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Reintroducing Endoscopic Skull Base Surgery During the COVID-19 Pandemic: A Single-Center Experience from the United States COVID-19 Epicenter

RESEARCH

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ABSTRACT

Background: The COVID-19 pandemic presented unique challenges for endoscopic skull base surgery (ESBS) given the elevated viral load in the nasopharynx and aerosolization of particles inherent to the endoscopic endonasal approach (EEA). Furthermore, reports and anecdotes shared within the skull base surgeon community suggesting potential elevated risk of COVID-19 transmission during ESBS led to an abundance of precaution and scrutiny regarding endonasal procedures during the pandemic. The Mount Sinai Hospital is a busy ESBS center located in New York City, the United States COVID-19 pandemic epicenter. We report a case series describing the early experience of resuming ESBS during the COVID-19 pandemic, including systems for case selection, surgical precautions and modifications, and patient outcomes.

Methods: All consecutive ESBS cases and deferred surgical cases were identified prospectively within the first three-week period after resumption of urgent scheduled surgery. Data regarding indications, pre-surgical screening, operative results, and postoperative course were collected retrospectively. All data are presented using descriptive statistics.

Results: With the study time frame, 14 patients underwent ESBS. Four patients had surgery deferred. The mean age was 57. The most common pathology was pituitary tumor, in 57% of patients. Visual symptoms precipitated the urgency in 36% of cases. All patients underwent COVID-19 screening with a minimum of one SARS-CoV-2 reverse transcriptase polymerase chain reaction (RT-PCR) nasal swab within 48 hours preceding surgery. All patients tested negative. There were no intraoperative complications. Median length of stay was two days. A total of 14% of patients experienced postoperative complications. Mean follow-up was 100.9 days.

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Conclusions: Due to its relatively low morbidity and potential short length of stay, ESBS is adaptable to unique pandemic challenges such as bed scarcity and exposure minimization. As endoscopic centers return to normal operations during the COVID-19 era, standard testing, case selection algorithms, and systematic surgical precautions and modifications can enable a safe resumption of ESBS.

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INTRODUCTION

Endoscopic skull base surgery (ESBS) during the coronavirus disease 19 (COVID-19) pandemic has garnered much attention in the realm of physician and patient safety in light of reports of disease transmission from Wuhan, China. One early anecdote in particular described a patient with a pituitary adenoma who underwent endoscopic endonasal approach (EEA) for resection [15]. Three days postoperatively, the patient became febrile and was confirmed to be COVID-19 positive, along with 14 members of the medical staff who were present in the operative room. Initially, as news spread among skull base surgeons, concern heightened, and extreme caution with respect to ESBS was exercised [8]. Once formally reported, spread of infection from this case was ultimately deemed to be due to postoperative, instead of intraoperative, transmission from a lack of personal airway protection [15]. Nonetheless, at this juncture in the pandemic, it is known that COVID-19 is caused by a strain recognized as severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2), with the primary nidus of infection being the nasal cavity. This poses a special risk in neurosurgical procedures involving the skull base that require a transnasal approach and has necessitated a fundamental change in practice to protect operative neurosurgeons. The EEA for skull base tumors in particular presents an elevated risk of SARS-CoV-2 transmission. An early study analyzing the differences in concentration of COVID-19 between throat and nasal swabs showed an elevated viral load in the nasal cavity and prolonged detectability in both symptomatic and asymptomatic patients [18]. Aerosolization inherent in the procedure also elevates the risk, especially from instrumentation, including electrocautery and high-speed drills [1, 13, 14].

The Mount Sinai Health System (MSHS) is uniquely poised to comment on the impact of COVID-19 as a busy ESBS center in the COVID-19 epicenter. The MSHS has treated 11,000 patients with positive COVID-19 tests, of whom over 1,000 required ventilatory support [11]. The Mount Sinai Hospital (MSH) is a 1,141-bed tertiary care academic center located in the New York City borough of Manhattan. Within the MSHS, at least 1,300 endoscopic cases are performed every year, averaging approximately 25 cases per week. A state of emergency in New York State was declared on Saturday, March 7, 2020. All surgeries within the MSHS were restricted to emergent cases as of Monday, March 16. This led to a massive restructuring of all hospital resources and intensive care unit (ICU) space, as well as the redeployment of all neurosurgery attending and resident physicians to assist in the treatment of the surge of COVID-19 patients. In response to this, the Department of Neurosurgery released a brain tumor triage algorithm that sorted surgical cases into emergent, urgent, and elective classifications, with clear indications for allowing certain cases to proceed with departmental chairman approval. This institutional protocol included pituitary adenoma management, which consisted of postponing all of these cases unless a patient presented with a true neurosurgical emergency. In those rare cases, an emergent neurosurgical procedure was carried out, such as installing a ventriculoperitoneal shunt to alleviate obstructive hydrocephalus caused by the tumor; endoscopic endonasal tumor resections were not performed under any circumstance. This represented a striking but necessary change in clinical practice at Mount Sinai and in the standard of care of neurosurgery [5].

As the pandemic plateaued, the decision was made to gradually resume conducting scheduled operative cases as of May 4, 2020. However, reintroduction of ESBS required re-evaluation of patient selection/screening, intraoperative precautions, and postoperative planning processes in order to minimize risk to patients, physicians, and staff. As we emerge from the peak of the pandemic in New York City, we present our experience with reintroduction of ESBS in the form of a case series and description of the precautions adopted.

METHODS AND MATERIALS

With approval from the MSHS Institutional Review Board, all consecutive ESBS cases were identified prospectively within the first three-week period after resumption of urgent scheduled surgery at our institution. Patients who were evaluated for ESBS but deferred in favor of conservative or alternative treatment plans were also identified. ESBS cases at MSHS sites other than the MSH were excluded from the dataset. Data regarding indications, pre-surgical screening, operative results, and postoperative course were collected retrospectively. All data are presented using descriptive statistics.

EXAMPLE CASES

Case #1

Patient #2 was a 71-year-old female, blind for 15 years secondary to advanced bilateral glaucoma, who initially presented to an outside hospital with right-sided facial palsy and altered mental status after a fall in the bathtub. She was found to have a large pituitary tumor with suprasellar expansion of 3.9 × 3.4 × 5.5 cm and significant hydrocephalus (***Figure 1***). The patient was transferred to the MSH. Since this occurred during the peak of the COVID-19 crisis in New York City, the decision was made to place a temporizing ventriculoperitoneal shunt for cerebrospinal fluid (CSF) diversion at the time. The patient was discharged home in a stable condition with the support of family. Ultimately, she was scheduled for resection of the pituitary mass five weeks after her initial surgery. On the morning of elective readmission for surgery, the patient was noted to have a new left third cranial nerve palsy, which had been present for the past two weeks per the family. The patient was brought to the operating room (OR) with neurosurgery and otolaryngology and underwent an extended EEA to the frontal base, sphenoid, sella, and clivus. Stereotactic navigation and endoscopic dissection were used throughout the case. The tumor was vascular, but a considerable portion was debulked, without CSF leakage. The skull base was repaired with an underlay of abdominal fat and a nasoseptal flap overlay to obtain a watertight seal. The patient was extubated and remained in stable condition. She was discharged home on postoperative day 2 (POD#2). On POD#7, the patient experienced two pre-syncopal episodes and was evaluated by the MSH Emergency Department. She was diagnosed with hyponatremia and adrenal insufficiency. She was started on hydrocortisone replacement and discharged home in a stable condition after a three-day readmission.

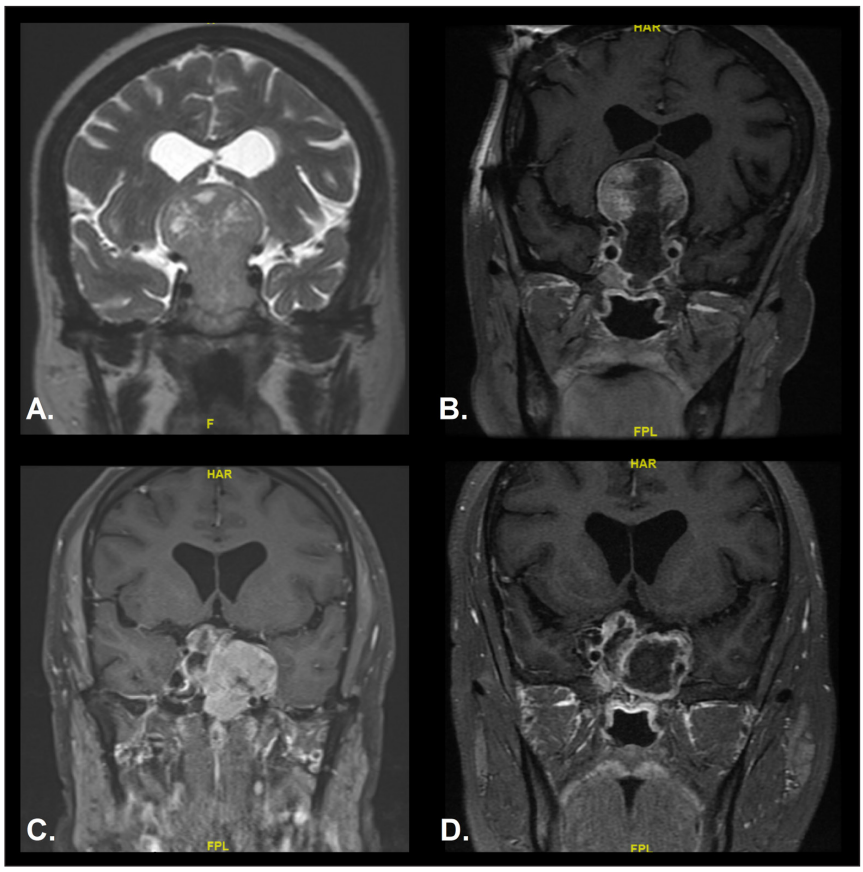

Figure 1 Imaging findings from the two presented cases. Panel **(A)** is a coronal preoperative post-contrast T1 MRI sequence for Case #1, demonstrating a 3.9 × 3.8 × 5.5-cm sellar/suprasellar mass, indenting but not involving the bilateral cavernous sinuses. The lesion also displaced the A1 segments of bilateral anterior cerebral arteries (ACAs) laterally and superiorly and the optic chiasm superiorly. Panel **(B)** shows the corresponding postoperative coronal post-contrast T1 MRI sequence for Case # 1, with significant debulking of the sellar mass and a small degree of solid enhancement on the lateral suprasellar areas, consistent with residual tumor. While the mass is now debulked, there is persistent effacement of the optic chiasm. Panel **(C)** shows a coronal preoperative post-contrast T1 MRI sequence for Case #2, demonstrating a 4.3 × 4.3 × 4.2-cm contrast-enhancing sellar mass with necrosis within its right-most part, consistent with recurrence of the patient's previously resected pituitary adenoma. There is extension into the bilateral cavernous sinuses with full encasement of the left internal carotid artery and partial encasement of the right internal carotid artery, with both arteries being patent on CT angiogram (not shown here). Both anterior cerebral arteries were displaced anteriorly, while the optic chiasm was displaced superiorly. Panel **(D)** demonstrates the corresponding postoperative post-contrast T1 MRI sequence for Case #2, demonstrating the interval debulking of the sellar mass, with significantly less solid contrast-enhancing content than the preoperative image. There is markedly decreased impingement on the optic apparatus but persistent involvement of the left cavernous sinus.

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Case #2

Patient #7 was a 76-year-old male with a remote history of stroke, with residual right-sided weakness and dysarthria, complaining of progressive visual decline over the last few years, as well as headaches, fatigue, and increased urination. Contrast-enhanced MRI demonstrated a large, 3.6-cm pituitary tumor with suprasellar extension leading to compression and elevation of the optic chiasm (***Figure 1***). Endocrinologic laboratory evaluation did not show evidence of a secreting tumor. The patient's vision was objectively limited, with visual acuity of 20/70 on the left and 20/200 in the right eye, in addition to left-sided temporal hemianopia. After detailed discussions with the patient and his family regarding the risks and benefits of ESBS during the COVID-19 pandemic, the patient agreed to the procedure. The patient was brought to the hospital two days later, was admitted, and was brought to the OR with neurosurgery and otolaryngology for an extended EEA. The tumor was found to be eroding the clivus and extending into the sphenoid sinus with a significant inferior component. After wide exposure and dural coagulation, debulking of the tumor was initiated. The lesion had both soft and firm components, and the diaphragm was separated from the tumor, allowing the tumor to be completely extirpated without CSF leak. The skull base was repaired in a multilayer fashion due to the large bony and dural opening using a synthetic underlay of collagen-based dural graft combined with a nasoseptal flap overlay. The patient was extubated and had an uneventful postoperative course. He was discharged home on POD#2.

RESULTS

Within the selected three-week period, 14 patients underwent endoscopic endonasal procedures, 13 of whom were adults (***Table 1***). The mean age was 57 years, and 57% of the patients were female. The most common criterion precipitating surgical urgency was visual deterioration, found in 36% (5/14) of patients. An underlying pituitary adenoma was found in 57% (8/14) of patients, three of whom were treated for severe Cushing disease. Severe epistaxis was the presenting symptom of 21% (3/14) of patients, and it was either refractory to or not amenable to embolization therapy. All patients underwent COVID-19 screening with a minimum of one SARS-CoV-2 reverse transcriptase polymerase chain reaction (RT-PCR) nasal swab within 48 hours preceding the scheduled surgery. A single screening nasal swab prior to surgery was performed in 79% (11/14) of patients, whereas three patients underwent two tests. A total of 71% (10/14) of patients were admitted the same day as surgery.

Table 1 Consecutive endoscopic skull base surgical cases performed at the Mount Sinai Hospital immediately following the SARS-CoV-2 peak during the first three weeks after resumption of scheduled urgent cases. *Abbreviations: F: female, M: male, OR: operating room, min: minutes, RT-PCR: reverse transcriptase polymerase chain reaction.*

CASE	AGE	SEX	NUMBER OF NEGATIVE RT-PCR NASOPHARYN-GEAL SWABS	TIME BETWEEN MOST RECENT NEGATIVE RT-PCR RESULT AND SURGERY (DAYS)	SAME-DAY ADMISSION	TOTAL OR TIME (MIN)	TOTAL ANESTHESIA TIME (MIN)	POSTOPERATIVE LENGTH OF STAY (DAYS)	TOTAL LENGTH OF STAY (DAYS)	TOTAL FOLLOW-UP (DAYS)
1	9	F	2	1	Y	270	444	72	72	112
2	71	F	1	2	Y	205	310	2	2	111
3	76	F	1	2	Y	131	223	2	2	110
4	24	F	1	2	Y	128	210	2	2	107
5	71	F	1	2	Y	136	205	5	5	103
6	76	M	1	2	Y	215	338	2	2	100
7	57	M	1	2	Y	278	373	1	1	100
8	36	F	1	1	Y	142	233	1	1	99
9	92	F	1	1	N	315	435	4	5	98
10	60	M	1	1	N	140	265	3	4	97
11	63	M	1	1	Y	241	339	0	0	97
12	58	M	1	1	Y	176	268	0	0	97
13	68	F	2	1	N	220	315	1	4	91
14	36	F	2	1	N	138	301	4	16	90

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Mean total OR time and total anesthesia time were 200 minutes and 312 minutes, respectively. There were no intraoperative complications. All patients were discharged home after the index surgery except the pediatric patient, who required a second-stage transcranial approach to resect a sellar/suprasellar mass. The median length of stay was two days. Three patients were discharged on the same day as surgery, and another three patients were discharged on POD#1. The most common final pathology type was pituitary adenoma, in 57% (8/14) of patients. Days of follow-up from surgery ranged from 90 to 112 days, with a mean of 101 days.

No immediate postoperative complications or readmissions occurred in 86% (12/14) of patients. The pediatric patient experienced cerebral venous sinus thrombosis as well as refractory diabetes insipidus. Another patient who underwent endoscopic transnasal resection of a large pituitary adenoma causing obstructive hydrocephalus (previously treated during the COVID-19 surge with a ventriculoperitoneal shunt) was readmitted seven days after the endoscopic procedure with hyponatremia and adrenal insufficiency. A repeat RT-PCR swab test was negative upon readmission. No patients developed COVID-19-like symptoms such as fever, cough, or shortness of breath during the follow-up period since surgery. Throughout their follow-up, none of the patients has been diagnosed with COVID-19.

Four patients had endoscopic endonasal surgery deferred (***Table 3***). After discussion at a multidisciplinary tumor board, three patients with neoplastic presentations, in whom an endoscopic approach was feasible, proceeded instead to adjuvant radiation and/or chemotherapy, which was felt to be non-inferior to surgery. A fourth patient responded to non-surgical treatments for refractory epistaxis.

DISCUSSION

The COVID-19 pandemic created new and unprecedented challenges for the New York City region and the MSHS. The ongoing care of neurosurgical patients requiring evaluation and management is balanced with the need to redeploy staff to the COVID-19 surge response and the imperative to protect hospital staff, patients, and families from unnecessary exposure. With the transition to increased surgical volume, the concept of performing ESBS received particular scrutiny given the aerosolization inherent in multiple aspects of a surgical case, including the administration of anesthesia and the procedure itself. This scrutiny was initially based upon reports and anecdotal evidence of elevated risk of transmission in endoscopic surgery and later supported by studies confirming the high viral load in the nasopharynx and elevated risk of aerosolization in several components of ESBS. We report the MSH ESBS experience across the first three weeks of expanded surgical practice after the COVID-19 surge response. The described practice may offer improved preparedness for other institutions returning to increased surgical volume or responding to future pandemics with similar risk profiles.

PREOPERATIVE TRIAGING AND TESTING

During the COVID-19 surge response, scheduled elective cases were canceled, leaving patients who were symptomatic yet stable awaiting surgery at an unknown future date. Patients were followed to ensure that they remained stable via telemedicine visits and phone calls. Once the hospital started to plan the resumption of scheduled urgent surgical cases, all prospective cases were evaluated preoperatively by neurosurgery or otolaryngology department leadership prior to scheduling to ensure that predefined urgency criteria were met based on previously described algorithms [7, 8]. Per the Italian Skull Base Society guidelines by Castelnuovo et al., only urgent surgery must be considered, including severe trauma, bleeding, and infection or abscess formation, as well as malignant tumors where a considerable waiting times might be fatal for their prognosis and skull base or pituitary tumors with rapid visual decline, hydrocephalus, or brainstem compression [2]. Within the otolaryngology evaluation, patients with a neoplastic presentation amenable to an endoscopic approach were selected for surgery if an aggressive pathology was not treatable with medical options, debilitating symptoms such as visual loss were present, or another surgical approach was less favorable. Non-neoplastic pathologies were evaluated based on degree of urgency, refractoriness to non-surgical treatment, and presence of urgent symptoms. Three of the four deferred surgical cases were patients with neoplastic disease who typically would have undergone surgical debulking prior to adjuvant therapy. In light of the COVID-19 response, after multidisciplinary evaluation, these patients were recommended to move directly to radiation and chemotherapy without surgery.

Neurosurgical patients were evaluated with a similar evaluation process (***Figure 2***). The backlog of patients who had their previously scheduled surgery canceled were followed via telemedicine during the surge response. Once scheduled urgent surgery was resumed, those patients with progressive or urgent symptoms such as visual symptoms or hydrocephalus were prioritized. Patients who required a tissue diagnosis to inform ongoing time-sensitive therapy were also given priority. Patients were screened for risk factors that would increase susceptibility to COVID-19 transmission or sequelae such as chronic kidney disease requiring dialysis or severe cardiac or pulmonary disease. Risk factors were weighed against the urgency of the patient's condition.

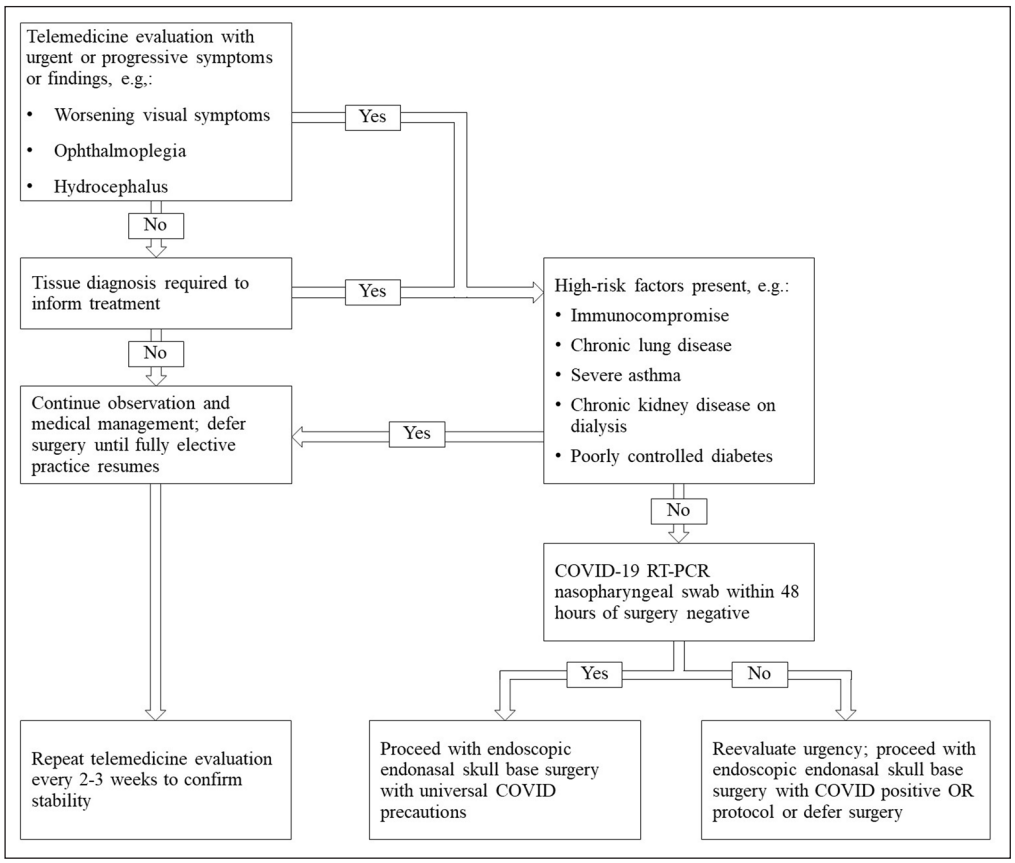

Figure 2 Algorithm used to triage case selection during resumption of ESBS in the first three weeks after the peak of the SARS-CoV-2 pandemic in a large academic institution in New York City.

In our series, the most common presentation was secondary to a pituitary tumor, in 57% (8/14) of patients (***Table 2***). Visual symptoms precipitated the urgency in 36% (5/14) of cases, including three patients with optic chiasm compression, one patient with pituitary apoplexy,

Table 2 Consecutive endoscopic skull base surgical cases performed at the Mount Sinai Hospital immediately following the SARS-CoV-2 peak during the first three weeks after resumption of scheduled urgent cases. Presented are the urgency criteria, pathologies, and immediate postoperative complications. *Abbreviations: DI: diabetes insipidus, POD: postoperative day, s/p: status post, VPS: ventriculoperitoneal shunt.*

CASE	CRITERIA FOR URGENCY	PATHOLOGY	IMMEDIATE COMPLICATIONS
1	Visual decline, s/p neoadjuvant chemotherapy	Germ cell tumor	Second-stage craniotomy POD#4, DI
2	Declining functional status/hydrocephalus s/p temporizing VPS	Pituitary adenoma, gonadotroph cell type	Adrenal insufficiency
3	Right eye diplopia	Metastatic papillary thyroid carcinoma	None
4	Cushing disease	Pituitary adenoma, corticotroph cell type	None
5	Skull base osteomyelitis	Chronic inflammatory tissue	None
6	Visual decline, chiasmatic compression	Pituitary adenoma, gonadotroph cell type	None
7	Visual decline, chiasmatic compression	Pituitary adenoma, lactotroph cell type	None
8	Cushing disease	Pituitary adenoma, corticotroph cell type	None
9	Refractory epistaxis	High-grade undifferentiated carcinoma	None
10	Visual decline, pituitary apoplexy	Pituitary adenoma, gonadotroph cell type	None
11	Refractory epistaxis	Chronic inflammatory tissue	None
12	Refractory epistaxis	Chronic inflammatory tissue	None
13	Falls, hyponatremia to 103	Pituitary adenoma, null type	None
14	Cushing disease	Pituitary adenoma, corticotroph cell type	None

DEFERRED CASE	AGE	SEX	PATHOLOGY	REASON FOR SURGERY DEFERRAL
1	17	M	JNA	Epistaxis controlled
2	80	M	SCC	Deferred to RT/chemotherapy
3	66	M	Adenosquamous carcinoma	Deferred to chemotherapy
4	46	M	Poorly differentiated SCC	Deferred to chemotherapy

Table 3 Patients who had endoscopic endonasal surgery deferred. *Abbreviations: F: female, M: male, JNA: juvenile nasopharyngeal angiofibroma, SCC: squamous cell carcinoma, RT: radiotherapy.*

and one pediatric patient with a sellar/suprasellar germ cell tumor who suffered visual decline after undergoing neoadjuvant chemotherapy. Cushing disease and refractory epistaxis each comprised 21% of the surgical cases.

Once scheduled, prior to surgery, all patients were tested with a SARS-CoV-2 RT-PCR nasopharyngeal swab widely available at multiple sites within our health system. The test was performed on an outpatient basis with results available within several hours. Patients were required to undergo the test within 48 hours of the scheduled surgery. Though the reported sensitivity of a single nasopharyngeal swab is moderate, ranging from 63–78%, the need for accurate testing was balanced against patients' exposure risk within a healthcare setting [16]. Thus, a single test was deemed sufficient and was compliant with screening protocols at the state, city, and institutional levels. Two tests were performed in 21% (3/14) of patients. In two of these cases, the patients were admitted for a medical work-up that eventually led to ESBS. They had a nasopharyngeal swab upon admission and then a second one within 48 hours of surgery. All patients in the series tested negative for COVID-19.

Admission prior to surgery was necessary for 29% (4/14) of patients, due to severe or urgent symptoms. One patient was transferred to our hospital with severe hyponatremia related to a pituitary mass. One patient was admitted to the medicine service with severe abdominal pain, poorly controlled diabetes, and refractory hypertension. She was diagnosed with Cushing disease and transferred to the neurosurgery service for treatment. The final two patients were admitted via the Emergency Department for refractory epistaxis and pituitary apoplexy on the day prior to undergoing surgery. Under normal operations, patients scheduled for surgery occasionally will be pre-admitted for medical optimization or advanced preoperative imaging. However, during the COVID-19 pandemic, planned pre-admissions were avoided in order to minimize patient exposure to the inpatient setting.

PERIOPERATIVE CONSIDERATIONS

To comply with city, state, and institutional guidelines, on the day of surgery, patients were not permitted to be accompanied by a companion beyond the perioperative arrival area. Perioperative visitation and accompaniment policies should be adjusted to reflect the most current risk assessment of COVID-19 transmission to patients, visitors, and HCWs. All hospital staff complied with current personal protective equipment (PPE) standards, including use of a surgical or cloth mask.

In our series, all patients tested negative for COVID-19. Thus, the institution's previously described COVID-19-positive OR protocol regarding strict patient isolation, use of a negative-pressure OR, and terminal cleaning after each case, was not directly applicable [11]. However, given the risk of a false negative RT-PCR test and the prioritization of HCW protection and risk minimization, certain practices were adopted for COVID-19-positive and COVID-19-negative patients alike.

In terms of PPE in the OR, at our institution, all OR staff at a minimum used an N95 respirator and face protection. Some members of the surgical staff elected to use half- or full-face elastomeric respirators, which offer the advantage of a reusable face mask and replaceable filters. These masks were neither supplied by the institution nor widely available, and therefore, the N95 respirator remained the standard mask used in the OR.

With respect to anesthesia, intubation is considered one of the highest-risk aerosol-generating procedures [3]. Therefore, the presence of staff inside the OR was minimized during intubation, extubation, and the 15-minute period after the procedure in order to minimize HCW exposure to aerosolized particles. In practice, this meant that all non-anesthesia staff exited the room

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but remained available in case of airway or other patient-related emergency. In our series, there were no adverse anesthesia-related events. Universal anesthesia-related precautions included minimization of coughing, use of rapid sequence intubation, and use of a disposable video laryngoscope.

Several intraoperative strategies were employed to minimize risk of aerosolization inherent to ESBS [11, 13, 14]. In preparation for surgery, a two-port VENT mask was fashioned for the patient (***Figure 3***). This mask is created from a rigid face mask such as an N95 respirator with a rectangular portion cut out and replaced with surgical glove material secured with staples on the external-facing side of the mask [11, 13, 14]. Small holes are cut into the glove material to enable passage of the endoscope and surgical tools. This construct enables smooth passing of the surgical tools during two- and four-hand surgery while minimizing transmission of aerosolized particles. Recent literature has evaluated several facets of ESBS and risk of particle aerosolization, including the use of electrocautery, microdebridement, a high-speed drill, and an ultrasonic aspirator [13, 14, 6]. In controlled cadaver studies, the use of a high-speed drill posed the most elevated risk of aerosolization. However, practically, the high-speed drill carries the benefit of speed, efficacy, and safety for the bony work required for access to the skull base. That said, the use of a microdebrider, electrocautery, and the drill could not be eliminated. Rather, use was judicious, and other protective techniques were used. For example, suctioning was always used concurrently with the aforementioned tools.

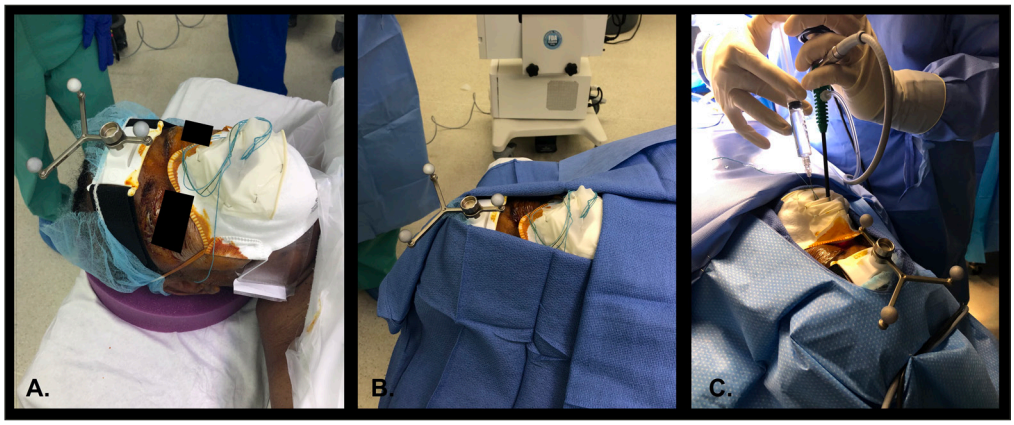

Figure 3 Intraoperative example of a two-port VENT mask. The patient is induced to anesthesia under standard COVID-19 intubation precautions, and skin is disinfected in a routine fashion. The mask is fashioned from a rigid mask with a central cutout that is replaced with a flexible material such as a latex or nitrile surgical glove. Central holes are punctured through the flexible material, allowing passage of the endoscope and surgical tools. The mask is fitted on the patient's face **(A)**. Then, draping is done in a standard fashion **(B)**. The operation is then done with all instruments passing through the holes in the flexible part of the mask **(C)**.

POSTOPERATIVE CONSIDERATIONS

Postoperative planning began with the initial telemedicine evaluation. At our institution, with the exception of patients with Cushing disease, it is often customary for patients undergoing ESBS for pituitary tumors to be discharged on POD#1 [10]. When scheduled urgent surgeries were resumed, open inpatient hospital beds remained scarce. Additionally, patients, families, and medical staff alike desired to minimize in-hospital exposure. Thus, ESBS and the opportunity for early discharge aligned nicely with hospital circumstances and patients' desires. In our series, patients and families were primarily prepared for a next-day discharge. Of the patients undergoing ESBS for pituitary adenoma, 37% (3/8) were discharged on POD#1. Two of the three patients who presented with refractory epistaxis were discharged on the same day as the procedure. Overall, excluding the pediatric patient with an extended hospital stay, the median length of stay after ESBS surgery until surgery was two days.

Readmission rates after endoscopic transsphenoidal surgery have been cited to range from 5.6–9.0% [12]. In the COVID-19 era, there is even additional scrutiny on readmission, again due to the shortage of inpatient beds and the need to minimize exposure to other patients. Of the 13 adult patients, only one patient required readmission, for hyponatremia and adrenal insufficiency on POD#7 after endoscopic resection of a gonadotropin-secreting pituitary tumor. Repeat RT-PCR test was negative upon admission. She was started on hydrocortisone replacement therapy and discharged in stable condition after a three-day readmission.

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EXPERIENCE FROM OTHER COUNTRIES

Among the first reports in the literature, Zoia et al. described the general situation in Lombardy, Italy, during the peak of the COVID-19 pandemic, during which neurosurgeons and other subspecialized physicians were reassigned to COVID-19 wards [17]. In a comment on this publication, Mattogno et al. give their account of transnasal endoscopic procedures during COVID-19 in the same area and time. Interestingly, the authors state that each patient undergoing transsphenoidal adenoidectomy (TSA) in their hospital was hospitalized for 24 hours prior to the procedure for work-up. Their algorithm included both antibody and nasopharyngeal swab testing prior to assigning the patient to a COVID-19-positive or COVID-19-negative unit. In contrast, our protocol included dedicated Patient Under Investigation (PUI) beds, where patients stayed while their testing was pending, as well as PUI ORs for emergency procedures in patients not yet confirmed to be positive or negative [7]. In a Letter to the Editor by Giovannetti et al., the authors describe their experience with four pediatric skull base operations performed during the COVID-19 pandemic in Italy, including for three pituitary tumors and an intracranial abscess with frontal sinus sinusitis [4]. All their patients tested negative once by nasopharyngeal swab, and the OR personnel utilized standard PPE. Intubation was performed in a dedicated room under additional precautions. The Italian Skull Base Society guidelines by Castelnuovo et al. were based on consensus opinions and the scant literature of the time. The authors recommended that only urgent procedures be considered and that patients be tested for COVID-19 by nasopharyngeal swab twice, with strong consideration for postponing any procedures for positive patients until after they tested negative. COVID-19-negative patients were recommended to be operated on with standard precautions, including at least FFP2 masks intraoperatively [2]. Radulesco et al. put together a systematic review of the literature and guidelines on sinus and anterior skull base surgery during the COVID-19 pandemic [9]. The consensus of all included articles was that elective surgeries should be postponed, COVID-19 status should be assessed preoperatively, the highest level of PPE should be utilized, high-speed drills should be avoided, and in-person postoperative visits should be limited as much as possible. The authors also proposed an algorithm to classify endonasal surgeries into three risk categories to assess eligibility for them to be postponed.

LIMITATIONS

Limitations of this assessment include the small size of the cohort evaluated, the single-center experience, the limited follow-up time frame, and the retrospective analysis. As other endoscopic centers face reopening and concerns about another wave of COVID-19 loom, the timeliness of presenting this experience was prioritized over an expanded data collection time period. Experiences with respect to the COVID-19 pandemic may differ between institutions based upon multiple factors including, but not limited to, local infection rates and differences in local responses. However, given the importance of preparedness and responsiveness, the report may offer guidance in the case of another wave of COVID-19 or future pandemics.

CONCLUSION

The COVID-19 viral load in the nasopharynx and the aerosolization inherent in endoscopic procedures pose unique challenges for ESBS in terms of patient and HCW safety. Another concern is the relatively moderate sensitivity of the RT-PCR nasopharyngeal swab. In an era where inpatient beds can be scarce and patients desire minimal hospital exposure, the relatively low morbidity and short length of stay associated with ESBS makes it uniquely appropriate to the unique challenges of the post-pandemic transition. As endoscopic centers return to normal operations, a standard means of case triage and selection along with pre-, peri-, and post-operative precautions may aid in a smooth transition back to practice and maintenance of patient and HCW safety.

ETHICS AND CONSENT

All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional and/or national research committee (name of institute/committee) and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards.

This is a retrospective study. For this type of study, formal consent is not required.

COMPETING INTERESTS

All authors certify that they have no affiliations with or involvement in any organization or entity with any financial interest (such as honoraria; educational grants; participation in speakers' bureaus; membership, employment, consultancies, stock ownership, or other equity interest; and expert testimony or patent-licensing arrangements), or non-financial interest (such as personal or professional relationships, affiliations, knowledge, or beliefs) in the subject matter or materials discussed in this manuscript. Unrelated to any subject materials discussed in this manuscript, Dr. Joshua Bederson maintains an ownership interest in Surgical Theater.

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