The transbasal approach (TBA) is an anterior craniofacial skull base approach providing access to the anterior skull base, paranasal sinuses, sellar-suprasellar region, and clivus. The TBA typically involves a bifrontal craniotomy with orbital bar and/or nasal bone osteotomies performed in 2 separate steps. The authors explored the feasibility of routinely performing this approach in 1 piece with a quantitative cadaveric anatomical study, and present an operative case example of their approach.

Methods. Seven latex-injected cadaveric heads underwent a 1-piece TBA, followed by additional bone removal typical for a traditional 2-piece approach. Six surgical angles relative to the pituitary stalk, as well as the surface area of the orbital roof osteotomy, were measured before and after additional bone removal. The vertical angle from the frontonasal suture to the foramen cecum was measured in all specimens. In addition to an anatomical study, the authors have used this technique in the operating room, and present an illustrative case of resection of an anterior skull base meningioma.

Results. Morphometric results were as follows: the vertical angle from the frontonasal suture to the foramen cecum ranged from 17.4° to 29.7° (mean 23.8° ± 4.8°) superiorly. Of the 6 surgical angle measures, only the middle horizontal angle was increased in the 2-piece versus the 1-piece approach (mean 43.4° ± 4.6° vs 43.0° ± 4.3°, respectively; p = 0.049), with a mean increase of 0.4°. The surface area of the orbital osteotomy was increased in the 2-piece versus the 1-piece approach (mean 2467 mm² ± 360 mm² vs 2045 mm² ± 352 mm², respectively; p < 0.001). The patient in the illustrative clinical case had a good outcome, both clinically and cosmetically.

Conclusions. The 1-piece TBA provides an alternative to the traditional 2-piece approach. It allows easier reconstruction, potentially decreased operative time, and improved cosmesis. While more of the orbital roof can be removed with the 2-piece approach, this additional bone removal offers only a small increase in 1 of 6 surgical angles that were measured.

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KEY WORDS • transbasal approach • subfrontal • anterior skull base • orbital osteotomy • cranial base surgery • 1 piece • anatomy

Abbreviation used in this paper: TBA = transbasal approach.
The 1-piece transbasal approach

Methods

Surgical Technique

A standard bicoronal incision was performed, reflecting the scalp and pericranium anteriorly as separate layers, and exposing the frontonasal suture, superior orbital rim, and superior aspects of the medial and lateral orbital rims. The periorbita was then dissected off the superior, medial, and lateral walls of the orbit. The temporalis muscle was minimally detached from the zygomatic process of the frontal bone and reflected posterosuperiorly to provide access to the anatomical keyhole (Fig. 1A).

The 1-piece transbasal craniotomy consisted of 7 osteal steps (Figs. 1–3). A midline frontal bur hole was made over the superior sagittal sinus, and the sinus was carefully stripped from the skull. This bur hole defined the caudal extent of the craniotomy (Step 1). Bilateral MacCarty bur holes were then drilled and placed more posteriorly so as to increase the amount of orbital roof removed (Step 2). Next, bilateral frontal bone cuts connecting the superior sagittal sinus bur hole to each MacCarty bur hole were made using a craniotome (Step 3). Next, the lateral orbital wall cuts were made using a reciprocating saw (Step 4). These cuts were made from the MacCarty bur hole to the lateral orbital rim at the level of the frontozygomatic suture. During this cut, the periorbita and orbital contents were protected. Next, the orbital roof and medial orbital wall osteotomies were made intraorbitally with a small curved osteotome while depressing the globe. The posterior orbital roof cut was made from the MacCarty bur hole across the orbital roof medially (Step 5). To maximize surgical exposure, this cut was aimed so as to remove as much orbital roof as possible. The medial....

Fig. 1. Cadaveric dissection demonstrating lateral (A), anterior (B), and anterolateral (C) views of the osteotomies in a 1-piece TBA: (1) midline frontal bur hole, (2) bilateral MacCarty bur holes, (3) frontal cut, (4) lateral orbital wall cut, (5) intraorbital orbital roof cut, (6) intraorbital medial orbital wall cut, and (7) frontonasal cut.

Fig. 2. Illustrations demonstrating the lateral and anterior views of the osteotomies in a 1-piece TBA. Copyright Jovany Cruz-Navarro. Published with permission.
orbital wall cut was made at the level of the frontonasal suture with the osteotome directed superomedially (Step 6). Finally, the frontonasal cut was performed with a reciprocating saw directed $30^\circ$ superiorly on the frontonasal suture (Step 7).

For closure, the frontal sinuses were cranialized and the pericranial flap was tacked to the basal frontal dura. For lesions creating a bone defect of the skull base (as in our illustrative case below), the anterior cranial fossa floor can be reconstructed with a split-thickness bone graft or titanium mesh. The 1-piece TBA bone flap was secured with mini plates and screws at the nasion, bilateral frontozygomatic sutures, and frontal bone.

### Morphometric Analysis

To compare the 1-piece TBA to a traditional 2-piece approach, we performed dissections on 7 fixed, injected cadaver heads. Standard microsurgical instruments, osteotomes, a high-speed drill (Midas Rex, Medtronic), and an operating microscope (Carl Zeiss) were used. Heads were secured in a supine position with a 3-pin head holder. The 1-piece TBA was performed on each cadaver per the technique outlined above. Detailed measurements of the surgical corridor as well as the surface area of the orbital osteotomy were recorded, as described below. To compare our method with the traditional 2-piece TBA, after all measurements were made, the remaining orbital roof bone that would be accessible transcranially in a 2-piece TBA (“Level I”) was removed.\(^8\) Mild frontal lobe retraction was applied, and retractors were not moved between the 1-piece and 2-piece measurements. The ethmoid bone and planum sphenoidale were left intact. Three anatomical measurements were recorded for each specimen.

**Frontonasal Suture to Foramen Cecum.** The vertical angle from the frontonasal suture to the foramen cecum was measured after completion of the 1-piece TBA in each cadaveric specimen. This angle was believed to be important because the foramen cecum represents the maximal posterior extent of the frontonasal osteotomy without entering the cribriform plate (Step 7). An axial plane perpendicular to the nasion was defined as $0^\circ$. The $x$ (anterior-posterior) and $y$ (superior-inferior) perpendicular lengths were measured in millimeters between the midline frontonasal suture and foramen cecum. The angle was calculated using the tangent formula: angle $= \tan^{-1}(y/x)$.

**Surgical Corridor Relative to the Pituitary Stalk.** We chose the pituitary stalk as a typical deep target with which to compare approaches.\(^1\) Surgical angles relative to the pituitary stalk were measured after the 1-piece TBA, then repeated after further osteotomy to approximate a 2-piece Level I TBA, as previously described by Acharya et al.\(^1\) For these secondary measurements, the dura was stripped off the entire anterior cranial fossa floor after completion of the 1-piece TBA. The crista galli was removed. The frontal lobes were gently retracted using two 1.5-cm self-retaining retractors, which remained in the same position for the 1- and 2-piece measurements. A midline dural incision was made at the level of the optic nerves to view the pituitary stalk. Six angles were measured for both the 1- and 2-piece TBAs (Fig. 1 upper). Horizontal angles were measured at the anterior cranial fossa floor (inferior), the upper limit of the globe (superior), and at the midpoint of the previous 2 measurements (middle). Vertical angles were measured at the midline (midline) and bilaterally at the medial limits of the globe (left and right). For each measurement, 2 straight probes were placed at the pituitary stalk, and the angle was widened until limited by soft tissue or bone (Fig. 4 lower). The angle was calculated by measuring the depth to an arbitrary extracranial point on 1 probe ($x$) and the perpendicular distance from this point to the other probe ($y$). The angle was determined using the tangent formula: angle $= \tan^{-1}(y/x)$.

**Extent of Orbital Roof Resection.** The surface area of the orbital osteotomy in the 1- and 2-piece TBAs was calculated, as previously described by Tanriover et al.\(^2\) The bone removed was traced onto 1-mm graphing paper, and the surface area was calculated using Adobe Photoshop CS6 (Adobe Systems Inc.). The total surface area for the 2-piece TBA was the sum of the orbital roof removed in 1- and 2-piece steps.

### Statistical Analysis

The surgical angles and surface areas for the 1- and 2-piece TBAs were compared using a 2-sided paired $t$-test with SPSS Statistics (version 21, IBM Corp.). A $p$ value $< 0.05$ was considered significant.
The 1-piece transbasal approach

Results

Illustrative Case

A 47-year-old woman presented to our clinic with a 1-year history of anosmia, diplopia, and right eye proptosis. On examination, she was found to have a large calcified mass in and about the middle turbinate. Her neurological examination was notable for bilateral anosmia, and weakness with medial deviation of the right eye resulting in horizontal diplopia when looking to the left. MRI showed an extradural anterior skull base enhancing mass, extending through the right lamina papyracea and compressing the medial side of the left globe (Fig. 5). An endonasal biopsy specimen of the mass revealed meningioma.

A 1-piece transbasal approach, as described above, was performed (Figs. 6 and 7). After tumor resection, the anterior skull base defect into the nasal cavity left by the tumor was reconstructed with titanium mesh, the frontal sinuses were cranialized, and a pericranial graft placed. A lumbar drain was inserted and drained continuously for 4 days, then removed. The patient tolerated the procedure well, and experienced no new neurological deficits after the procedure. The postoperative hospital course was uneventful; she was discharged home on postoperative Day 6 (Fig. 8).

Anatomical Study

In all cadaveric specimens, the frontonasal osteotomy ended anterior to the foramen cecum. The vertical

![Fig. 4.](image_url) Cadaveric dissection showing the surgical angle measurements relative to the pituitary stalk. White lines represent the horizontal angles, and blue lines represent vertical angles. HS = horizontal superior, HM = horizontal middle, HI = horizontal inferior, VL = vertical left, VM = vertical medial, VR = vertical right.
angle from the frontonasal suture to the foramen cecum ranged from 17.4° to 29.7° (23.8° ± 4.8°) superiorly.

The mean surgical angle relative to the pituitary stalk was slightly increased in the 2-piece TBA relative to the 1-piece for all measurements (Table 1). However, this increase was statistically significant solely for the horizontal middle angle (p = 0.049). For this angle, the mean increase was only 0.4° and ranged from 0° to 1.2°.

The surface area of the orbital osteotomy was 2045 ± 352 mm² in the 1-piece and 2467 ± 360 mm² in the 2-piece TBA (Table 1). This increase was statistically significant (p < 0.001).

**Discussion**

The TBA is a widely used anterior, midline, craniofacial skull base approach, with numerous modifications and extensions. Recently, Feiz-Erfan et al. thoroughly summarized these modifications and provided a new classification system to unify the TBA terminology. Their Level I TBA involves a frontal craniotomy with an orbital bar and/or nasal bone osteotomies. It provides access to the anterior skull base, planum sphenoidale, sphenoid sinus, sellar/suprasellar region, and clivus. Traditionally, the orbital bar is removed as a second piece after the frontal craniotomy. At our institution, we have successfully performed a 1-piece variation of this approach. From our experience in the operating room, we have noted that the 1-piece variant provides easier bone reconstruction, decreased operative time due to the simplified closure technique, and improved cosmesis by eliminating unaesthetic bone cuts.

A traditional, 2-piece TBA has unique cosmetic implications because it requires that a craniotome be used to create an osteotomy across the entire low frontal bone, essentially creating a defect in the face. Repairing this osteotomy requires either shifting the bone flap inferiorly (an imperfect solution causing increased gap in the superior aspect of the flap), placement of cement to fill the gap, and/or placement of additional hardware. These maneuvers may hinder bone healing or lead to suboptimal facial cosmetic outcomes. The 1-piece approach, which lacks this osteotomy, eliminates these issues.

Our idea for a 1-piece TBA comes from extensive experience with the 1-piece orbitozygomatic approach. The 1-piece variant of the orbitozygomatic approach has been extensively studied. One anatomical study on this approach found a decrease in the amount of orbital roof removed in the 1-piece variant, which limited the exposure to structures, working angles, and illumination. Nevertheless, the 1-piece orbitozygomatic approach...
TABLE 1: Surgical angles and surface area of orbital osteotomy for the 1- and 2-piece Level I TBA

<table>
<thead>
<tr>
<th>Measurement</th>
<th>1-Piece</th>
<th>2-Piece</th>
<th>p Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>mean horizontal angles ± SD (°)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>superior</td>
<td>59.6 ± 3.5</td>
<td>59.8 ± 3.6</td>
<td>0.058</td>
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<tr>
<td>middle</td>
<td>43.0 ± 4.3</td>
<td>43.4 ± 4.6</td>
<td>0.049*</td>
</tr>
<tr>
<td>inferior</td>
<td>33.5 ± 2.7</td>
<td>33.8 ± 2.9</td>
<td>0.096</td>
</tr>
<tr>
<td>mean vertical angles ± SD (°)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>left</td>
<td>11.5 ± 1.4</td>
<td>11.8 ± 1.4</td>
<td>0.079</td>
</tr>
<tr>
<td>medial</td>
<td>10.6 ± 1.1</td>
<td>10.8 ± 1.3</td>
<td>0.173</td>
</tr>
<tr>
<td>right</td>
<td>11.8 ± 1.0</td>
<td>12.0 ± 1.2</td>
<td>0.089</td>
</tr>
<tr>
<td>orbital roof removed (mm²)</td>
<td>2045 ± 352</td>
<td>2467 ± 360</td>
<td>&lt;0.001*</td>
</tr>
</tbody>
</table>

* Statistically significant.

Conclusions

The 1-piece variant TBA is a good alternative to the traditional 2-piece approach. While more orbital roof can be removed with the 2-piece approach, this additional bone removal offers little advantage. The approach is potentially easier to perform, simplifies reconstruction, and improves cosmesis. Further anatomical studies and operative experience are needed to validate this approach for routine use.

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Disclosure

The authors report no conflict of interest concerning the materials or methods used in this study or the findings specified in this paper.

Author contributions to the study and manuscript preparation include the following. Conception and design: Duckworth, Effendi. Acquisition of data: Effendi, Rao, Momin. Analysis and interpretation of data: Duckworth, Effendi, Rao, Momin. Drafting the article: Duckworth, Effendi, Cruz-Navarro. Critically revising the article: all authors. Reviewed submitted version of manuscript: all authors. Approved the final version of the manuscript on behalf of all authors: Duckworth. Statistical analysis: Effendi. Administrative/technical/material support: Effendi. Study supervision: Duckworth, Effendi.

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