OBJECTIVE
To detail the authors 22-year experience in anterior skull base tumor resection and survival at our institution.

Educational Objectives:
- To discuss common tumors of the anterior skull base.
- To demonstrate understanding of challenges presented by individual tumor types.
- To examine the benefits of endoscopic techniques combined with open approaches.

BACKGROUND
Due the complex anatomy, proximity to vital structures, and ease of intracranial extension, anterior skull base malignancies are a difficult entity to treat. In the 1960's the first combined transcranial and transfacial approach was utilized. Since that time, advancements in endoscopic instruments and techniques, surgical tools, radiologic studies, and image guidance intraoperatively have afforded great advances in the resection of anterior skull base tumors.1-4

METHODS
We performed a retrospective chart review for patients who underwent an anterior skull base resection over the past 22 years at Kansas University Medical Center. Endoscopic telescopes and techniques were used in all cases. The surgical approach is individualized for each patient, depending on the location and extent of the tumor, as well as, the overall health of the patient. Often times a cosmetic incision, such as a sublabial/transmaxillary, is combined with an endoscopic approach. Prior to the common use of endoscopic resection, patients were often subjected to large lateral rhinotomy incisions combined with a bicominal craniotomy incision. Now, if the tumor size and location allows, patients often have a smaller craniootomy incision combined with an endoscopic transnasal or sublabial approach, as the endoscopic instruments provide excellent visualization.5 Reconstruction of the resulting defect after resection of an anterior skull base mass can present a challenging problem. A pericranial flap6 provides a quick and durable solution, while also providing the crucial watertight seal. The flap is sutured first at the posterior edge of the dural defect, then both lateral aspects, and finally sewn along the anterior edge of the dural defect. This effective closure helps to prevent cerebrospinal fluid leaks, meningitis, and pneumocephalus postoperatively. A split thickness skin graft is placed over the pericranial flap to provide a protective barrier from the nasal cavity. The use of a split thickness graft helps to avoid the complications seen with free bone grafts (bone necrosis, crusting) and metal hardware (extrusion, crusting). Lumbar drains were utilized in the majority of the patients in this series, however, recently with a trend of shorter duration and at a low drainage rate (10cc/hr). The final part of the reconstruction is a 1-cm layer of abdominal fat, which is used to reinforce the pericranial flap and split thickness skin graft. Fibrin glue is then placed to hold the split thickness skin graft and abdominal fat graft in place. Nasal trumpets are placed in the inferior meatus, which help to prevent post-op pneumocephalus and air trapping through the newly repaired anterior skull base.

RESULTS
Patients with malignant tumors of the anterior skull base undergoing resection were followed for an average of nearly five years (57 months). There were a total of 170 cases, 113 malignant and 57 benign. Of the 170 patients, 104 were male (61.2%) and 66 female (38.8%) with a mean age of 50.2 years (standard deviation 16.5 years). Presentation commonly included unilateral epistaxis, nasal obstruction, or sinusitis. The three most common tumors included squamous cell carcinoma (26), adenoid cystic carcinoma (12), and esthesioneuroblastoma (21). Patients with malignant tumors had an average follow up of fifty-seven months. The overall survival of patients with malignant pathology was 83% (n=94) at the end of this review. Sixty-two percent (62%, n=70) of patients had no evidence of disease, and 21% were alive with disease. Thirty-five percent (n=73) of the patients with recurrence had no evidence of disease at the primary site. This is an indication of the complete microscopic tumor resection the visualization provided by endoscopic telescopes and the use of endoscopic instruments allows.

Tumor histology as well was an important factor in survival. Patients diagnosed with squamous cell carcinoma had a worse survival and although rare, small cell neuroendocrine carcinomas had a 100% fatality rate. Those patients diagnosed with either a T3 or T4 tumor comprised 92% of the deaths during this review.

CONCLUSIONS
Endoscopic techniques have been utilized along with open incisions to gain access and visualization of anterior skull base tumors for over 20 years. Our survival rates compare favorably with other large series. The use of endoscopic techniques has improved our ability to visualize and completely resect tumors of the anterior skull base. The 35% having local recurrence during our follow up were largely very aggressive tumor types (melanoma, poorly differentiated squamous cell carcinoma, etc.). Endoscopic techniques allow for smaller incisions, less tissue disruption, and faster healing hastening preparation for the important modality of post-operative radiation therapy.

REFERENCES

Table 1. Malignant Histologic Tumor Type

<table>
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<tr>
<th>Tumor Type</th>
<th>Number</th>
<th>Mean Patient Age</th>
<th>Mean F/u (months)</th>
<th>Survival</th>
<th>Living with NED</th>
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<tbody>
<tr>
<td>Squamous Cell Carcinoma</td>
<td>26</td>
<td>62</td>
<td>53</td>
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<td>Esthesioneuroblastoma</td>
<td>21</td>
<td>44</td>
<td>31</td>
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<td>Adenoid Cystic Carcinoma</td>
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<td>Adenocarcinoma</td>
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<td>43</td>
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<td>Melanoma</td>
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<td>59</td>
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<td>Other Types*</td>
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<tr>
<td>Total</td>
<td>113</td>
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</table>

*Other Types (6 or fewer cases): meningioma, hemangiopericytoma, sinonasal undifferentiated carcinoma, chordoma, small cell neuroendocrine carcinoma, pituitary carcinoma, paraganglioma, oncocytoma, mucoepidermoid carcinoma, malignant peripheral nerve sheath tumor, lymphoma, ameloblastoma, basal cell carcinoma

Figure 1. Sagittal MRI of sinonasal undifferentiated carcinoma (SNUC) showing lesion filling nasal cavity and extending through the skull base displacing frontal lobe back to the third ventricle.

Figure 2. Axial CT of Figure 1 SNUC patient demonstrating the sublabial transmaxillary/transfacial and transnasal endoscopic approach for resecting the lower portion of this tumor (red=bone resection, yellow=surgical approach)

Figure 3. Endoscopic view of SNUC patient in Figure 1 at beginning of endoscopic resection

Figure 4. Endoscopic photo of left nasal esthesioneuroblastoma arising from the left cribriform area

Figure 5. Coronal CT scan with contrast demonstrating the same esthesioneuroblastoma pictured in Figure 4. This tumor was resected entirely by transnasal endoscopic approach, a resultant cribriform defect and CSF leak was repaired transnasal endoscopically.

Figure 6. Coronal CT scan with contrast demonstrating the same esthesioneuroblastoma pictured in Figure 4. This tumor was resected entirely by transnasal endoscopic approach, a resultant cribriform defect and CSF leak was repaired transnasal endoscopically.

Figure 7. Coronal CT scan with contrast demonstrating the same esthesioneuroblastoma pictured in Figure 4. This tumor was resected entirely by transnasal endoscopic approach, a resultant cribriform defect and CSF leak was repaired transnasal endoscopically.