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Hadad-Bassagasteguy flap in reconstruction of skull base defects after endonasal skull base surgery

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ABSTRACT

Background: To study the clinical outcomes of Hadad-Bassagasteguy flap (HBF) in endonasal reconstruction of anterior skull base defects.
Methods: We prospectively analyzed the demographic data and the outcome results particularly Post-operative CSF leak in 53 patients who underwent HBF in our hospital from February 2013 to June 2014. The early harvested flap was used to reconstruct anterior skull base defects among patients with high-flow on-table CSF leak. Post-operatively the patients were analyzed for CSF leak and bleeding.
Results: Most of the study subjects were between 21-50 years of age (73.6%). The mean age of the study subjects was 41.8±13.8 years. Male/female ratio of the study sample was 1.2 with 29 males and 24 females. Of the total 53 patients 46 (86.8%) has macro defects while 7 (13.2%) had micro defects. Non-secretary lesions were present in 60.4% (32/53) patients while secretary were present in 39.6% (21/53) patients. Cerebrospinal fluid leak was present in all the patients undergoing surgery and majority of them were put on lumbar drain, while bleeding was present in 49.1% patients. Of the total 53 patients only 2 had post-operative cerebrospinal fluid leak (2/53; 3.8%).
Conclusions: Use of HB posterior nasal septal flap for reconstruction of anterior skull base among patients with high-flow intra-operative CSF leak has a remarkable impact in preventing post-operative CSF leak. Its applicability to wide patient-profiles with respect to age, size of defect, diagnosis is making it a versatile choice of reconstruction after endonasal anterior skull base surgeries.

Keywords: Hadad-Bassagasteguy flap, Endonasal flap, Reconstruction of anterior skull base defect, Reconstruction of cerebrospinal fluid leak

INTRODUCTION

In the patients with large dural defects of anterior and ventral skull base, there is a significant risk of post-operative cerebrospinal fluid (CSF) leak. Reconstruction with the vascularised tissue is desirable to facilitate rapid healing, especially in irradiated patients. Hadad-Bassagasteguy flap (HBF), a vascular pedicled flap of the nasal septum mucoperiosteum and mucoperichondrium based on the posterior septal artery (branch of sphenopalatine artery), was first developed in university of Rosario, Argentina, for reconstruction of ventral skull base dural defects.[1] It is increasingly becoming a "workhorse" for the reconstruction in extended endonasal skull base surgery. Endoscopic endonasal repair of traumatic CSF leaks with the nasoseptal flap (NSF) has a success rate of approximately 95% - comparable to that of traditional approaches.[2]

METHODS

Study area

This study was conducted in the Department of Oto-rhinolaryngology and Department of neurosurgery at Bombay hospital and institute of Medical sciences, Mumbai, Maharashtra.

Study design

Prospective, nonrandomized, observational, descriptive study

Period of study

A prospective analysis was performed from January 2013 to May 2014.

Study population

Patient were selected from Department of Neurosurgery and Department of Oto-rhinolaryngology irrespective of gender, urban or rural population and identified patients who underwent skull base surgery via an Endoscopic endonasal approach (EEA) where the Posterior nasal septal flap (PNSF) was harvested early during the procedure.

Sample size and sample technique

Study was conducted in a prospective manner involving 53 patients with CSF leak due to skull base defect following endonasal skull base surgery. Post-operative CSF leak reconstruction was done with vascularised tissue to facilitate rapid healing.

Sample size calculation

Sample size is calculated on the basis of following formula:

$$N= \frac{2x\ (Z\alpha + Z\beta)\ 2}{\Delta 2}$$

$$\text{Where } \Delta = \frac{P1 - P2}{\sqrt{P(1-P)}}$$

$$\text{And } P = \frac{P1+P2}{2}$$

Significance level 5% = 1.96 i.e. Zα

Power of study 90% = 1.2816 i.e. Zβ

These values when applied on the study of Hadad et al and Kassam et al study of patients with using HBF flap.[1,2]

P1 =0.75, P2 =0.44, P =0.595, (1-P) =0.405

P × (1-P) =0.240975

$\sqrt{P(1-P)}$ =049089

Δ =0.31/0.49089 =0.6315

Δ =0.398796

So, N = 2 × (1.96 + 1.2816) 2/ 0.39892 × 0.398796

$$N= \frac{21.01594}{0.398796}$$

N=52.68 (approximately 53 patients)

53 cases were included in the study.

Data collection technique and tools

All patients who presented with impaired vision, hemianopsia, headache, nausea and vomiting, oculomotor paralysis, hypopituitarism, polydipsia, polyuria, amenorrhea and galactorrhea underwent a complete preoperative out-patient evaluation by a neurosurgeon, rhinologic surgeon, endocrinologist and neuro-ophthalmologist when indicated.

The clinical diagnosis was established after taking a detailed history and doing clinical examination which include systemic examination and local ear, nose and throat examination.The examination of nose included anterior rhinoscopy, posterior rhinoscopy and paranasal sinus examination. In the investigation include complete haemogram, coagulation profile, liver profile, serum creatinine, human immunodeficiency virus-1 and 2, hepatitis B surface antigen, blood sugar and electrocardiogram had done in all patients. Endocrine function evaluation, examination of the visual field and visual acuity, radiological evaluation. In radiological evaluation CT PNS scan: Axial sagital and Coronal section CT is essential for a preoperative review of the approach, including bony landmarks and relationships, extent of pneumatization of the sinuses and skull base, and areas of dehiscence with potential for injury.

MRI with contrast enhancement: Gadolinium contrast enhanced MRI was done in all the patients for detailed preoperative assessment of intracranial content and extent.

A written consent was taken from each patient prior to surgery. All cases were operated under general anaesthesia.

Inclusion criteria

1. All the patients who were subjected to endoscopic approaches for resection of skull base pathologies with significant risk of having a cerebrospinal fluid (CSF) leak on pre-operative assessment.

2. Patients with traumatic high-flow CSF leaks with large skull base defects that were repaired with a posterior nasal septal flap (PNSF) were included in this study.

Exclusion criteria

1. Nasal septal injury due to trauma, previous surgery.
2. Tumors that infiltrate the nasal septum, pterygoid fossa, or the anterior wall of sphenoid sinus.
3. Patients with less the 18 years of age.

Surgical procedure

The posterior nasal septal flap (PNSF) is harvested at the beginning of the operation if a high-flow CSF leak is anticipated and is placed in the nasopharynx for protection during the case. After the skull base approach and tumor resection, the subsequent skull base defect is prepared by denuding approximately 1 cm of mucosa around the bony defect to prevent delayed mucocele formation from trapped paranasal sinus mucosa. The sphenoid sinus is also completely denuded of mucosa in the transsellar and transplanum- transtuberculum repairs to avoid potential sphenoid sinus mucocele formation. This step also optimizes flap adherence to the native bone, and prevents residual intervening mucosa from causing delayed flap dehiscence. The use of a vascular pedicle flap has become the preferred skull base reconstruction.

The most commonly used technique is a vascular flap of the nasal septum mucoperiosteum and mucoperi-chondrium that is pedicled on the nasoseptal artery, a branch of the posterior septal artery, which is one of the terminal branches of the internal maxillary artery.

Technique for harvesting HBF

The nasal cavity is decongested with oxymetazoline (0.05%). The inferior, middle and superior turbinate's are out-fractured to allow the visualization of anterior wall of sphenoid. This is done bilaterally to facilitate bimanual technique, which allows HB Flap to take on one side and reverse flap on other side. The flap is designed according to the size and shape of the anticipated defect. Two parallel incisions are taken following the axial plane of the septum, superior incision at the level of sphenoid ostium up to the level of anterior end of middle turbinate, then curved superiorly, coming anteriorly to muco-cutaneous junction then extended inferiorly to join inferior horizontal line of incision. Inferior incision starts laterally just above the ET opening and continue along just above the choana on to the septum. It then proceeds anteriorly along the floor of the nose to join the anterior vertical incision and allow elevation of this HB flap. The flap is elevated anteriorly with a freer elevator. Elevation of the flap from the anterior face of the sphenoid sinus is completed with preservation of a poster lateral vascular pedicle. HB Flap thus elevated can cover defects from frontal recess to the clivus. Reverse flap is harvested on other side, to cover the bare cartilage. Once harvested, the flap is displaced into the nasopharynx until the pathology has been removed. Fat harvested from the thigh or abdomen is used to assist in the repair, if required. Fibrin glue or other biologic glue is used to help secure the flap. Nasal packing is done.

Data analysis

Data analyses were performed using Microsoft Office Excel 2007 (Microsoft Corp). Data was stored in a Microsoft Excel 2007 file for descriptive statistical evaluation. The observed data for various parameters was presented in terms of minimum, maximum, and mean ±SD for the descriptive analysis.

Technique for harvesting HBF: How we do it

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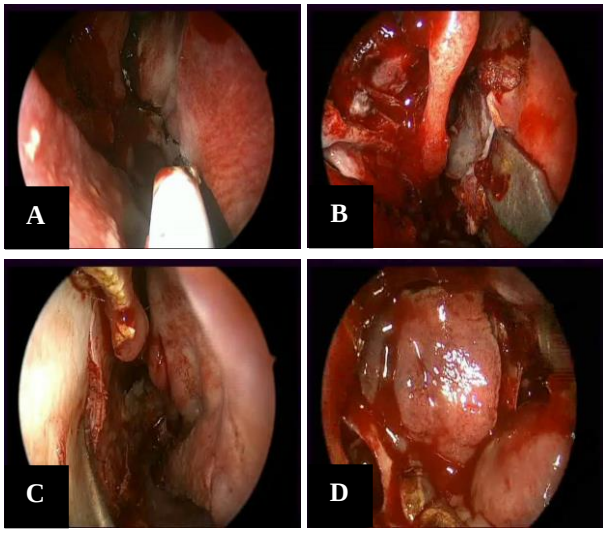

Figure 1: Intraoperative dissection of nasoseptal flap (Hadad-Bassagastegay flap). (A) Starting the incision; (B) harvesting the flap; (C) continuing to dissect the nasoseptal flap from the underlying septal cartilage; (D) reposition of flap.

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septum. It then proceeds anteriorly along the floor of the nose to join the anterior vertical incision and allow elevation of this HB flap.

The flap is elevated anteriorly with a freer elevator. Elevation of the flap from the anterior face of the sphenoid sinus is completed with preservation of a poster lateral vascular pedicle. HB Flap thus elevated can cover defects from frontal recess to the clivus.

Reverse flap is harvested on other side, to cover the bare cartilage. Once harvested, the flap is displaced into the nasopharynx until the pathology has been removed.

Fat harvested from the thigh or abdomen is used to assist in the repair, if required. Fibrin glue or other biologic glue is used to help secure the flap. Nasal packing is done.[1]

RESULTS

A total of 53 patients were treated with HBF for the reconstruction of skull base defects in the endonasal skull base surgery. The mean age of the study subjects was 41.8±13.8 years with approximately equal number of males and females. Out of total patients, 86.8% had macro skull based defects while micro defects were present in about 13.2% cases. Headache was the most common presenting complaint (71.7%) followed by decreased vision (56.6%) and acromegaly (13.2%).

Table 1: Age distribution of patients.

Age (years)	N	%
<20	3	5.7
21-30	10	18.9
31-40	14	26.4
41-50	15	28.3
51-60	7	13.2
>60	4	7.5
Total	53	100.0

Mean age - 41.8±13.8 years

Table 2: Gender wise distribution of patients.

Sex	N	%
Male	29	54.7
Female	24	45.3
Total	53	100.0

Table 3: Distribution of patients based on type of defects.

Type of defects	N	%
Macro	46	86.8
Micro	7	13.2
Total	53	100.0

Table 4: Distribution of patients based on type of lesion.

Type of lesion	N	%
Secretary	21	39.6
Non-Secretary	32	60.4
Total	53	100.0

Table 5: Distribution of patients based on presenting complaint.

Complaints	N	%
Headache	38	71.7
Decreased vision	30	56.6
Acromegaly	7	13.2
Others	5	9.4
Amenorrhea	3	5.7
Cushingoid features	2	3.8
Vomiting	3	5.7

Table 6: Distribution of patients based on past history.

Past history	N	%
Hypothyroidism	3	5.7
Surgery in past	3	5.7
Hypertension	2	3.8
Diabetes	2	3.8
Cardiac problems	1	1.9
Tuberculosis	1	1.9

Table 7: Distribution of patients based on examination findings.

Examination		N	%
Eye	Normal	17	32.1
	Abnormal	36	67.9
CNS	Normal	51	96.2
	Abnormal	2	3.8

Table 8: Distribution various hormonal levels in the patients.

Laboratory findings		N	%
S. prolactin	Normal	33	62.3
	Deranged	20	37.7
S. cortisol	Normal	40	75.5
	Deranged	13	24.5
T3/T4/TSH	Normal	40	75.5
	Deranged	13	24.5
Growth hormone	Normal	37	69.8
	Deranged	16	30.2

After the reconstruction by HBF flap, post-operative CSF leak was observed in 2 patients, giving it a failure rate of 3.8%. In first patient leak resulted from straining and was observed on 3rd post-op day. The leak was repaired with

the help of fascial graft. In second patient, leak was observed on 2nd post-op day. A lumbar drain was inserted with and complete bed rest was advised, the leak stopped subsequently.

Table 9: Distribution of intra-op findings among the patients.

Intra-op findings	N	%
CSF leak	53	100.0
Lumbar drain	46	86.8
Bleeding	26	49.1
30/45 Scope used	7	13.2
Cavernous bleed	2	3.8

Table 10: Distribution post-operative cerebrospinal fluid leak.

Post-op complications	N	%
Yes (CSF leak)	2	3.8
No	51	96.2

DISCUSSION

The well-known skull base surgeon, Prof. Paolo Cappabianca from Naples said that "reconstruction is more problematic than resection". Therefore it comes as no surprise that it were the advantages in reconstructive techniques for the closure of surgically induced defects of the skull base that enabled the important progress in endonasal skull base surgery. The ultimate goals of all techniques for reconstruction in the region of the skull base are the stable separation between the nose and the cranial cavity, the protection of neurovascular structures, the conservation or reconstruction of cosmoses, the preservation or reconstitution of function and the avoidance of dead spaces. In this respect, the separation of nasal and cranial cavity is of utmost importance because it prevents postoperative CSF leaks, pneumocephalus, and intracranial infections, and protects cranial nerves and large vessels from infection and trauma. The effects of postoperative radiotherapy also have to be considered. Although a number of different techniques have been used successfully to rhinoliquorrhea, these methods have proven insufficient to reconstruct the large defects in extended endonasal skull base surgery.[3-6]

Since the neuro-endoscope is applied, especially after EEA, the incidence of complications, such as CSF leakage, infection and encephalocele formation, is high. Carrabba et al reported that the incidence of CSF leakage was 24% after EEA.[7] Therefore, the reconstruction of skull base defect is of paramount importance to prevent CSF leakage after endoscopic endonasal surgery.[8,9]

In patients with large dural defects of anterior and ventral skull base, there is a significant risk of post-operative cerebrospinal fluid (CSF) leak after reconstruction. Reconstruction with vascularised tissue is desirable to facilitate rapid healing, especially in irradiated patients. HBF, a neurovascular pedicled flap of nasal septum mucoperiosteum and mucoperichondrium based on the nasoseptal artery, was first developed in university of Rosario, Argentina, for reconstruction of ventral skull be dural defects.[1]

It was not until local vascularised flaps in particular the HBF 5 (Hadad-flap) were developed that the rate of postoperative CSF leaks even after expanded resections at the skull base could be reduced to below 5%.[1,2,10]

Postoperative CSF leak

The landmark study which introduced HB flap, Hadad et al reported a post-operative leak rate of 4.5% without any, partial or complete flap loss, in the study.[1] And recently, in total, 96 skull base defects with high-flow CSF leaks which included 47 sellar (including 2 revision cases: 1 recurrence and 1 residual tumor) defects, Eloy et al, reported a post-operative CSF leak rate of 3.1%.[11]

A post-operative CSF leak rate of 3.8% (2/53) observed in our study following the HB flap repair of 54 sellar defects with the use of external lumber drain (ELD) in around 87% of cases keeps well with theses published results of Post-operative CSF leak rates after PSNF. The relatively higher rate (10.66%) of post-operative CSF leak observed by Kassam et al was predominantly found in those patients which required intra arachnoidal dissection and the authors partly attributed it to the initial experience with the technique.[2] Against that all patients in our study has sellar defects; 7/53 macro sellar defects and 46/53 micro-sellar defects.

Pre versus post flap harvest

A substantial, non-traumatized and well perfused flap is must for achieving the desired efficacy of the repair technique. The approach of early harvesting of the flap (before resection) is meant to ensure the quality of the flap and there by the repair. Like most of the published studies used we also employed the pre-harvesting approach in all of our patients. Although the exact size of the expected skull base and dural defect is unknown, a good estimation can be obtained by carefully reviewing the preoperative imaging. Early harvest of the PNSF allows harvest of a maximal sized flap (when needed) that can be tucked into the nasopharynx or maxillary sinus, away from inadvertent trauma during the approach and tumor resection. A maximally sized PNSF that has not been compromised by trauma with a well-preserved vascular pedicle may provide the most robust closure. This is even more important in cases where the approach to access a lesion may involve sacrificing a portion of the PNSF.[11]

Complications other than CSF leak

Disruption of the surgical barrier between relatively septic nasal cavity and highly aseptic arachanoid cavity is

inherent to the trananasal approaches to anterior cranial fossa and so is the risk of iatrogenic meningitis. The surgical dissection area that is involved in such surgery will also have an inherent risk of olfactory dysfunctions and like all other surgical procedures post-operative bleeding, especially in an area of compromised access, remains a possibility. Though rare, such complications are real with endoscopic nasal approaches to the skull base. The true extent of rarity of these complications should be viewed cautiously keeping in view the relatively smaller sample size of the all studies reported on the subject till now. Like most of the reported studies we did not observe any post-operative episodes of meningitis or nasal bleeding even in those cases which had intra-operative bleeding from cavernous injury (2/53).

Kassam et al has reported post-operative bleeding in 1/75 patients.[2] Wang et al reported a single death due to post-operative meningitis in among 20 patients studied by them. The study however does not specify the kind of mucosal vascular flap used in that patient.[12] None of our patients had significant post-operative nasal synechiae, nasal obstruction or significant nasal crusting.

Some recent published reports have highlighted the olfactory dysfunction that is associated with HD flap reconstruction. Brain et al has reported a decrease in mean UPSIT (University of Pennsalyvania Smell Indentification Test) scores from preoperative 37.2 (normosomic) to 30.8 (hyposomic). These decreased scores of UPSIT persisted even after complete healing at 6 months post-surgery. The authors hypothesized that olfactory impairment results from use of the HB flap. And recommend that the possibility of permanent olfactory changes be added to routine patient counseling and consent for this procedure, and that HB flaps be raised judiciously during trans-sphenoidal endoscopic procedures.[13] We regret for not including such evaluation in our study.

Limitations

The limitations of the study include:

i. The patients were not evaluated for pre- and post-operative olfactory status,
ii. The study lacked a control group,
iii. The study is single institutional. Consequently, multi-institutional study as well as prospective randomized controlled double blinded studies would be ideal to validate these results.

Table 11: Presenting outcome profile of Hadad flap as published by various authors.

Author and year	No. of patients	Post-operative CSF leak rate (%)	Post-operative nasal bleeding	Post-operative meningitis	Flap loss
Eloy et al (2013)[11]	96	3.1	0	0	0
Kassam et al (2008)[2]	75	10.66	1.3%	0	0
Hadad et al (2006)[1]	44	4.5	0	0	0
Our study	53	3.8	0	0	0

CONCLUSION

Endonasal reconstruction of anterior skull base defects by posterior nasal septal flap (HBF) is associated with very low rates of post-operative CSF leak. Endoscopic endonasal skull base reconstruction using a nasal septal flap seems to be useful and reliable for ventral skull base defects after endoscopic endonasal approaches (EEA) as compared with our previous single-layer reconstruction using free fat grafts or fascia lata. Its use has resulted in a sharp decrease in the incidence of postoperative CSF leaks after EEA.

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Conflict of interest: None declared
Ethical approval: The study was approved by the Institutional Ethics Committee

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