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Literature Review

Plastic Defects of the Base of the Skull in Transnasal Removal of Tumors of Sellar Localization

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The urgency of the problem

The reconstruction of the skull base defects (Sellar and parasellar localization) in transnasal surgery is of great relevance due to the large number of unresolved issues. Even at the current stage of endoscopic neurosurgery, lead centers (Pittsburgh Groups, Carrau, and Prevedello, 2016) report an incidence of postoperative nasal liquor (PNL) greater than 15% for advanced trans nasal access. PNL is one of the most important reasons why the types of skull defect closure and the choice of materials used should be critically considered. Yes, of course, prevention of infection, since untreated PNL leads to 35-50% in meningitis in inpatient languages. The analysis of the literature confirms the relevance of the planned study on the material of endoscopic interventions of the Institute of Neurosurgery for 2016-2017 and current observations.

RESEARCH DESIGN: will cover retrospective analysis and prospective studies. (a total of 100-150 cases are planned). Two groups will be considered:

- Tumors of predominantly sella localization, mainly the pituitary adenoma;
- Tumors removed with advanced trans-nasal access (suprasellar tumor resection) - for example, craniopharyngioma (2a. Opening of the cistern\2b. Ventricular opening).

The aim of the work is to improve the results of neurosurgical treatment by increasing the efficiency of reconstruction of the defects of the skull base when removing tumors of sella localization.

Scientific novelty

- It consists in developing a differentiated approach to the methods of skull base plasticity in the structure of transnasal endoscopic surgical treatment of patients with sella and parasellar tumors;
- Clarification of options for intraoperative nasal liquor;
- Scientific justification for the use of lumbar drainage based on the statistical processing of remote results of operations,
- Investigation of the viability and effectiveness of the mucous membranes of the nasal septum.

Practical importance will be

- A reasonable choice of materials to close defects of the skull base (natural or autologous), their combination;
- Introduction of new advanced materials to close defects of the skull base;

Objectives of the study

1. To evaluate the risks and peculiarities of intraoperative CSF depending on the variants of the tumor localization;
2. To evaluate the technical aspect of the closure of the skull base defect after removal of sellae localized tumors through the nose;
3. To evaluate the viability of nasoseptal flaps using intraoperative ultrasound and endo-rhinoscopic techniques
4. To evaluate the feasibility and effectiveness of intraoperative and long-term postoperative lumbar drainage;
5. Evaluation of the results and prognosis of postoperative recovery and hospital stay in carrying out various variants of plastic defects of the skull base;
6. Determining the feasibility of using fibrin adhesives to close the defect of the base of the skull after removal of tumors of localization through the nose.

Transsphenoidal surgery: closure and reconstructive techniques following skull base surgery

Complete sellar floor reconstruction is critical to avoid postoperative cerebrospinal fluid (CSF) leakage during transsphenoidal surgery. As defect sizes increased following endoscopic skull base

resections, the use of free tissue grafts or engineered materials often led to unacceptable postoperative complications, despite a multilayer closure technique. Complications primarily included postoperative CSF leaks (with rates as high as 50%), infection (meningitis and intracranial abscess), pneumocephalus, meningoencephalocele, seizure, and even death.

The Problems with closure of the dura mater and prevention of CSF leaks are a persistent source of complication in both endoscopic and microscopic skull base surgeries.

Schloffer and Harvey Cushing proposed a transseptal transsphenoidal approach to the pituitary gland in the beginning of 1900s. The first successful surgical treatment for CSF rhinorrhea was reported by Dandy in 1926. The postoperative CSF fistula remains the most serious complication following transsphenoidal surgery [1].

Since the introduction of endoscopy for transsphenoidal pituitary surgery in 1992, endoscopic endonasal transsphenoidal approach (EETSA) for sellar and parasellar regions has been considerably advanced. EETSA is a minimally invasive technique that is considered to be safe and effective for treatment of pituitary adenoma and other parasellar (midline) lesions. Despite the advancement, it permits only for a very limited space for instrument manipulation and results in difficulties in dura repair for cerebrospinal fluid (CSF) leak after tumor removal. If not completely controlled during surgery, postoperative CSF leaks may be troublesome.

The endoscopic endonasal pituitary surgery differs from the transsphenoidal microsurgery in the following aspects: plane vision, close vision, no nasal speculum, endonasal and ample vision field; microscopy, however, featuring a three-dimensional vision, in the distance, with transnasal speculum [2]. The use of the endoscope during the transsphenoidal surgery is important in that it allows maximum tumoral excision and gives room for a better visibility of slight CSF fistula. The decision to use the microscope or the endoscope or both, is primarily based on the surgeon's experience and preference.

Closure techniques used in micro neurosurgery and endoneurosurgery are different hence Potential morbidities associated with CSF leakage after transsphenoidal surgery include:

- Prolonged hospitalization [3]
- Reintervention
- Bacterial meningitis
- Abscess
- Subdural hematoma and
- Pneumoencephalus of tension.

Thus, in order to avoid postoperative CSF leakage, it is essential to achieve the complete sellar floor reconstruction. However, using nasoseptal flaps in all patients who undergo transsphenoidal surgery, including those who had none or only minor CSF leakage, appears to be overly invasive and time-consuming.

Traditional transsphenoidal surgery is associated with a postoperative cerebrospinal fluid (CSF) leak rate ranging from 0.5 to 15% [1,4,5].

Techniques and differences materials used

- Inlay and onlay - dural substitutes
- Overlay and underlay
- Materials: Autologous and Synthetic [4,6]

Autografts

Nasoseptal flap – with (Hadad-Bag. or without pedicels), Fat graft, Fascial lata, muscles, pericranium, septal bone, sphenoid mucosa.

Biocompatible materials [3,6,7]

1. Oxidative cellulose packing (Surgicel®, Ethicon; Johnson and Johnson)
2. Dural substitutes (Duraform®, Codman; Johnson and Johnson) and
3. Collagen hemostatic agent (TachoComb®, CSL Behring)
4. Tissue sealants and adhesives (DuraSeal®, Covidien), vivostat, Dura

The 'sliding-lock-knot' technique is simple and useful for dural suturing in microscopic/endoscopic extended TSS. This technique is one of helpful tools for preventing CSF leakage after this challenging surgical procedure and also applicable for a number of other surgeries.

Factors that determine choice of closure and reconstruction techniques

CSF Leak: High-flow or low-flow leak.

The technique of covering the sella membrane and dural defects with the use of free fat graft in the case of intraoperative CSF leakage appeared to be most reliable and cost effective technique for intraoperative CSF leak. However, the size and anatomic site of the defect are factors that are predictive of postoperative CSF leaks. larger defects that span the tuberculum sellae and the planum sphenoidale are inherently more complex to reconstruct than smaller defects involving only a small portion of the sella. Most pituitary tumors are resected either without a CSF leak or with a resulting low-

flow CSF leak. Low-flow CSF leaks, as a rule, are easier to control than high-flow leaks. Low-flow CSF leaks can be defined as leaks that occur after dural opening but do not involve an opening into the ventricle or arachnoid cistern (such as the basilar or suprasellar cistern). In contrast to most pituitary tumors, other tumor types, such as meningiomas and craniopharyngiomas, may also be at increased risk for intraoperative and postoperative CSF leak.

Patient factors for high-risk postoperative CSF leak potential

1. Body habitus of the patient. Large body mass is associated with high ventricular pressure.
2. Pathology being treated, especially craniopharyngiomas and lesions involving the cisterns.
3. Entry into cisterns or ventricles.
4. Site and size of the defect. Defects in the anterior cranial base are much more likely to leak than clival defects.
5. Patients with Cushing disease with extrasellar adrenocorticotropic hormone–secreting tumors, likely owing to the poor state of tissue healing in these patients.
6. Patients with no vascularized tissue reconstructive options owing to prior surgery or chemoradiotherapy.
7. Socioeconomic factors
8. Age of the patients
9. Religion view point of the subject
10. Sex.

CSF diversion: Lumbar drainage (LD) placement or without

With the increased dependability of vascularized pedicled flaps for skull base reconstruction, the need for routine LDs in skull base reconstruction is being challenged, even when there is a high-flow fistula. The primary purpose of CSF drainage from the lumbar subarachnoid space is to provide a controlled, low-resistance egress of CSF in the immediate postoperative period [4]. CSF is typically drained at 5 to 10 mL/h for 48 to 72 hours. It empirically decreases the chance of continuous CSF fistula.

There is an increasing body of evidence to suggest that LDs are not necessary in the setting of endoscopic skull base reconstruction. Proponents argue that there is no significant difference in the postoperative CSF leak rate when a vascularized pedicled flap is used, the complications associated with LDs and the evidence on the usefulness of LDs in preventing postoperative CSF leaks after endoscopic skull base reconstruction will be taking into consideration. Hadad and colleagues reported that the use of a pedicled nasal septal flap (PNSF) reduced the rate of postoperative CSF leaks rate by about 50%. Their overall CSF leak rate using the PNSF was approximately 5%, [2,8] and it has become the mainstay of endoscopic skull base reconstruction at most major neurosurgical institutions. Although there is increasing evidence that LDs are not routinely required for repair of iatrogenic and low-flow CSF leaks, the effectiveness of LDs has not been well established in skull base reconstruction and there is a limited review of literature on the topic. The use of endonasal vascular pedicles flaps combined with multilayer reconstruction techniques , postoperative CSF is now below 5% [2].

Extent of the approach, CSF intra-operative leakage, risk of flap de-vascularisation. The choice of flap is based on the individual case and anatomical specifics

CSF leakage classification

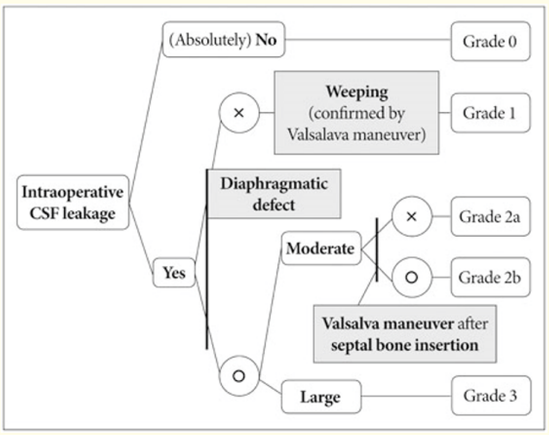

Figure 1: Modified grading system for cerebrospinal fluid (CSF) leak after endoscopic transsphenoidal surgery [7].

Esposito and co. reported postoperative CSF leak of 1.6% for grade 0 to 2 intraoperative leaks (low-flow group) compared with grade 3 intraoperative leaks (high-flow group) with a failure rate of 12.0%. They used LDs only in grade 3 leaks and left them in place for at least 48 hours. This practice was initiated after 2 cases with postoperative leaks resolved after LD placement. The investigators did not use a pedicled flap as part of their reconstruction protocol. Overall, the risk of postoperative leak was 2.5%.

CSF leak is the single primary goal why closure and the choice of materials used should be considered critically.

Closure and reconstruction of the skull base directly relates to the nature of the surgical defect with differing goals between surgical groups. For instance, many extradural tumor resections neces-

sitate reconstruction to promote healing (especially in the setting of radiation therapy). In these cases, primary reconstructive goals are not avoidance of postoperative CSF leak and potential intracranial infection, but rather defect coverage to facilitate healing. This is in contrast to intradural surgery, as postoperative CSF leak and potential intracranial infection must be taken into consideration.

Intradural tumor surgery can be divided into 2 main groups

- Intradural, but extra-arachnoidal, as is the case with pituitary surgery when the diaphragm is not violated Intra-arachnoidal surgery where by definition an intraoperative CSF leak is appreciated 100% of the time

Closure techniques

Zanation., *et al.* classified these techniques into 2: the free graft and vascularized tissues [2].

1. Endoscopic Reconstruction with Free Tissue Grafts
2. Endoscopic Reconstruction with Vascular Pedicled Flaps

Vascularised tissue techniques

- Nasoseptal flap (Hadad-Bassagastegay flap)
- Posterior pedicled inferior turbinate flap
- Posterior pedicled middle turbinate flap
- Endoscopic-assisted pericranial flap
- Temporoparietal fascial flap
- Pedicled palatal mucosal flap

Nowadays, in the trans-sphenoidal department of the institute of Neurosurgery, well over 200 patients have undergone skull base reconstruction postoperatively, and those with high-flow CSF leaks intraoperatively typically benefited from use of a vascularized pedicled flap rather than a free tissue graft, with postoperative success rates of 94 versus 82%, respectively [4] Vascularized nasal septal pedicleflaps appear to promote rapid healing and provide excellent coverage of skull base defects [1].

Our study Method would embrace (nonrandomized) prospective and retrospective

The goal of this study will be,

1. To assess efficacy and technical aspect of the NSF
2. To evaluate the viability of the flaps postoperatively using ultrasonic and endo-rhinoscopic assessments, liquor leak rate, efficacy of the pre- or intraoperative LD placement and the recent statistics of postoperative recovery (hospital stay).
3. Placement of Lumbar Drainage(LD): how long if needed, to what extent and recovery prognosis

It was reported by Duc A. Tien., et al. (2016) that Placement of LD is an invasive procedure and since it has 5% minor and 3% major complication rates, its use are selected only in cases where high flow leak and challenging closure have been anticipated [9].

Risk factors such as intracranial hypertension, large or complex skull base defects, tumour aggressiveness, the size and anatomic site of the defect are also predictive of the CSF leak [4].

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Conflicts of interest

None.

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