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Review Article

Perioperative management of endoscopic transsphenoidal pituitary surgery

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Abstract The contemporary embrace of endoscopic technology in the approach to the anterior skull base has altered the perioperative landscape for patients requiring pituitary surgery. Utility of a multi-disciplinary unit in management decisions facilitates the delivery of optimal care. Evolution of technology and surgical expertise in pituitary surgery mandates ongoing review of all components of the care central to these patients. The many areas of potential variability in the pre, intra and post-operative timeline of pituitary surgery are readily identifiable. Core undertakings and contemporary controversies in the peri-operative management of patients undergoing endoscopic transsphenoidal pituitary surgery are assessed against the available literature with a view to providing guidance for the best evidence-based practice.

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Introduction

The endoscopic transsphenoidal approach has become widely adopted for the resection of pituitary tumors. The popular embrace of a multi-disciplinary stratagem to disease management has seen the incorporation of otolaryngologists, neurosurgeons, and neuroendocrinologists as integral parts of teams addressing pituitary lesions. While the surgical procedure is usually straightforward, poor attention to detail in the perioperative management can lead to adverse outcomes. In this review, the management decisions of the preoperative, intraoperative, and postoperative periods relating to endoscopic transsphenoidal pituitary surgery are addressed, with a focus on evidence-based practice shown to improve patient outcomes.

Preoperative management

Multi-disciplinary disease management approach

The management of pituitary adenomas and other less common sellar or parasellar pathologies can be medical, surgical, or radiation-based and is best addressed in a formal, multi-disciplinary environment. Sellar and parasellar pathologies can result in complex presentations and tumor anatomy, requiring specialized input from a range of experts, including neurosurgeons, endocrinologists, otolaryngologists, ophthalmologists, radiation oncologists, pathologists, neuro-oncologists and radiologists. A multidisciplinary tumor board should ideally include individuals from these disciplines, with expertise and a focused practice on the anterior skull base and specifically the parasellar environment. The combined, consensus opinion of a high-volume unit is beneficial to patients undergoing preoperative counseling/decision-making and their overall outcomes.

History

Symptoms of pituitary tumor are largely dependent on tumor size and local invasion, and the hormone-secreting status of tumor cells. Space-occupying effects of the lesion may include reduction in the visual field, diplopia, headache, nausea, or lethargy. Symptoms may also originate from hormonal disequilibrium, such as decreased libido, galactorrhea, weight gain, and acrofacial growth during adulthood. In preparation for surgery of the known lesion, symptoms of concomitant sinonasal pathology should be explored for rhinorrhea, nasal obstruction, epistaxis, and smell disturbance. Preexisting hyposmia or anosmia is particularly relevant because of the potential for damage to the olfactory epithelium during an endoscopic transsphenoidal approach to the sella. Consideration of risk factors for impaired olfaction in a general population such as advanced age, past history of olfactory loss or head trauma, male sex, and pregnancy, must also be made.[1] Objective assessment of olfaction in the literature suggests a 2.1% risk of hyposmia and anosmia in the immediate postoperative period. There is a 1.4% risk of hyposmia and 3.5% risk of anosmia at 12-months post-surgery.[2] Surgical reconstructive techniques have also been shown to influence time to return to olfactory baseline. Therefore, a deliberate effort to discuss hyposmia or anosmia risk enables optimal informed consent, impacts surgical technique, and provides a baseline for assessment of postoperative functional outcomes.[3]

Physical examination

Ophthalmological evaluation of visual acuity, visual fields, relative afferent pupillary defect, and extraocular movements are required for detailed evaluation of the neuro-ophthalmologic function preoperatively. A thorough nasal examination, with an anterior rhinoscopy looking for nasal septal deviation followed by flexible nasal endoscopy to evaluate for septal perforation, nasal polyps, mucous, and nasopharyngeal swelling, will help ascertain the presence of concomitant nasal conditions. Studies show that up to 8% of patients undergoing transsphenoidal pituitary surgery may have preexisting sinusitis.[4] Diagnosis of local comorbidities enables medical optimization of the sinonasal cavity preoperatively. It also facilitates counseling of the patient for the potential performance of septoplasty and functional endoscopic sinus surgery at the same setting as the pituitary surgery. Examination should also readily identify the potentially difficult airway with abnormal airway anatomy in the acromegalic patient resultant from soft tissue and bony hypertrophy.

Pre-surgical testing and pre-anesthetic evaluation

A mandatory, pre-operative base-line pituitary hormone panel, including thyroid stimulating hormone (TSH), free T4, serum prolactin, growth hormone (GH), insulin-like growth factor 1, follicle-stimulating hormone, luteinizing hormone, adrenocorticotrophic hormone (ACTH), fasting cortisol, serum sodium level, testosterone (if the patient is male) and estradiol (if the patient is female) is performed.[5] Additional endocrinology testing may be performed for evaluation of the hypothalamic-pituitary-end-organ axis. Laboratory screening for bleeding diathesis includes complete blood count and coagulation profile. A current type and screen may also be beneficial, especially in the setting of cavernous sinus extension. Pre-surgical assessment of medical comorbidities, common among patients with pituitary adenoma, should be performed by the anesthesia team. Acromegalic patients are well known to develop diabetes mellitus, hypertension, heart failure, obstructive sleep apnea (OSA), and goiter.[6] Pituitary Cushing disease patients are likely obese, diabetic, hypertensive, and hyperlipidemic; they are at high risk for atherosclerosis, OSA, infections and thromboembolic events.[7] Patients with hypopituitarism may have undiagnosed central hypocortisolism or hypothyroidism that needs hormonal repletion perioperatively in order to avoid life-threatening hypotension or increased sensitivity to anesthesia. Difficult airway and OSA management can be planned, and postoperative neurocritical care placement may be sought.

Imaging

On magnetic resonance imaging (MRI), pituitary adenomas are generally visible as hypointense lesions on T1 but 10–15% can be isointense and intra-tumoral hemorrhage can cause the adenoma to be hyperintense. With gadolinium-based contrast, adenomas enhance, but not as much as the normal pituitary gland. This allows the identification of adenomas that are otherwise occult on non-contrasted sequences.[8] Up to one-third of ACTH-secreting adenomas are not localizable on MRI. In these situations, bilateral inferior petrosal sinus sampling is a sensitive and specific tool for confirmation of ACTH secretion from the sella/parasella area, as opposed to an ectopic source.[9] Arachnoid outpouchings through the diaphragma sellae can be identified on sagittal T2 images; careful instrumentation of sella arachnoid invagination and limited superior extension of durotomy may minimize the risk of a cerebrospinal fluid (CSF) leak if any are present.[10]

A fine-cut computed tomography (CT) of the paranasal sinuses is also essential for preoperative planning and can be combined with MRI during intraoperative navigation. CT allows for identification of the extent of sphenoid pneumatization, the thickness of the bone of the sellar wall, the attachment of the intrasphenoidal bony septum, and bony dehiscence over the carotid, optic canal, maxillary nerve, and planum sphenoidale. If exposure of the cavernous sinus is contemplated, the posterior ethmoid configuration should also be carefully assessed.[11] The sphenoid sinus may be conchal (common in younger patients) (2%–3%), presellar (10%–27%), or sellar (70%) in pneumatization.[12,13] Radiological bony dehiscence over the carotid, optic canal, and maxillary nerve are found in 2.9%, 2.1%, and 7.4% of patients, respectively, but true intraoperatively identified dehiscence is less common.[14] Dehiscence of the carotid canal in acromegalics is 3–4 times more common than in non-acromegalics.[15] A sphenoethmoidal cell that overrides the sphenoid sinus is encountered in 48% of Asian patients, significantly higher than Caucasians. Fifteen percent of these sphenoethmoidal cells qualify as Onodi cells, which increases the risk of optic nerve injury.[16] Careful, preoperative analysis of the CT sinus allows the surgeon to visualize the operative steps, improve surgical efficiency, and reduce the risk of complications.

Optimization of comorbidities

The elective nature of most pituitary surgeries provides time for the optimization of endocrinological, sinonasal, and cardiopulmonary co-morbidities. Even in the case of pituitary apoplexy, evidence suggests that waiting up to a week to optimize the patient medically before surgery[17] may be considered. Preoperative optimization of the sinonasal tract when necessary can lead to a reduction in bleeding intraoperatively and an improvement in nasal symptoms postoperatively.[18] Treatment of concomitant rhinitis and sinusitis involves 2–4 weeks of intranasal steroids, anti-histamines, nasal irrigation with the employment of decongestants, and culture-directed antibiotics, depending on the diagnosis.

Consent

Informed consent, jointly taken by a neurosurgeon and an otolaryngologist, details potential complications from the proposed surgery. Neurosurgical risks may include hypopituitarism, diabetes insipidus (DI), CSF leak, pneumocephalus, meningitis, injury to the optic apparatus with subsequent visual decline, diplopia, hypoesthesia of the forehead or infraorbital cheek, injury to major blood vessels with bleeding, pseudoaneurysms and/or stroke. Rhinologic risks may include epistaxis, hyposmia, nasal crusting, and sinusitis. While nasal crusting is universal and transient, the risks of epistaxis, hyposmia, and sinusitis are around 1%, 2%, and 6% respectively.[19–21] Delayed sphenoid mucocele may present with retroorbital pain, visual deterioration, and diplopia and has been described in about 1% of patients.[22] Reported rates of CSF leak and meningitis are around 1% in high-volume centers.[19,20] With respect to beneficial outcomes from endoscopic pituitary surgery, gross total resection for a non-functioning macroadenoma can be expected in up to 83% of patients when utilizing intraoperative MRI and 71.7% without it.[23] Visual function is likely to improve in 80% of patients and completely recover in 40% of patients.[24] Recovery of hypopituitarism may be seen in approximately one-third of patients experiencing hypopituitarism prior to the resection of non-functional adenomas.[25] The biochemical cure rate for an ACTH-secreting microadenoma is around 70%.[26] A GH-secreting microadenoma ranges from 50% to 90%, depending on the degree of extension into the cavernous sinus.[27,28] Radiation therapy can play an important role in the management of unresectable or recurrent non-functioning adenomas. For secretory tumors, medical treatment with dopamine agonists is the first line of therapy for prolactinomas. For GH and ACTH tumors, surgery remains the treatment of choice. However, many patients are not cured by surgery alone, or recur after initial remission, requiring medical therapy.

Medications: what to avoid and what to continue?

Systemic corticosteroids or levothyroxine, if prescribed for the correction of hypopituitarism, should be continued perioperatively to avoid an Addisonian crisis or prolonged reversal from anesthesia. When the function of the hypothalamic-pituitary-adrenal axis is intact, systemic steroids may be avoided preoperatively; however monitoring for post-operative hypocortisolism should be vigilant. Morning serum cortisol levels should be obtained postoperatively and should exceed 9 μg per deciliter. Antiplatelets and anti-coagulants are discontinued prior to surgery and restarted postoperatively when the risk of bleeding is low. Although continuation of anti-thrombotic agents perioperatively has been demonstrated safely by Ogawa and Tominaga, such a practice should be supported by a patient's compelling anti-thrombotic needs.[29]

Intraoperative management

Intraoperative considerations in endoscopic transsphenoidal pituitary surgery involve anesthetic and surgical refinements that optimize endoscopic visualization, instrumentation, and patient safety. Tight 3-dimensional confines in the immediate vicinity of important anatomic structures mandate the maintenance of optimal conditions throughout.[30] Given the endoscopic approach to the skull base traverses the sinonasal cavity, it would appear that well-defined concepts in endoscopic sinus surgery are particularly relevant here as well.[31]

General anesthesia and intraoperative hemostasis

The vascularity and relative frailty of the sinonasal mucosa can rapidly complicate surgery in this area. Limited bleeding may interrupt the surgical field. Anesthetic techniques that reduce nasal perfusion by safely reducing the cardiac output are preferred. Although total intravenous anesthesia (TIVA) and inhalational anesthetics have not been shown to greatly differ in the establishment of hemodynamic parameters, multiple publications support superior surgical visibility in patients undergoing TIVA.[32,33] It reduces cardiac output by depressing central sympathetic tone, avoiding the peripheral vasodilatory mechanism by which inhalational anesthetics induce hypotension. Wormald et al established superior operating conditions in multiple measures, with the use of a Remifentanil and Propofol protocol, compared to a volatile agent such as isoflurane or sevoflurane.[34] In the most challenging of sinonasal environments, such as high-grade sinusitis, TIVA has been shown to significantly improve intraoperative visualization and decrease total blood loss.[35] This finding has also been confirmed in a recent meta-analysis by Lu et al.[36]

Controlled hypotension and bradycardia have been a standard for endoscopic sinus surgery to reduce bleeding and improve the conditions of the operative field. Concerns around the safety of this technique have been addressed. One study, by Ha et al, used a novel measure of flow through the middle cerebral artery; it suggested that maintaining a mean arterial pressure above 60 mm Hg can maintain the flow velocity in the middle cerebral artery above 50% of baseline for the majority of intraoperative time.[37]

High-quality evidence espouses the safe utility of antifibrinolytics in endoscopic sinus and skull base surgery. Perioperative tranexamic acid administration has been shown to improve surgical field quality, while reducing blood loss, edema, and ecchymoses after nasal surgery.[38] Athanasiadis et al showed a potential benefit using these medications in a topical manner.[39]

Airway management

Airway management difficulty can be expected in about 4% of patients undergoing resection of pituitary lesions.[40] Retrospective data from the University of Virginia showed an increased risk of unexpectedly difficult airway in acromegalics, at over 9%.[40] Airway adjuncts for improved visualization, such as the fiberoptic endoscope and videoscopic-direct laryngoscopes, should be readily available during the intubation process in patients with acromegaly.[41]

The literature around the optimal airway medium for endoscopic skull base surgery is varied. An endotracheal intubation may elicit a stimulatory laryngeal effect and increase respiratory and cardiovascular reflexes, when compared with the employment of a laryngeal mask airway (LMA). Conversely, the endotracheal tube (ETT) provides more airway protection than the LMA. Atef et al suggest that the LMA enables more rapid achievement of target hypotension and decreased blood loss than ETT; this significantly improves the visibility of the operative field in the first 15 min of the procedure, potentially from decreased sympathetic stimulation.[42] While large case series describe the use of LMA without adverse consequences, studies around airway contamination resulting from both mediums deliver varied outcomes.[43–45] The risk of regurgitation with the utility of the LMA is real, with gastric insufflation activating an airway threat the LMA does little to protect against. Given studies showing equivalent outcomes between LMA and ETT have excluded patients with hiatus hernia, reflux, and obesity, it is reasonable to conclude that choice of airway should be individualized to patient comorbidities and surgical risks.

Head position

The reverse Trendelenburg position has long been supported as a simple technique that reduces intra-cranial bleeding during neurosurgical procedures. In endoscopic pituitary surgery, surgical technique may be compromised as the head-tilt rises. Ko et al demonstrated total blood loss, rate of blood loss, and the grading of the endoscopic surgical field are all significantly improved by positioning the operative patient with a head-up of 10°.[46] The literature shows no significant difference in mean arterial pressure between head-up and supine patients, suggesting blood loss is influenced more heavily by decreased venous return than arterial pressure. Gan et al compared 5-, 10-, and 20-degrees of elevation; they found 20-degree reverse Trendelenburg position produced significantly better surgical field-of-view and resulted in the lowest blood loss without compromising surgical technique.[47] This position may be considered for routine endoscopic transsphenoidal pituitary surgery.

Antibiotic prophylaxis

Standardized antibiotic regimes have established efficacy in preventing infectious complications in skull base surgery. These were primarily derived from open craniofacial approaches to skull base lesions, with the premise that broad spectrum coverage of Gram positive, Gram negative, and anaerobic pathogens could engender positive impacts on outcomes, quality of life, and survival.[48] With a recognized risk of meningitis around 1%, and the most common causative pathogens being Staphylococcal, Acinetobacter, Enterobacter, Pseudomonas, and Enterococcus species, the combination of Ceftazidime, Metronidazole, and Vancomycin provides complete coverage.[49] The evolution of minimally invasive approaches to the skull base via endonasal endoscopy has seen refinement of perioperative antibiotic usage. Brown et al showed single agent antibiotic prophylaxis may be safe for endoscopic skull base surgery.[50] A survey of surgeons operating endoscopically on pituitary lesions by Little et al found that despite greater than 90% of responders believing there was no compelling evidence supporting antibiotic use, more than 80% still used them; this acknowledged the safety data from non-endoscopic procedures.[51] Smith et al showed antibiotic use to be highly dependent on each surgeon's perception of the invasiveness of the endoscopic skull base procedure.[52] Given pituitary cases may be a less invasive undertaking, the use of antibiotics should be employed judiciously.

Intraoperative navigation

The increased availability and economic viability of CT and MRI image-guided navigation have led to their adoption as a practical standard of care for endoscopic transsphenoidal pituitary surgery. Through technological evolution, the benefits of reduced patient morbidity, increased completeness of resection, and decreased duration of postoperative hospitalization originally established by Javer et al will continue to be optimized.[53] In the same manner as neural monitoring techniques for the thyroid and parotid, routine employment will aid familiarity with the equipment when crucially required in more difficult procedures.[54] Advances in the accuracy and precision of both navigation and surgical instrumentation present an exciting frontier for the endoscopic skull base surgery.[55]

Nasal decongestion and infiltration

Nasal decongestion with topical vasoconstriction is fundamental to the creation of an optimal endoscopic operative setting. Historically, cocaine, with its unique vasoconstrictive and anesthetic properties, has been used in sinonasal mucosal preparation preoperatively. More recently, tighter controls around access and storage combined with safety concerns has seen the employment of alternative topical preparations.[56] In their blinded randomized controlled study, Valdes et al showed no difference in the quality of the surgical field achieved through topical cocaine or topical epinephrine.[57] Kuan et al and Orlandi et al suggest topical epinephrine is a safe intervention; however, care must be taken when applying to patients at cardiac risk.[58,59] Yim et al have shown topical epinephrine to cause adverse cardiovascular effects in a small subgroup of patients undergoing anesthesia by volatile agents; these sensitize the myocardium to the effects of epinephrine, increasing the likelihood of arrhythmias and hypertension.[60] Higgins et al in a systematic review advocate for the judicious use of concentrated epinephrine (1:1000 or 1:2000) as a first-line agent for adult endoscopic sinus surgeries.[61] Oxymetazoline was shown to be safe, although less efficacious, and may have a role in certain pediatric populations. The review further suggests the use of cocaine should be limited in patients with cardiovascular risks.[61]

Focused anatomic injection of lidocaine with epinephrine is a further common hemostatic technique. The literature attests to the safety profile of considered mucosal infiltration but shows no significant reduction in blood loss with preoperative infiltration of local anesthetic with epinephrine.[62,63] A meta-analysis by Hwang et al demonstrates additional optimization to the subjective operative field without hemodynamic adversity with transoral injection of the greater palatine canal.[64] Transnasal sphenopalatine injection, another common practice, may be effective in improving postoperative analgesia. However, its impact on intra-operative bleeding is more poorly correlated.[65]

Surgical preparation

Published and validated surgical checklists for these endoscopic skull base surgical procedures have not included recommendations for intranasal or facial preparation preoperatively.[66,67] The concept of sterilizing the nasal cavity may not only be implausible but may interrupt the equilibrium of the nasal microbial environment. A sensible compromise may be preparing the exposed face to reduce potential contamination.

The protected eyes should be visible to the operating surgeon, giving observable clues to potential and otherwise unrecognized intraorbital complications. The routine use of pharyngeal packing in endoscopic sinus surgery was originally based on the premise that this would decrease postoperative nausea and vomiting by preventing blood ingestion. Despite this historical assumption, a considerable body of high-level evidence has concluded pharyngeal packs have no effect on pain or postoperative nausea and vomiting.[68]

Instrumentation

Given the vascularity of the nasal mucosa, the use of cautery for incisions and flap elevation is advantageous for the maintenance of the operative field. While a learning curve may have contributed to original concerns about epithelial loss and olfactory impairment with cautery, cohort studies have shown no difference in UPSIT or SNOT22 smell/taste scores with this technique compared to cold steel.[69]

Surgical irrigation

Utility of the endoscope has significantly improved operative field visualization in pituitary surgery, providing significant and obvious benefits. However, the magnification of the endoscope and the proximity of the visualization instrument to the operating field means that even a small amount of bleeding or blood pooling may cause significant hindrance to the surgeon. Self-irrigating camera sheaths have become commonly used to counter this problem. Hot (compared with room-temperature) saline irrigation improves the surgical field of view by producing a hemostatic effect, with a significant decrease in rate of blood loss 2 h into operating.[70]

Middle turbinectomy

The role of the middle turbinate in nasal airflow, sinonasal drainage, and as an intraoperative landmark ensures that preservation of this structure is highly regarded in endoscopic sinus surgery. Extensive clinical and cadaveric studies have shown middle turbinectomy (MT) improves access to only the middle 1/3 of clivus and ipsilateral sphenopalatine artery and bilateral MT did not improve access to any target compared with unilateral.[71] While the middle turbinate may need to be carefully lateralized for instrumentation in pituitary surgeries, MT should be a rare consideration, with new techniques being espoused to aid in its preservation.[72]

Pedicled flaps for skull base reconstruction

The nasoseptal mucoperichondrial flap described by Hadad & Bassagasteguy has become the standard for skull base defect repair.[73] This tissue, pedicled on the posterior septal branch of the sphenopalatine arterial outflow, is often elevated near the commencement of the endoscopic pituitary case and safely positioned in the nasopharynx to protect it from the trauma of dissection instrumentation. If required, care must be taken during fixation to ensure the mucosal aspect of the flap is not applied to the cranial defect. Despite initial concerns about the postoperative morbidity of the nasoseptal flap, especially with respect to olfaction, prospective studies have established that this technique elicits minimal impact on each patient's quality of life.[74–76]

The "rescue" flap described by Rivera-Serrano et al is a modification of the nasoseptal flap, whereby the pedicle preserved and flap elevation delayed, and may minimize potential morbidity.[77] Further modifications have been described, with techniques allowing for bilateral elevation and utility currently prevalent.[78,79]

Frozen section

With the advent of dramatic improvement to surgical field and tissue differentiation manifested by the utility of the endoscope, reliance on frozen section has decreased despite it being a sensitive measure of excised pituitary tissue.[80,81] Lim et al proposed that multi-staged resection and frozen section identification allow for the most complete resection of pituitary lesions in Cushing disease.[82] Despite being embryonic in its development, a recent study has shown confocal reflectance microscopy may provide a future alternative to frozen section.[83]

Vascular injury

The most feared and disastrous complication of endoscopic pituitary surgery is carotid artery injury. Overwhelming and uncontrolled blood loss from carotid artery injury is a potential cause of intraoperative mortality. In a systematic review, Chin et al found no evidence to support image guidance or other adjuncts as mitigators of internal carotid artery (ICA) injury.[84] Therefore, every endoscopic skull base team should have an established protocol for its occurrence. This complication requires 2 surgeons working intranasally in a complementary fashion with large bore suction. Once appropriate packing (cautionary if the dura has been opened), anesthetic, and resuscitative measures have been undertaken for immediate control, one surgeon becomes responsible for suctioning to direct blood flow away from the endoscope, as the other surgeon actively manages the hemorrhage control.

Padhye et al[85] described the use of thigh muscle (quadriceps or sternocleidomastoid) to be effective tamponade for ICA bleeding. After initial control, the muscle patch is applied to the vascular defect, without significant pressure, and may take up to 12 min to exert its effect. Endovascular intervention may be necessary, with occlusion/stenting having significant technical difficulties and risk of complication. Generally, proprietary hemostatic agents have not been shown to significantly stem the high velocity flow in ICA injury. Emphasis should be placed on surgical competency, teamwork, and technical expertise through education with Wormald's sheep model, the current gold-standard example for catastrophic vascular injury in endoscopic surgery.[86]

Lumbar drain

The insertion of a lumbar drain is not routinely employed in endoscopic pituitary surgery, as the risk of a high-flow CSF leak is low.[87] High-flow CSF leak is associated with dural defects greater than 1 cm^2 or with arachnoid, ventricle, or cistern dissection. A perioperative lumbar drain used together with vascularized nasoseptal flap closure significantly reduces the rate of postoperative CSF leak, as shown by Zwagerman et al[88] and others.

Splints and nasal packing

The use of nasal packing and splints is often at the discretion of the treating surgeon and is based on patient and intra-operative surgical factors. Orlandi et al suggested the routine use of packing and/or splints is not supported in endoscopic sinus surgery; these adjuncts may be beneficial in patients undergoing transsphenoidal pituitary surgery, especially in support of grafts and reconstruction of the skull base.[89]

Anesthetic reversal and emergence

Cooperation with the anesthetic team is vital to ensure a smooth extubation and emergence from general anesthesia. Avoidance of coughing and intermittent spikes in blood pressure will help maintain hemostasis during the reversal. The provision of adequate analgesia in the recovery room is paramount with non-opioid agents, such as Gabapentin, and Acetaminophen, having literature supporting their use for pain control after endoscopic sinus surgery.[90] It is important such agents are scheduled regularly for maximum efficacy in the immediate postoperative period.

Postoperative management

After transsphenoidal pituitary surgery, a patient is typically admitted to a high-dependency unit for close monitoring of consciousness level, blood pressure, visual acuity, sodium level, urinary output, epistaxis, and CSF leak.

Sodium management

Sodium abnormalities can occur after pituitary resection, the hypernatremia being caused by central DI and the hyponatremia a result of syndrome of inappropriate secretion of antidiuretic hormone (SIADH), cerebral salt wasting (CSW), or hypocortisolism. The recognized rates of transient and permanent DI are 4.3% and 0.3%, respectively. The rates of symptomatic hyponatremia and hypocortisolism are 4.2% and 0.2%, respectively.[20] The diagnosis is suspected when a patient with polyuria has elevated serum sodium and serum osmolality and is confirmed when serum osmolality increases with the administration of 1-deamino-8-D-arginine vasopressin (DDAVP). Central DI is usually transient and does not always require DDAVP. For patients who are awake, allowing them to drink to thirst liberally can suffice. However, when patients are asleep, DDAVP administration may be necessary. In obtunded patients, close monitoring and regular administration of DDAVP is needed to avoid worsening hypernatremia.[91]

Euvolemic hyponatremia may result from SIADH, while hypovolemic hyponatremia is caused by CSW. Low serum sodium and osmolality but high urinary sodium and osmolality in the presence of normal TSH, cortisol, and renal function is characteristic of SIADH. The management of SIADH after pituitary surgery entails a period of watchful waiting, followed by free water restriction if the hyponatremia persists. In contrast, CSW is managed by fluid repletion with normal saline and oral salt replacement. In refractory cases, fludrocortisone may be used with monitoring for hypokalemia, fluid overload, and hypertension.[91]

CSF leakage

Bedrest, stool softeners, sneezing with the mouth open, avoidance of nose-blowing, straw-sipping, or straining are measures aiding in prevention of CSF leak. The timing of safe post-operative ambulation is poorly described in the literature. The occurrence of CSF leakage is usually clinically apparent, presenting either as watery rhinorrhea or as persistent, salty postnasal drip. This fluid should be collected and tested for beta-trace protein if its nature is equivocal.[92] Once confirmed, the role of conservative management with a lumbar drain must be discussed. If the leak is profuse or persistent, examination under anaesthesia to identify and repair the dural defect is indicated.

Epistaxis

Mild oozing is common and self-limiting within 1—2 days. Profuse epistaxis may be attributable to the posterior septal artery but should also raise the suspicion of an ICA injury. If the source of the bleeding is not apparent to the surgeon, the patient can be brought to the operating room for an examination under anesthesia. Bleeding from the posterior septal artery can be controlled with monopolar or bipolar suction cautery. Absorbent hemostats, such as Surgicel (Johnson & Johnson; USA) may be applied to raw mucosal edges to aid in the hemostasis. The rare bleeding from the carotid artery can be managed by firm packing with or without a muscle plug. The patient is then resuscitated and brought to the neuroangiography suite for expeditious endovascular treatment.

Postoperative antibiotics

Evidence does not support the use of prophylactic antibiotics beyond the first 24 h. However, when nasal packing is present, it is reasonable to continue coverage against staphylococcus or streptococcus until removal of the packing.[93]

Neurological assessment

Bedside examination of the visual acuity, extraocular movement, and sensation to the forehead and infraorbital cheek are checked daily postoperatively. If unexpected, new onset diplopia or deterioration in visual acuity is experienced, systemic corticosteroids may be administered to reduce neuronal swelling. Emergent imaging of the brain (CT or MRI) should be obtained to look for hematoma and packing effects. If mass effect on the optic apparatus or the cavernous sinus is observed, an emergent return to the operating room is indicated.

Obstructive sleep apnea

The prevalence of OSA can reach up to 42% in patients with acromegaly, 19% in patients with Cushing disease, and 16% in patients simply undergoing pituitary surgeries.[94] Nasal canula or continuous positive airway pressure (CPAP) devices should be avoided postoperatively to minimize the risk of tension pneumocephalus in these patients, as should the use of opioids and sedatives. Continuous pulse oximetry should be utilized for the detection of hypoxia within the first 48 h, with humidified oxygen delivered via a facemask indicated as corrective treatment. Despite study limitations, a recent study by Rieley et al challenged a blanket avoidance of CPAP in the immediate postoperative period; it suggested that patients with low risk of CSF leak may benefit from CPAP if the severity of their OSA warrants such treatment.[94]

Nasal care

When the sellar defect is closed in a multi-layered fashion with grafts such as fat, mucosa, or Alloderm (Lifecell; Branchburg, NJ, USA), tissue sealant is placed over the repair, and packing is not required. The donor site on the nasal septum can be protected with splints removed in the first week to facilitate nasal breathing. The patient can commence gentle nasal saline irrigation from the second week postoperatively. Antibiotics can be stopped once the splints are removed.

Antithrombotics

In patients at high risk of cardiovascular events without these medications, antiplatelet and anticoagulant medication can be resumed the day after the surgery if there is no ongoing bleeding. This is supported by a case—control study conducted by Sargi and Casiano.[95] The risk of deep vein thrombosis is estimated at 0.6%; routine mechanical prophylaxis is an adequate preventative measure in most patients.[96,97]

Discharge criteria

The patient is fit for discharge when there is hemodynamic stability, appropriate sodium homeostasis, resumption of ambulation, and adequate diet. There must be no evidence of epistaxis, CSF leakage, or fluid neurological findings. Generally, most patients can be discharged within 2—3 days.

Follow-up schedule

Postoperative scheduling typically involves a clinic review 1-week postoperatively for removal of the nasal splint and debridement of the nasal cavity. Another visit in 2—4 weeks is usually arranged to inspect the healing of the sella and the nasal cavity. A recent review by Tzelnick et al supports the benefits of postoperative nasal debridement in reducing adhesion formation; however, the clinical significance of this is unclear.[98] Conservative and considered debridement, particularly of crusting over the skull base, aids in completing the healing process by 6—8 weeks. Long-term follow up with the endocrinology members of the multidisciplinary team facilitates the monitoring of pituitary function and disease recurrence. Follow-up serum Na is recommended at 5—7 days post-operatively due to the risk of transient hyponatremia in the post-operative period.

Conclusion

Attention to detail in the perioperative care of patients undergoing endoscopic transsphenoidal resection of pituitary tumors can help minimize complications and maximize therapeutic outcomes. Well-considered and evidence-based perioperative care is fundamental to this aim. Regular review among colleagues in the multidisciplinary pituitary team helps achieve sustained quality improvement. As the expertise of endoscopic transsphenoidal pituitary surgeries deepens worldwide, concerted and thoughtful consideration of management steps, both surgical and non-surgical, can elevate the safety, efficacy, efficiency, and patient satisfaction of this procedure to a new level.

Declaration of Competing Interest

None.

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