChS) identifiable on the intracranial surface does not have a mirror structure from an endonasal perspective.

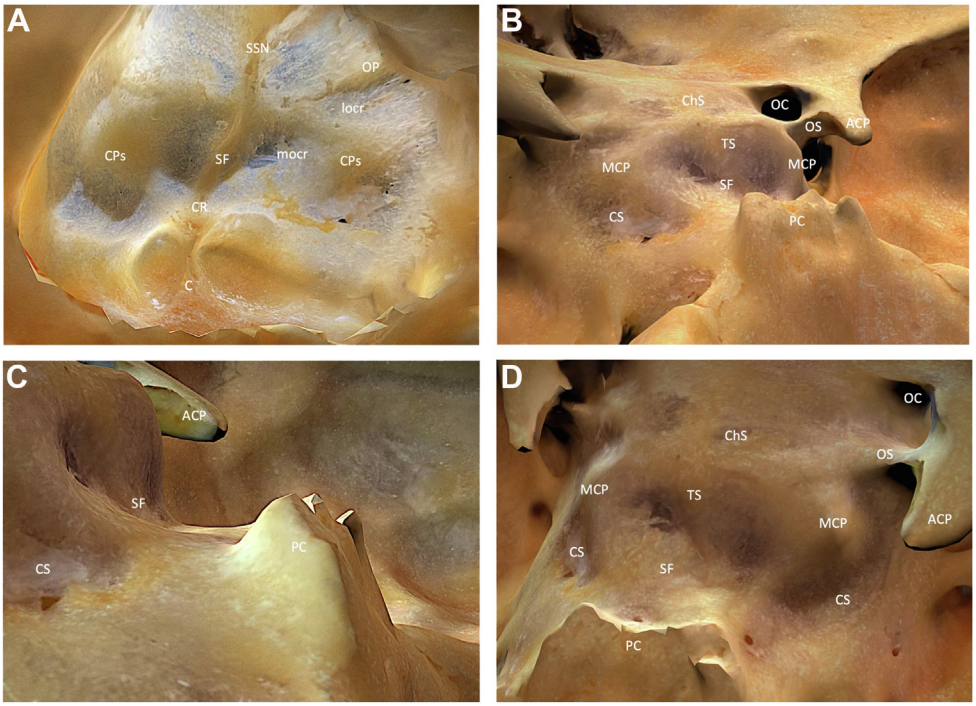

Figure 4. Photorealistic three-dimensional model reconstruction showing main bony landmarks of the sellar region through endonasal (**A**) and transcranial perspectives (**B**–**D**) from different angulations. SSN, suprasellar notch; OP, optic nerve protuberance; mocr, medial optic-carotid recess; locr, lateral optic-carotid recess; SF, sellar floor; CS, carotid sulcus; PC, posterior clinoid; TS, tuberculum sellae; OC, optic canal; MCP, middle clinoid process; OS, optic strut; CPs, parasellar segment of carotid protuberance; CR, clival recess.

turning upward medially to the anterior clinoid process (Figures 3 and 4B–D).

CR versus PC. The CR, the deep angle resulting from the convergence of the dorsum sellae (posteriorly) and SF (anteriorly), exposed via an endoscopic endonasal route was identifiable in the 3D photorealistic model (Figures 3 and 4A). This wide shallow indentation corresponds to the bony prominence, rectangular, namely the PC, exposed through a transcranial route and forming the posterior wall of the sella turcica (Figures 3 and 4B–D).

DISCUSSION

Anatomy is the most ancient medical discipline to be taught and several educational methods have succeeded each other over centuries, starting from cadaveric animal and human dissection, through plastination, observation of live models, live surgery, radiology instruments, up to more recent virtual reality models.[24] Although many scientific reports stress the leading role of cadaveric dissection in neurosurgical training,[1,25,26] combining microsurgical anatomy learning and technical skills acquisition, shifts in medical education toward a more technology-based curriculum were already occurring before the coronavirus disease 2019 pandemic and are undoubtedly ongoing. In this setting fits photogrammetry, which is defined as "the art, science and technology of obtaining reliable information about physical objects and the environment through processes of recording measuring and interpreting images and patterns of electromagnetic radiant energy and other phenomena".[27] Since its first application in microsurgical neuroanatomy,[8] several laboratory studies have been reported,[9,10,14-16] focusing on fiber dissection,[10] various neurosurgical approaches,[14] white matter connectivity of the human brain,[15] and anatomy of the brain hemisphere surface.[16]

Our anatomic laboratory study investigated one of the most complex regions of the skull base, namely the sellar region, providing its reconstruction in a photorealistic interactive 3D model that allows comparison of the endonasal and transcranial point of views of the same anatomic structures, which represent key anatomic landmarks during the endoscopic endonasal approach (EEA) and which guide surgery. Detailed knowledge of these bony structures is mandatory for a neurosurgeon; indeed, bony landmarks serve as crucial reference points in skull base surgery, particularly within the sellar region, given their role as immutable navigational markers during surgical procedures. Some of them are strategic keyholes to safely access deep lesions (e.g., SSN for accessing lesions of suprasellar space, or SF for pituitary lesions, or removing bone

Table 2. Main Advantages and Limits of Photogrammetry Applied in Neurosurgical Training

Advantages	Limits
Easy to perform	Need of light
Quick and cost-effective collection of data	Reflective surfaces decrease images resolution
Highly accurate, reliable, quantifiable results	Minor resolution for deep-seated cavities
Effectively used to simulate angles of attack of a neurosurgical approach	Time consumption: creating accurate three-dimensional models using photogrammetry can be time-consuming
Easy to re-process data for new information	Inaccuracy in measurements: although it can provide visual representations, the exact measurements (e.g., distances between structures) can be imprecise, especially when compared with modalities such as magnetic resonance imaging or computed tomography
Interactive model	Not suited for quantitative analysis: because of potential inaccuracies in measurements, photogrammetry might not be the best tool for quantitative analysis in neurosurgery
Anatomy exposure at 360°	Dependency on image quality: the accuracy of photogrammetry heavily relies on the quality of the images used. Any distortion, blurriness, or inconsistency in the photographs can lead to inaccuracies in the final model
Highly realistic	
Depth perception	

at the level of the MOCR on both sides is important for attaining wider views of the supraclinoid portion of the ICA and the optic nerve[28]); others could be seen as red flags (i.e., bony structures hosting highly functional, e.g., optic nerve, or vital structures, e.g., protuberance of CPs) to be identified and not violated.

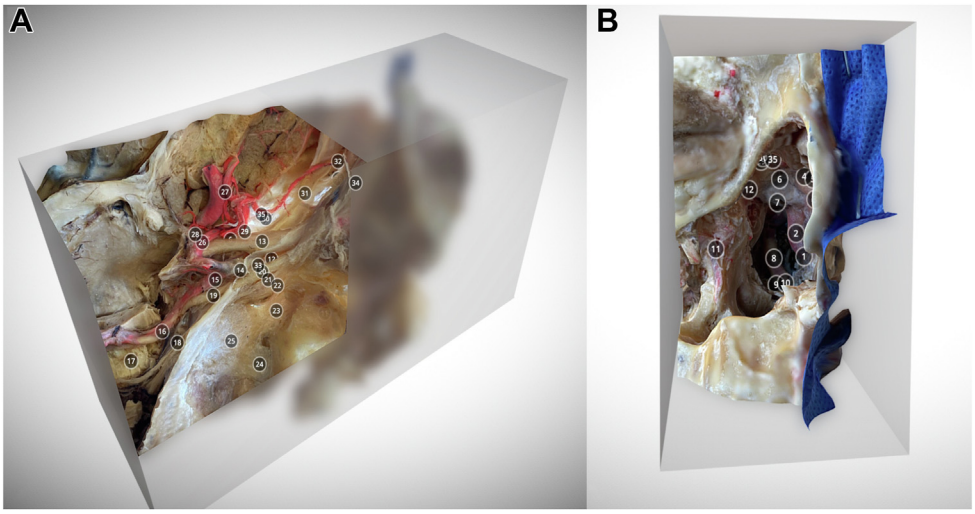

Figure 5. Anatomic three-dimensional (3D) box-type preparation concept from photogrammetry scanned specimen presenting the sellar region from an exocranial and endocranial anatomic perspective. A focused formaldehyde-fixed cadaver head dissection was a whole-head specimen photogrammetry-based surface scanning. As a surface scanning methodology, it can present only the surface relief along with the textures and the inside of the 3D model is empty (in contrast to volumetric computed tomography scanning). Therefore, if the photogrammetry 3D model is sectioned, the hollow part of the model is visualized, which reduces the anatomic accuracy of the model. Therefore, to create a representative anatomic study model, we used basic 3D modeling in Blender software and placed the sectioned photogrammetry scanned model in a semitransparent glass box and presented only the anatomic regions of interest (parasellar endocranial/exocranial perspective) that are important for the current study. All important structures are labeled and the camera automatically turns to the appropriate perspective on selection of the desired anatomic structure.

Sellar region surgery via the endonasal corridor has evolved over the years from microsurgical approaches,[29] through endoscopic-assisted procedures, to purely endoscopic procedures,[30,31] first using 2D endoscopes and, more recently, 3D endoscopes, as optical devices, progressively providing increased visualization of the target area. In particular, 3D endoscopes enhance visuospatial orientation and improve understanding of the relationships between anatomic structures, aspects that are especially important when you are dealing with the subtle septa, bony ridges, and shallow grooves of the skull base covering important neurovascular structures, and identification of which is fundamental for selecting safe entry zones and for preserving vulnerable healthy tissues. Recognition of anatomic landmarks becomes even more important when neuronavigation is unreliable.

Early identification of the fetus face during the sphenoid phase accounts for the low mortality and morbidity of the EEA[32]; identifying the CPs during pituitary surgery via EEA makes it possible to work in a corridor between them, but keeping them under control at all times. Because a key concept of skull base surgery consists of drilling and flattening of bony prominences to expand the surgical corridor and decrease brain retraction, it is important to know exactly what there is beyond the drilling to avoid intraoperative and postoperative life-threatening complications.

Bony structures that appear as protuberances from an endocranial perspective appear as depressions from an exocranial perspective, and vice versa. Just as anatomic feasibility studies can drive neurosurgical procedures,[33] similarly, photogrammetry is a digital tool that can drive microsurgical neuroanatomy learning and assist neurosurgical residents' training. A 3D reconstruction interactive photorealistic model provides several benefits in neuroanatomy learning: first, it replicates bony structures with high degrees of realism, accuracy, and fidelity; in addition, it provides a realistic spatial perception of the depth of the visualized structures and their anatomic relationships, compared with flat 2D reproductions; again, because it can be rotated in any spatial axis, the 3D model is interactive and allows a 360° self-guided tour of the reconstructed object, so that the learner can read the bones and their anatomic relationship from all desired points of view and distances. These concepts are fundamental for a better learning of the microsurgical anatomy of a region as complex as the sellar region, which is not flat and linear but features mountains, peaks, and valleys. Photogrammetry can be effectively used to simulate the angle of attack of a neurosurgical approach. Reconstructing the spatial environment and the anatomic structures allows for precise visualization from the perspective of a surgeon.

The 3D photorealistic model carries numerous other advantages: it is easy to perform; collection of data is quick and cost-effective; results are reliable and quantifiable; collection of data is permanent and accurate (**Table 2**). In addition, it avoids the inconveniences related to cadaver use: the lack of availability; economic costs of the specimens and facilities for their use; discomfort of manipulating the toxic substances required to preserve the cadaver; and the psychological effects of facing a dead person.

On the other hand, the complex process is subject to several limitations and technical considerations: moving objects or featureless surfaces might interfere with the measuring process because they might provide insufficient or conflicting data; in low-light conditions (i.e. deep cavities, such as the sphenoid sinus), some segments of the image might be blurred. To overcome this limitation, image acquisition from the head specimen for reconstruction of the sellar region from an endonasal perspective requires the adoption of an endoscope light source, as in our study, or a wide exposure of the target area through extensive resection of nasal and maxillary bones. As we can appreciate from the present study, although the sphenoidal sinus is an internal cavity, a relative depth was conferred: more shallow spaces appeared lighter and less shadowed; deeper negative spaces appeared darker.

Reflective surfaces are known to decrease the resolution and quality of 3D-rendered photogrammetric models.

The 3D models we have made so far have been uploaded to https://sketchfab.com/3d-models/exo-endo-dry-skull-c2eb0875910 14809ba22052f451e698 and can be observed free of charge.

Although the present study is focused on bony anatomic landmarks, photogrammetry allows reconstruction of a 3D photorealistic and interactive model including soft tissues and neurovascular structures too, such as in the setting of the sellar region, ICA and its branches, optic, oculomotor, trochlear, abducens, and ophthalmic nerves, which can be explored side by side, together with related well-known anatomic triangles, from above and from below[34,35] (**Figure 5**). From the EEA perspective, the parasellar segment of the ICA, after skeletonization of its bony protuberance, comes into endoscopic view before the cranial nerves, which lie in the lateral wall of the cavernous sinus, sitting laterally to the pituitary gland and medially to the abducens; conversely, from a transcranial view, it is possible to appreciate the cranial nerves hosted in the cavernous sinus lateral wall, from superior to inferior, III, IV, V1, covering the sixth cranial nerve and cavernous ICA. Detailed knowledge of the anatomic relationship of these structures is of paramount importance for approaching the lesions involving primarily or secondarily the cavernous sinus from the different corridors, including transcranial, endonasal, and more recently transorbital.[34] In this scenario, because cranial nerves III, IV, and V1 and the ICA are seated on 3 different spatial planes, 3D model reconstruction allows us to perceive the sense of depth and distance between them, which is not provided by a flat 2D anatomic atlas.

A 3D photorealistic and interactive model reconstruction of the sellar region from endonasal and transcranial perspectives, including neurovascular structures, has been uploaded to https://sketchfab.com/3d-models/exo-endocranial-perspective-dissection-ea6578698f054a9094eead2ec9cad98e and can be consulted free of charge.

Limitations of the Study

Limitations of this study are the anatomic interindividual variability, including bone degrees of pneumatization, bone thicknesses, and bone mineralization, and the relatively small number of specimens used.

The scope of this study is confined to the delineation of bony anatomy within the sellar region, deliberately omitting soft tissue structures. This approach was chosen to enhance clarity and

provide a more focused exposition of the anatomic landmarks that are pivotal for surgical orientation. Consequently, although this selective emphasis on bony features aids in a clear and direct anatomic display, it also constitutes a limitation of the study, because the comprehensive surgical landscape, including soft tissue relationships, is not addressed.

CONCLUSIONS

Although some aspects resulting from cadaveric specimen dissection can be replicated in alternative ways, cadaver laboratory experience remains, in our opinion, a milestone in the training of neurosurgical residents. In our view, photogrammetry serves as an invaluable tool for introducing young residents to neurosurgery. It acts as a preparatory step for microsurgical neuroanatomy learning, particularly when dealing with intricate regions such as the skull base.

CRediT AUTHORSHIP CONTRIBUTION STATEMENT

Sergio Corvino: Conceptualization, Data curation, Investigation, Methodology, Writing – original draft. **Amedeo Piazza:** Conceptualization, Data curation, Methodology. **Toma Spiriev:** Data curation, Methodology, Software, Supervision, Validation. **Roberto Tafuto:** Investigation, Methodology. **Francesco Corrivetti:** Methodology. **Domenico Solari:** Supervision. **Luigi Maria Cavallo:** Supervision. **Alberto Di Somma:** Conceptualization, Data curation, Investigation, Methodology, Supervision. **Joaquim Enseñat:** Supervision. **Matteo de Notaris:** Conceptualization, Data curation, Methodology, Supervision. **Giorgio Iaconetta:** Supervision.

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