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Case study

Reconstructive outcome of intraoperative cerebrospinal fluid leak after endoscopic endonasal surgery for tumors involving skull base

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ABSTRACT

Endoscopic transnasal surgery for tumors located at the base of the skull has a high incidence of postoperative cerebrospinal fluid (CSF) leaks. Here, we assessed the repair outcomes for high-flow CSF leaks based upon the tumor location, and analyzed the reasons for repair failure after transnasal endoscopic surgery solely for tumors involving the base of the skull. From Feb. 2009 to Dec. 2014 we performed endoscopic endonasal surgery for a variety of skull base lesions in 788 patients at our institution. Among them, 95 patients with intradural skull base tumors underwent endoscopic transnasal surgery. We performed surgical repairs with a multilayered nonvascularized construct (38 patients) and a vascularized pedicled nasoseptal flap construct combined with a fascia graft (57 patients). Overall, 14 of 95 patients (14.7%) who underwent endoscopic transnasal surgery for skull base tumors developed postoperative CSF leaks. The major causes of repair failure included graft disruption by a lack of counterpressure in the multilayered non-vascularized technique, and inadequate drilling of the sphenoid bone, displacement of the flap due to pressure from CSF or gravity, or disruption of flap integrity in the vascularized pedicled flap technique. Logistic regression analysis revealed that there was no significant association between repair failure and age, sex, type of reconstructive method used, and primary tumor type ($p > 0.05$). Reconstruction after endoscopic endonasal surgery remained challenging, especially for non-pituitary skull base tumors requiring intra-arachnoidal dissection. Recent advances in reconstructive techniques require the accumulation of experiences with sufficient dexterity to achieve an acceptable morbidity rate.

1. Introduction

The surgical technique for skull base pathologies has evolved from limited microscopic transnasal approaches to the pituitary gland, to endoscopic transnasal approaches to the skull base during the past 15 years [1]. With concurrent advancements in endoscopic instrumentation, neuro-navigational guidance, and a comprehensive understanding of surrounding anatomical relationships, the scope of endoscopic transnasal surgery has widened to various zones of the skull base for the surgical management of pathologic lesions [2]. As endoscopic transnasal surgery has been increasingly applied to treat more complex lesions, one of the most significant challenges has been how to reconstruct skull base defects caused by these procedures [3].

One of the main criticisms of the new minimal access transnasal approaches to the skull base has been the relatively high rate of CSF leaks [4,5]. After endoscopic transnasal surgery, postoperative CSF leak rates vary from 5 to 20% [5–7]. Since an innovative reconstructive technique was introduced by Hadad et al. [8], further studies have demonstrated the efficacy of pedicled vascularized nasoseptal flap as a highly reliable reconstructive method [5–13]. The excellent patient outcomes found in these studies prompted many institutions to transition from the multilayered non-vascular construct to the vascularized flap as the main reconstructive method after endoscopic endonasal surgery. However, a

Abbreviation: CSF, cerebrospinal fluid.

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significant number of these studies included extra-arachnoidal lesions, such as pituitary adenomas or Rathke's cleft cysts, which consequently may have contributed to the low complication rates [7]. To date, a growing number of studies have demonstrated that CSF leak after endoscopic endonasal surgery is more likely in those with critical risk factors, such as significant arachnoid dissection, ventricular entry, or a history of surgery or radiation therapy [9,12]. Therefore, it is critical to reduce any selection bias in order to accurately assess repair outcomes. To avoid overestimation of repair outcomes, investigators should carefully consider whether their study design should include intra/extradural or extra-arachnoidal lesions. Thus, the primary objective of this study was to assess repair outcomes for high flow CSF leak after endoscopic transnasal surgery for non-pituitary skull base tumors. We also analyzed the major reasons of repair failure.

2. Materials and methods

A retrospective chart review was performed on patients who underwent endoscopic skull base surgery from February 2009 through December 2014 at Samsung Medical Center. The inclusion criteria for this study included patients with non-pituitary tumors involving the skull base region who required intra-arachnoidal dissection. Of the skull base series, extradural lesions, including fibrous dysplasia involving the ventral skull base or intradural extra-arachnoidal lesions, such as pituitary adenomas and Rathke's cleft cysts, were excluded (Fig. 1).

Patient demographics, pathological findings, indication for surgery, history of radiation to the surgical area, and repair outcome were recorded. Repair failure was defined as CSF leak or meningitis due to persistent rhinorrhea from the skull base defect. Pre- and postoperative imaging, operative reports, medical records, and, in some cases, operative videos were reviewed to determine the skull base defect characteristics, technique used for wound closure, and the presence of a CSF leak.

2.1. Follow-up

Follow-up examinations were performed in all patients to monitor CSF leakage. Pituitary function was evaluated one month after surgery to determine if hormone replacement therapy was needed. Postoperative magnetic resonance imaging was routinely performed 2 days and 3 months postoperatively in each case. Within 2 months after surgery, the nasal cavity was cleaned and examined monthly to monitor nasal mucosa status until healing was complete.

2.2. Reconstructive methods

Two different surgical procedures were used for primary CSF leak repair after endoscopic transnasal skull base surgery after endoscopic transnasal skull base surgery. Selection of reconstruction techniques was chosen according to the surgeon's choice. First, a multilayered nonvascularized construct such as the gasket seal method, was one of the methods employed. In this method, a piece of autologous fascia lata or an allograft of fascia was fashioned according to the size and shape of the existing defect. The tissue graft material was then centered over the defect. The diameter of the fascia lata was 2 cm larger than the bone defect in all directions to ensure that the radius of the graft exceeded and covered the bone defect by at least 1 cm. A piece of the vomer was placed over the center of the fascia lata and countersunk into the defect, so that the edges of the buttress were wedged immediately beyond the bony edges of the defect in a manner that held the fascia lata in place. The center part of the fascia lata was embedded subdurally, and the edges remained in the sphenoid sinus, covering the bony edges of the defect (Fig. 2).

The second procedure involved a pedicled vascularized nasoseptal flap. The technique for harvesting the vascularized nasoseptal flap has been described previously by Hadad et al. [8]. The defect was typically closed with a layer of fascia lata. Septal splints were placed over the denuded septal cartilage and bone, and left in place for 3–4 weeks. In the cases of certain sphenoid and clival defects, Merocel sponges were applied directly in the nasopharynx on the nasoseptal flap. All multilayered nonvascularized constructs were made by a single neurosurgeon (D.K., 38 cases). One neurosurgeon and one rhinologist specializing in skull base surgery performed the vascularized pedicled flap procedure combined with a fascia lata graft (D.K. 12 cases and S.H. 45 cases). Lumbar drainage was continued for 3–5 days postoperatively, draining at a rate of 10 cc/h.

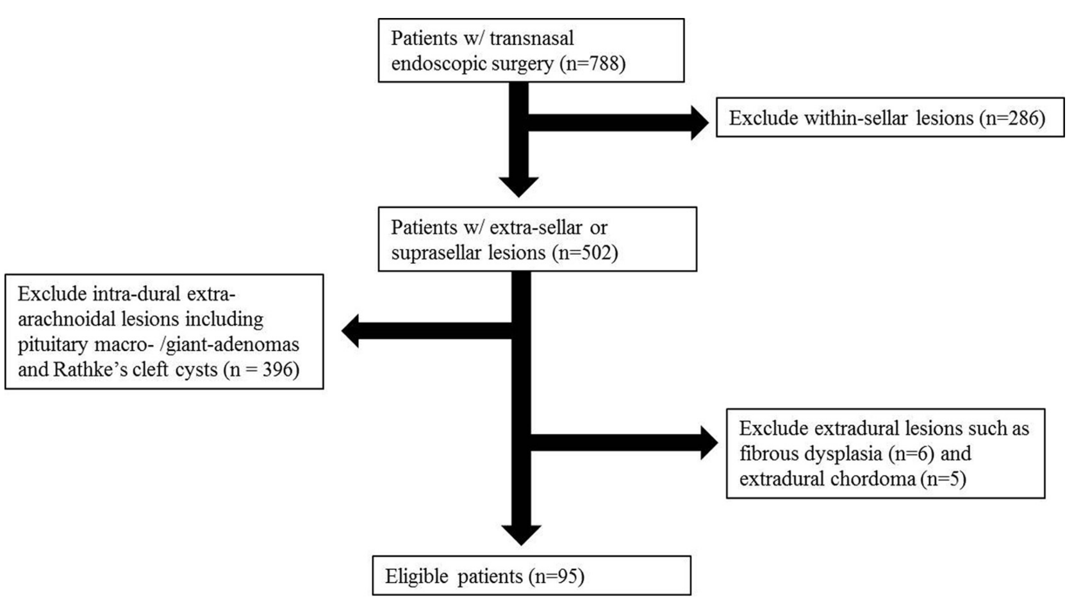

Fig. 1. Flow chart of patient eligibility.