Pedicled Nasoseptal Flap as Final Layer of Reconstruction for Skull Base Defects

SAMEH M. AMIN, M.D.*; AHMED HEGAZY, M.D.** and AYMEN A. ENAB, M.D.**
The Department of Otorhinolaryngology, Head & Neck Surgery, Fayoum University* and the Department of Neurosurgery, Cairo University**

Abstract

Purpose: Assessment of the efficacy of nasoseptal vascularized flap (NSF) in reconstructing the skull base defects after transsphenoidal procedures and CSF rhinorrhea.

Material and Methods: Thirteen patients with intraoperative diagnosis of skull base defects and/or CSF leak after endoscopic transsphenoidal surgery or preoperative diagnosis of CSF rhinorrhea were included in this study. Multilayer reconstruction of skull base was done including duraplasty, skull base bone if necessary and final layer of nasoseptal vascularized pedicled flap (NSF). The NSF is finally fixed and supported in target region with surgicel.

Results: Seven cases were of the low flow and two cases of the high flow CSF leak. Four cases had large sellar cavities with prolapsed diaphragma. The technique was successful in preventing postoperative CSF leak immediately in 12 of the 13 cases. The remaining case was managed by ambulant lumbar drain with subsequent CSF leak cessation. Sinusitis or epistaxis was not encountered postoperatively in any patient. Nasal encrustations disappeared postoperatively with meticulous follow-up.

Conclusion: Our results supports that multilayer reconstruction technique with final NSF layer as described is highly effective in preventing both the low flow and high flow CSF leakage postoperatively.

Key Words: Nasal septal flap – Trans sphenoidal – Skull base reconstruction – CSF leak.

Introduction

TRANSSPHENOIDAL endonasal endoscopic pituitary surgery has long been a standard technique, reaching state-of-the-art level. Increasing interest has been focused towards more parasagittal and coronal areas of skull base. Subsequently the expanded endonasal approach (EEA) has been established and advocated by the Pittsburgh and Napoli skull base groups [1,2]. The prerequisite for successful EEA is challenging and includes multidisciplinary approach, neuronavigation and perhaps most importantly; reconstruction of skull base for CSF leaks [3]. The incidence of CSF leak after transsphenoidal surgery and EEA is variable and can be noticed either intra or postoperatively. Occasionally CSF leak can be anticipated after removal of a pituitary macroadenoma exposing a ballooned diaphragma sellae or suprasellar cistern. Ciric et al., reported a CSF leak ranging between 1.5 to 4.2% among 958 North American neurosurgeons recording complications of transsphenoidal surgery [4]. Cappabianca et al. [5], described an incidence of postendoscopic transsphenoidal CSF fistula around 2% in 170 surgeries. Potential morbidities associated with CSF fistula after transsphenoidal surgery include: Prolonged hospitalization, reintervention, bacterial meningitis, abscess, subdural hematoma and pneumoencephalus of tension. It seems therefore that every effort should be attempted to avoid CSF leak after endoscopic transsphenoidal surgery to maintain its uneventful postoperative course. Several techniques are described to prevent and treat CSF leaks after endoscopic transsphenoidal surgery. These include lumbar drain, autologous grafts like fat muscle and fascia and synthetic materials like polyester-silicon dural substitute. These grafts alone were associated with high failure rate particularly in large defects. The application of vascularized flaps promote more rapid and complete healing and were associated with sharp decrease of CSF leak. These vascularised flaps include nasoseptal, inferior turbinate and pericranial flaps. The most commonly used one is however the nasoseptal flap (NSF) based on the nasoseptal artery, a branch of the posterior septal artery.
artery, and the terminal branch of the internal maxillary artery. It is highly versatile, possess long arc of rotation and readily available in operative field [6]. The author aimed in this study to evaluate the NSF as part of multilayer reconstruction of CSF leaks mostly after endoscopic transsphenoidal surgery as well in cases of large spontaneous and posttraumatic cases.

**Material and Methods**

Thirteen patients were involved in this study.

**Case one to eleven:**

Eleven patients underwent endoscopic transsphenoidal surgery for pituitary adenomas. Seven of these suffered from probable intraoperative CSF leak. The other four had large sellar cavities with ballooned prolapsing diaphragm sella after removal of huge macroadenoma and reconstruction deemed necessary to avoid imminent postoperative CSF leak.

**Case twelve and thirteen:**

The other two patients suffered from CSF rhinorrhea.

**Case 12:**

This patient was a 40 years old Sudanese female suffering from persistent spontaneous CSF rhinorrhea. The patient first experienced CSF leak 7 years ago during delivery and persisted for three month and disappeared without treatment. Three years later patient suffered again from CSF rhinorrhea and persisted inspite of conservative treatment for two years. CT cisternography revealed a small meningocele with CSF leak in the left lateral recess of sphenoid sinus (Fig. 1).

**Case 13:**

The other patient suffered from posttraumatic CSF leak. External approach repair was performed three times without success and nasal swab revealed colonization of Methicilin resistant Staphylococcus aureus (MRSA). Repeated preoperative treatment with Vancomycin and Rifampicin was not successful to eradicate MRSA from nasal swab. The patient suffered from repeated attacks of meningitis. Endoscopic repair and thecoperitoneal CSF shunt was mandatory to avoid fatal MRSA ventriculitis. Radiologically a large defect in posterior ethmoids was encountered with encephalocele prolapsing in nasal cavity and left orbital cavity (Fig. 2a,b).

A multilayered technique was usually performed for reconstruction of skull base. In transsphenoidal surgery a fat plug obtained from the abdomen and packed partly in the sella and partly in the sphenoid sinus. An onlay pedicled nasal septal flap is then spread to cover the dural defect and the fat plug (Fig. 3a,b). Surgicel was used then to fix and support edges of the NSF in position in early postoperative period. In other cases of CSF rhinorrhea a three layer technique is usually acquired in which dura, skull base bone and nasal mucoperiosteum are reconstructed separately. Autologous grafts are usually used. Fascia lata, abdominal fat are used for duraplasty, while skull base bone is reconstructed using local septal cartilage (Fig. 4a,b). The NSF is always the final layer representing reconstruction of nasal side mucoperiosteum.

**Technique of nasoseptal flap harvest:**

We usually start harvest the flap by dissecting and preserving the pedicle carrying the posterior nasoseptal artery. This usually applies for transsphenoidal surgery while in other conditions we usually start first with harvesting the mucoperiosteum over the nasal septum. The former can be done by performing two parallel incisions just above the posterior choana over sphenoid face and extending from posterior septum medially to area of sphenopalatine foramen. The superior incision is made with microscissors and carried back to the sphenoid face 1.0 to 1.5cm below the skull base. The natural ostium of the sphenoid is identified. The mucosa is dissected off the anterior sphenoid wall downwards creating a bipedicled mucosa from the sphenoid ostia and choanae to the level of the sphenopalatine foramen. The major remaining septal part of the flap can be fashioned according to the case and made continuous with previously mentioned pedicle. An anterior incision is made just behind the caudal septum and dissection can then proceed inferiorly over nasal floor and superiorly to skull base. Posterior dissection is directed towards sphenoid face to connect septal mucoperiosteum with that over face of sphenoid or previously mentioned pedicle. The last step to free the NSF is achieved by cutting the upper and lower margins of septal mucoperiosteum. This pedicled NSF is then placed in the nasopharynx, maxillary antrum or preferably in inferior meatus for the duration of the case (Fig. 5a,b).

**Results**

The age of the patients ranged between 16 and 44yrs with a mean of 32. They were eight males and five females. The main presenting symptom was headache which was present in all of them. Visual manifestations in the form of blurring, field...
defects and sudden loss of vision were present in eight patients. Eight patients out of the eleven pituitary tumors were non secretory and two were prolactinomas with visual loss and poor response to the medical treatment and one case of acromegaly. One case of the prolactinoma group suffered from pituitary apoplexy. Watery rhinorrhea was the presenting symptom CSF rhinorrhea group with one patient suffered from repeated attacks of meningitis.

In pituitary adenoma cases total resection was achieved in all cases. We had one case of postoperative Diabetes insipidus which was controlled by nasal puffs of desmopressin. We never start using the drug except after ruling out volume overload by means of fluid deprivation.

The CSF leakage was of the low flow nature in 7 cases and high flow in the remaining 2 cases. Mostly we had just CSF flowing from a small hole in the arachnoid of the diaphragma sellae. In few cases, the presence of CSF was suspected due to its mix with blood and we confirm it by the valsalva maneuver. Whenever there is uncertainty regarding the existence of the leak, we take the precaution by reflecting the flap. High flow CSF leak was encountered from a encephalocele in posttraumatic CSF rhinorrhea case and one pituitary macroadema with suprasellar extension and marked prolapse of diaphragma at end of operation.

The flap was successful in 12 cases in preventing immediately postoperative CSF rhinorrhea (Fig. 6a,b). One acromegalic patient with high flow CSF leak had leak on day 2 postoperative and we applied ambulant lumber drain for 3 days and that was enough to stop the leak permanently after one week.

CSF diversion procedures were done only in posttraumatic CSF rhinorrhea case (case 13). A thecoperitoneal shunt was done intra operatively. This was justified because of expected CSF high pressure from repeated meningitis and three times failure of external repair approach. Usually we leave the pack for 2 days postoperative and we then remove it unless we encounter some bleeding necessitating leaving the pack for another one or two days.

Postoperative bleeding was not encountered in any patient. None of the patients developed postoperative sinusitis. Most patients experienced nasal encrustations which disappeared with meticulous postoperative care.
Fig. (2-B): Sagittal cuts showing large encephalocele.

Fig. (3-A): Pituitary macroadenoma in MRI sagittal cut.

Fig. (3-B): Fat plug and NSF reconstruct postoperatively in MRI brain sagittal cut.

Fig. (4-A): A large defect (Sh D) in lateral recess (LSR) of sphenoid sinus (SS).

Fig. (4-B): The defect closed with nasal septal cartilage graft.

Fig. (5-A): The enasoseptal flap (NSF) elevated and lying beside inferior turbinate (IT). The sphenoid sinus (SS) appears opened.

Fig. (5-B): NSF elevated and rotated towards SS to cover a defect. Medially nasal septum (NS) appears and laterally inferior and middle turbinates (MT and IT).
Discussion

The initial experience after endoscopic resection of skull base tumors using endoscopic transsphenoidal surgery or EEA revealed a 3% culture positive bacterial meningitis rate and a CSF leak up to 20% [6]. The implication of vascularized pedicled flap changed the history of such procedures and CSF leak as a common subsequent complication. Several regional and intranasal vascular flaps presents options for reconstruction of the skull base for large defects. These include NSF, inferior and middle turbinate, pericranial flap, palatal flap and temporoparietal flap. However the most popular and commonly used one is the NSF [7]. Vascularized septal mucosal flaps have been previously described for closure of small CSF leaks of the anterior skull base and pedicled turbinate flaps have been described for the closure of septal perforation and sellar floor reconstruction [8]. To reduce the high rate of CSF leaks, a broad vascularized nasal septal flap (NSF) based on the posterior nasoseptal artery, a branch of the posterior septal artery, has been formally described for closure of skull base defects [9]. The addition of the pedicle originating near the sphenopalatine foramen clearly defines the arterial supply, allows harvest of large flaps composed of nearly the entire septal mucosa, and allows rotation of the flap in the posterior, superior, inferior, or lateral planes [9]. In case of transsphenoidal surgery it is not essential to harvest the NSF totally before the procedure. The pedicle of NSF carrying the posterior nasal artery is kept intact by dissecting the mucoperiosteum off the sphenoid face and keeping the latter in continuity with the rest of septal mucoperiosteum. This usually necessitates early identification of the sphenoid ostium prior to posterior septectomy. This task is usually not difficult for experienced rhinologists.

In a series of 43 patients, Fortes et al., reported a 5% CSF leak using the Hadad-Bassagasteguy NSF, which is similar to the rate after open craniotomy. The same group subsequently described their approach using a pedicled inferior turbinate flap as an alternate flap [10].

The incidence of permanent CSF leakage in this series was zero as was the infection rate. The only one case with the leak was temporary and
stopped after lumbar drain. This result is more or less coinciding with other investigators [11]. Our results cannot be however overemphasized due to relatively low number of cases and prevalence of the adenomas in our series. Although we encountered a huge encephalocele in case 13 which was successfully repaired using NSF. In this study four patients with pituitary macroadenoma did not develop actual CSF leak intraoperatively. Sonnenberg et al., looked at endoscopic pituitary resection without CSF leaks and found no need for intranasal reconstruction intra operative in these cases [12]. However Lorenz et al., reported a CSF leak rate of 8.3% after resection of 24 hypophyseal tumours 23 of which were greater than 1cm [13]. In our experience large sellar cavities with huge prolapsing diaphragma sella are associated with high incidence of postoperative CSF leak. Such cases will not benefit with simple fat plugs for sellar reconstruction. As every attempt should be done to prevent CSF leak, early sellar reconstruction seems logic provided total resection is appreciated.

Many authors used Fibrin glue in conjunction with other techniques. It is basically a bioadhesive containing human lyophilized fibrinogen, leading to the formation of a semi-rigid fibrin clot, seen by the naked eye and stable enough to help wound healing, preventing the migration of the remaining material. It enhances adhesion of the graft, when healing, preventing the migration of the remaining material. Many authors used Fibrin glue in conjunction with other techniques. It is basically a bioadhesive containing human lyophilized fibrinogen, leading to the formation of a semi-rigid fibrin clot, seen by the naked eye and stable enough to help wound healing, preventing the migration of the remaining material. It enhances adhesion of the graft, when healing, preventing the migration of the remaining material.

The NSF is readily available bilaterally, highly versatile and can cover most skull base defects. The NSF is well deferentiated in postoperative neuroimaging and therefore does not hinder accurate and early identification of tumour recurrence [1]. The NSF represents the top of options available for skull base reconstruction [7]. In interdisciplinary skull base approach an experienced rhinologist can cover the fat with oxidized cellulose to prevent rapid absorption.

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**Conclusion:**
The skull base reconstruction algorithm in literature points towards increased use of vascularized flaps. Among these the NSF represents an effective technique with reproducible results.

**References**