Short Communication

Strategies to Protect the Cranial Base in Endoscopic Skull Base Surgery

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Abstract

Introduction: Large cranial base defects after transsphenoidal surgery exposes the brain to iatrogenic injury via insertion of endonasal tubes. It has been reported in the literature that nasogastric tubes have inadvertently been placed into the brainstem or spinal cord postoperatively. This can have devastating ramifications including neurologic sequelae or fatality. For these reasons, it is prudent to implement surgical techniques to help protect the cranial base against iatrogenic injury after endoscopic, endonasal skull base surgery.

Methods: We performed a Pub Med literature review of cases of inadvertent intracranial placement of a NGT. We categorized the causes as traumatic, non-traumatic, and surgical, and identified trends to assess potential risk factors. Articles not in English were excluded from our review.

Results: We identified 37 articles describing 41 instances of a misguided NGT intracranially. Twenty-seven cases (65.8%) were in the setting of trauma, 7 (17%) in non-traumatic settings, and 7 (17%) after surgery. Sixteen of forty-one (39%) died of various causes and 5 (31.3%) were directly attributable to intracranial insertion of the NGT.

Discussion: We describe several techniques to protect the cranial base including middle turbinate preservation and medialization, limited posterior nasal septectomy and trans-septal approaches. In addition, we provide a video illustrating the how the cranial base is protected using these methods.

Conclusion: Operative techniques in endoscopic transsphenoidal skull base surgery that facilitate closure of the sphenoid sinus likely decrease the risk of postoperative iatrogenic injury via inadvertent placement of endonasal tubes.

ABBREVIATIONS

NGT: Naso Gastric Tube

INTRODUCTION

Although relatively uncommon, inadvertent instrumentation of nasogastric tubes into the brain stem (Figure 1) or spinal cord (Figure 2) is a recognized post-operative complication of endonasal skull base surgery or acute head trauma. This can lead to devastating consequences such as hemiplegia, meningitis, and intracranial hemorrhage (ICH) [1]. According to Fletcher et al., this misplacement is lethal in 64% of cases [2]. Sites of entry of a NGT into the cranial vault include: a comminuted fracture of the basilar skull or floor of the anterior cranial fossa providing entry from the nasopharynx, and disruption or fracture of the cribriform plate or an unusually thin cribiform plate, which is especially at risk when a transversely oriented rigid NGT is improperly advanced [3,4]. For this reason, relative contraindications to NGT insertion include CSF rhinorrhea in association with head or maxillofacial trauma and failure of an NGT to pass freely and easily [4]. To avoid these potential complications, it is prudent to confirm the placement of a NGT by anteroposterior and lateral radiographs of the skull rather than by aspiration of gastric contents or auscultation of air injected through the tube [4,5]. Alternatively, confirmation via water-soluble contrast is another option in adults. It is recommended that patients with craniofacial...
injury should instead undergo placement via the oral route with direct visualization [3].

Endoscopic skull base surgery, in particular, creates a potential direct pathway to the intracranial compartment from the nostrils. This increases the likelihood of intracranial NGT placement. The majority of the literature reporting these instances is in the form of individual case reports. There have been 3 instances reported in the literature of this complication occurring after endoscopic transsphenoidal surgery and 1 case after endoscopic transnasal resection of a clival chordoma [6]. Three of these patients died [6-9] and one survived with severe thalamic and cortical injuries [10].

METHODS

We performed a Pub Med literature review of cases of inadvertent intracranial placement of a NGT. We categorized the causes as traumatic, non-traumatic, and surgical, and identified trends to assess potential risk factors. Artides not in English were excluded from our review.

RESULTS

We identified 37 articles describing 41 instances of a misguided NGT intracranially. Twenty-seven cases (65.8%) were in the setting of trauma, 7 (17%) in non-traumatic settings, and 7 (17%) after surgery (Table 1). Surgeries included endoscopic transsphenoidal resection of pituitary tumors (3), endoscopic transnasal transclival resection of a clival chordoma (1), craniotomy for pituitary adenoma (1), craniotomy for intracranial hemorrhage (1), and repair of choanal atresia (1). Non-traumatic cases included: a patient with thin cribriform plate, status epilepticus and congenital defect (possibly nasal glioma), treacher-collins syndrome, routine nasal intubation of a premature infant, premature infant with ARDS, Goldenhar syndrome with cribriform plate agenesis, and healthy patient who volunteered for a study on bile secretions.

Sixteen of forty-one (39%) died of various causes including intracranial hemorrhage, bronchopneumonia, or head injuries they presented with upon admission. Five of these deaths (31.3%) were directly attributable to intracranial insertion of the NGT. The most common insertion point was via the cribriform plate (19 cases, 46%), with the second most common being the sphenoid sinus (6 cases, 14.6%).

DISCUSSION

Operative techniques to protect the cranial base

Herein we describe operative techniques that serve to protect the cranial base after transsphenoidal surgery. In all instances, a wide bony sphenoidotomy is created, and just the mucosa on one or both sides may be limited. One method to protect the cranial base is by creating conservative sphenoidotomies (1.5 approaches, Figure 3). For example, a right-sided wide sphenoidotomy is performed along with a small contralateral sphenoidotomy. A limited posterior septectomy of <2 cm is created. Once healed, the opening to the sphenoid sinus is very narrow. In our experience, not only does a smaller posterior septectomy serve to protect the cranial base, but it also has the additional advantage of decreasing post-operative sinonasal morbidity [11]. This protective feature of a limited posterior septectomy should not outweigh the need for exposure, especially in larger tumors or based on patient's anatomy. Adequate exposure should always be maintained even if it results in a larger posterior septectomy.

A septoplasty with a sub mucosal “tunnel” approach can be utilized to correct septal deviations. On the side of the spur or deviation, a hemi-transfixion incision is made and the surgeon works inside the submucosal septal tunnel to create a sphenoidotomy (in a submucosal fashion) and access the...
skull base. Thus, the sphenoid sinus ostium on the side of the hemi-transfixion incision is not widened and the skull base is not exposed (Figure 4). This helps to protect the skull base because the majority of the mucosa overlying the sphenoid face is preserved, thereby closing off the large bony sphenoidotomy.

Another method involves preserving the middle turbinates. Complete ethmoidectomies are not performed but rather limited posterior ethmoidectomies are utilized when needed for access. The middle turbinates are medialized at the end of the procedure (Video 1). This serves to protect access to the sphenoid by a NGT because it closes off the sphenoidotomy, allowing the NGT to preferentially pass into the nasopharynx. While some may advocate for routine middle turbinate sacrifice in endoscopic sinus surgery, preserving the middle turbinate, as we do here, also decreases risk of cerebrospinal fluid leak, maintains the basal lamella as a surgical landmark for further endonasal navigation, and decreases scarring, among other advantages [12]. A prospective observational study by Nyquist et al. found that middle turbinate preservation in endoscopic endonasal transsphenoidal surgery can still provide adequate exposure for successful tumor resection and skull base reconstruction while preserving postoperative sinonasal function [13]. Additionally, a recent retrospective cohort study by Sowerby et al. compared patients who underwent middle turbinate sacrifice and middle turbinate sparing endonasal approaches to the sella and found no effect on postoperative radiographic frontal sinusitis [14]. These studies advocate routine middle turbinate preservation and suggest no advantages to routine middle turbinate sacrifice in endoscopic endonasal transsphenoidal surgery.

In contrast to routinely removing bone over the carotid artery and optic nerves, we maintain these protective bony structures.
Routine bony removal exposing critical structures along the cranial base is avoided and exposure is based on the access required for each individual case. These surgical techniques also allow for preservation of bilateral nasal septal flaps, which is also an advantage of these techniques.

Additionally, we ensure patients are adequately informed of their risk for a cranial base defect after their surgery, and some have found wearing medical alert bracelets (Figure 5) detailing their special circumstances to be extremely helpful in relaying this potentially life-saving information to other medical providers in emergency settings.

CONCLUSION

Inadvertent intracranial placement of NGT's after endoscopic skull surgery is a recognized and potentially lethal complication. Intraoperative techniques can be employed to prevent incorrect NGT instrumentation and ensuing life-threatening neurologic sequelae. We describe techniques including middle turbinate preservation and medialization, a limited posterior nasal septectomy, and transseptal approaches to help fortify the cranial base after transsphenoidal surgery.

REFERENCES