The Role of Anterior Ethmoidal Artery During Endonasal Endoscopic Access to the Lateral Frontal Sinus and Skull Base

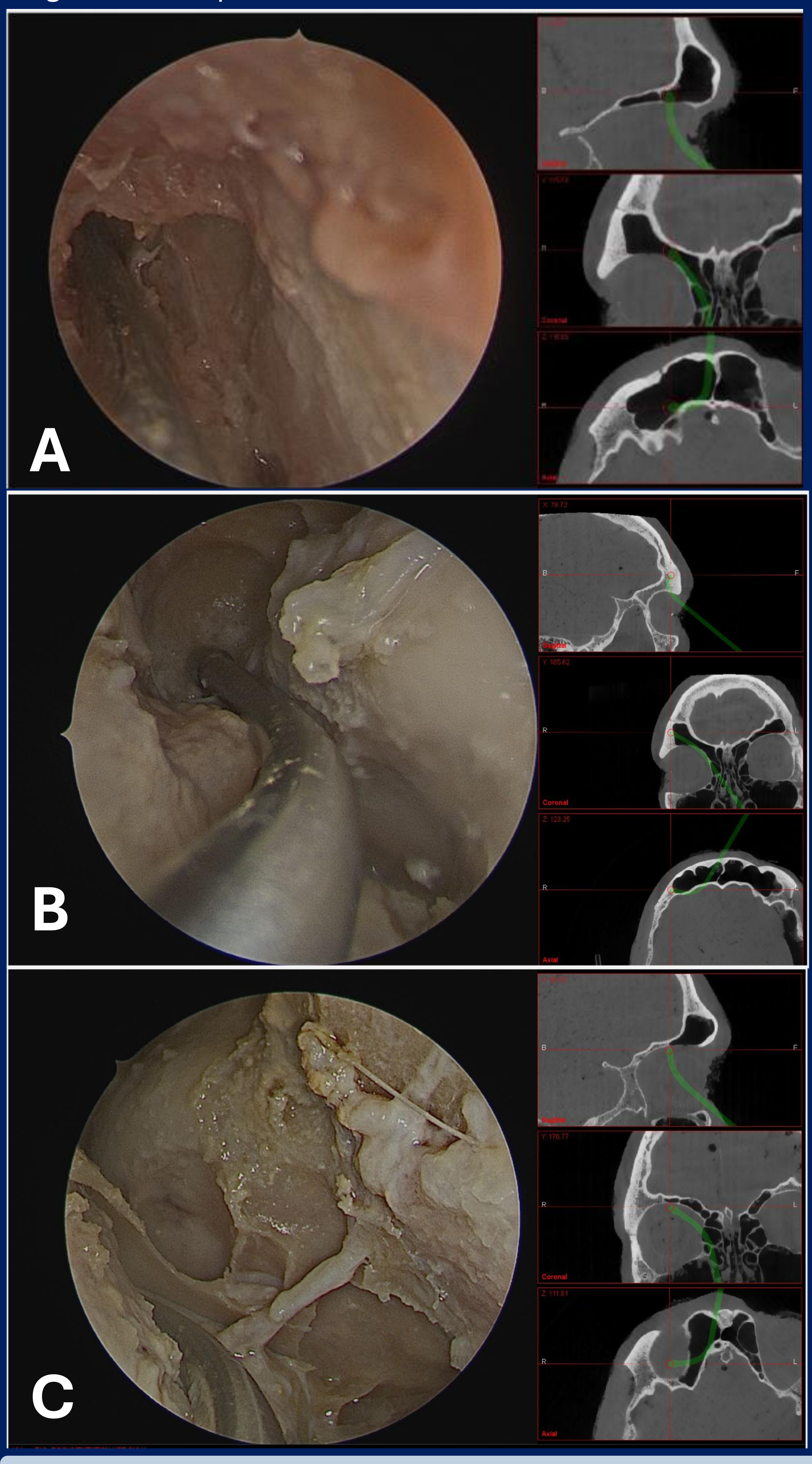
Cem Meco[1,2,3], Suha Beton[1], Hazan Basak[1], Nihal Apaydin[4]

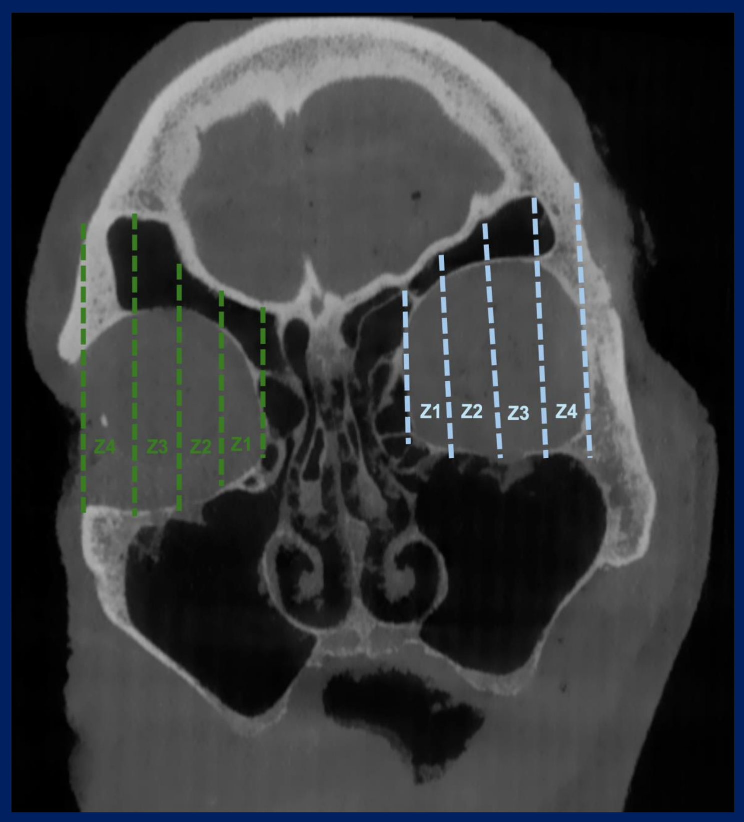
[1]Ankara University Medical School, Department of Otorhinolaryngology Head and Neck Surgery
[2]Salzburg Paracelsus Medical University, Department of Otorhinolaryngology, Head and Neck Surgery
[3]Cornell University, Weill Cornell Medical Collage, Department of Otolaryngology, Head and Neck Surgery
[4]Ankara University Medical School, Department of Anatomy

Accessing the lateral portion of the frontal sinus and skull base during endonasal endoscopic surgery remains a significant challenge due to anatomical constraints, particularly in cases of well-pneumatized frontal sinuses. Traditional endonasal techniques, such as Draf procedures, often fail to provide sufficient access, necessitating external approaches that are invasive and cosmetically undesirable. The periorbital suspension technique has shown promise in overcoming these limitations.[1-7] This study evaluates the role of the anterior ethmoidal artery (AEA) in enabling enhanced access and manipulation of lateral frontal sinus, supraorbital recess, orbital roof and associated skull base through endonasal endoscopic approaches (EEA).

Method

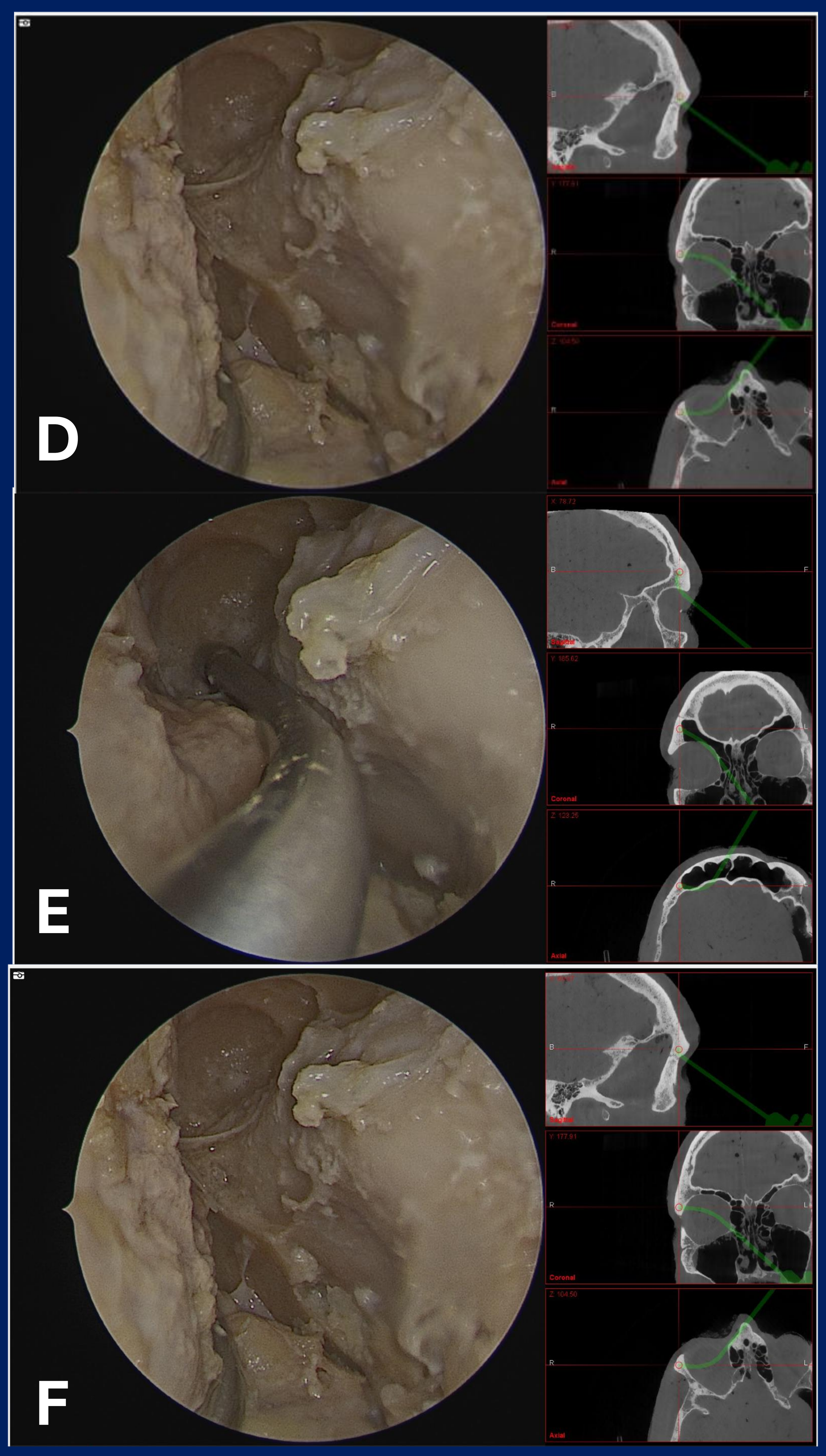
In this study we used 5 cadaver heads with 10 sides that have computed tomography (CT) done before dissections. Pre-dissection CT scans assessed frontal sinus pneumatization and the supraorbital recess anatomy. Gradual dissections were done using Draf 2A, 2B, and 3 procedures to evaluate access to Zones 1–4 (defined anatomically by orbital quadrants). Using a navigation system (Storz, Germany) measurements for visualization (V), visualized reach (VR) as well as manipulation under vision (MUV) to all areas within a Zone but especially to the far lateral aspect of the frontal sinus, skull base and supraorbital recess area through EEA were documented to determine the extent of access on every occasion using 0-, 30- and 45- degree endoscopes. Then dissection and transection of the AEA was done followed by the completion of the periorbital suspension technique through removing the bony lamina papyracea and orbital roof and utilizing a malleable brain retractor to suspend periorbita laterally. After addition of periorbital suspension to the surgical approach, the same measurements were done again from the ipsilateral nostril to see the additional effect on Draf 2B approach and from the contralateral side nostril to see the additional effect on Draf 3 approach to assess periorbital suspension's impact on V, VR and MUV on both occasions with 0-, 30- and 45-degree endoscopes.





Orbital Zones on CT scan (Fig. 1)

- **Zone 1:** Medial quarter of the orbit.
- **Zone 2:** From Zone 1 to the midorbital point.
- **Zone 3:** Lateral to the midorbital point, extending halfway to the lateral orbital edge.
- **Zone 4:** Lateral-most quarter of the orbit.



Endoscopic dissection views with three-planar CT demonstration of trajectory and tip of curved instrument using the navigation system

A) Draf 2A approach allowing limited VR to Zone 2 using curved (70^0) instruments **B)** Draf 2B approach enabling V and VR to Zone 3 almost all of zone 4 with 30^0 endoscope. **C)** AEA limiting lateral suspension of orbita. **D)** AEA transected and periorbital suspension done with the curved instrument through Draf 2B to far lateral frontal and orbital roof. V, VR and MUV along the orbital roof and far lateral frontal/supraorbital recess possible with more than 1,5 cm space created inferiorly through periorbital suspension. **E)** Endoscopic view through solely Draf 3 approach demonstrating V, VR and MUV access to the Zone 4, however difficult MUV along lateral orbital roof. **F)** Draf 3 with periorbital suspension providing better access and easier MUV to orbital roof as well as all lateral, posterior and anterior walls with better MUV at the junctions in comparison to Draf 2B with periorbital suspension.

Results

Pre-dissection CT's of 10 sides of 5 cadaver heads dissected, revealed a frontal sinus pneumatization of Zone 4 in 4 sides, Zone 3 at 5 sides and Zone 2 at 1 side. The mean distance from midline to the midorbital point was 29 ∓ 2.7. The mean distance between the frontoethmoidal sutures was 22.7 ∓ 2.5. The shortest distance from the first olfactory neuron or olfactory fossa to the inner periosteum of Frontal sinus measured 15.8 ∓ 2.5.

Zone 1 posterior wall was easily visualized with a 30- and even better with a 45-degree endoscope, but anterior wall visualization was limited even with a 45- degree through a Draf 2A approach. Visualized reach (VR) was limited in general and manipulation under vision (MUV) was not possible. When a Draf 2B was done, Zone 1 had no problems for V, VR and MUV with a 45- degree endoscope. **Zone 2** posterior wall could be visualized to an extend with a 45- degree through a Draf 2A approach but V was limited and VR and MUV was not possible at the anterior wall and orbital roof. When a Draf 2B was done VR and MUV was possible at all surfaces of Zone 2. Beyond the midorbital point at **Zone 3**, Draf 2A provided limited general visualization and Draf 2B with a 45- degree endoscope allowed good visualisation and VR of anterior and far lateral frontal walls with curved instruments. However, despite improved access to Zone 3; MUV was limited, and especially manipulation of the orbital roof remained challenging and was not possible at the lateral aspect. It was possible to have adequate VR to this area coming from the contralateral side after conducting a Draf 3 approach, but MUV remained challenging and was either limited or not possible at the very far lateral aspect especially along the orbita roof and anterior wall. The most lateral **Zone 4** could be visualized well with a 45-degree endoscope starting from Draf 2B approach but VR and MUV was not possible. Draf 3 helped to have better V but still limited VR and MUV but even coming from the contralateral side, this Zone couldn't be reached adequately for VR and MUV to conduct proper surgery.

Transection of AEA being the only medial attachment of periorbita enabled risk free laterilization of periorbita after removing the bony lamina papyracea and orbital roof as much as needed. Malleable brain retractor used to suspend periorbita laterally also helped to protect integrity of the periorbita and provided a strong protection but also helped to the stable use of the introduced instruments. **Addition of periorbital suspension to Draf 2B** provided full and even better access for V, VR and MUV to the orbital roof, supraorbital recess, and lateral aspect of the frontal sinus anterior as well as posterior walls at all Zones, overcoming all difficulties earlier mentioned for each Zone with Draf 2B and Draf 3 approaches alone and even occasionally by reducing the angle of the endoscope to 30- and rarely to 0- degrees. However, **addition of periorbital suspension to Draf 3** provided an even better angle for MUV as using both nostrils were possible providing a larger angle to reach to the most lateral areas within the frontal sinus. Additionally, it was much easier to reach the corner areas between the edges of anterior and posterior walls for MUV as using both nostrils enabled introducing endoscopes and instruments from different nostrils facilitating improved mobility in contrast to single nostril use in Draf 2B.

Conclusion

Our dissection findings confirmed that the AEA plays a key role as an anatomical structure to perform periorbital suspension procedure to be added to Draf 2B and Draf 3 approaches. Transection of the AEA facilitates periorbital suspension, significantly enhancing access and maneuverability to the far lateral frontal sinus, orbital roof, supraorbital recess and associated skull base. In the light of this anatomical study, the extent of adequate necessary approach to these areas can be better tailored to address individual pathology for the best possible outcome. Our study reveals that while adding periorbital suspension to Draf 2B could solve most of the problems in almost all instances, combining Draf 3 with the periorbital suspension technique represents the most effective approach for lateral frontal sinus and skull base surgeries, reducing the need for external procedures.

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