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Nasoseptal Flap Versus Middle Turbinate Flap in Skull Base Reconstruction

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ABSTRACT

Background: The expanded endonasal approaches to the skull base are modular approaches that arise from the sphenoidal sinus. The reconstructive techniques in these approaches are key to avoid postoperative complications. Available flaps for reconstruction include the pedicled nasoseptal flap, the trans- pterygoid temporoparietal fascia flap, and the posterior pedicle inferior turbinate flap (PPITF), among others. Recently, the middle turbinate flap and nasoseptal flap have been described in a cadaveric study.

Objective: The aim of the current study was to compare results of using nasoseptal versus middle turbinate flaps in skull base reconstruction. **Patients and methods:** This interventional cohort study was carried out on 24 patients in Department of Otorhinolaryngology, Head and Neck Surgery, Zagazig University Hospitals. All patients with CSF leaks of variable reasons (congenital, traumatic, spontaneous) who required surgical repair with either vascularized nasoseptal mucosal flap or vascularized middle turbinate mucosal flap and fit for general anesthesia were included in the study.

Results: Incidence rate of operation failure that was temporary (8.3%) in NSF group while in MTF the success rate was 100%. **Conclusions**: There are no significant differences in results of using nasoseptal versus middle turbinate flaps in skull base reconstruction.

Keywords: Middle turbinate flap, Vascularized flap, Endonasal expanded approach, Skull base reconstruction.

INTRODUCTION

A dysfunctional communication between the subarachnoid space and the sinonasal cavity is known as cerebrospinal fluid (CSF) rhinorrhea. CSF leaks are often separated into traumatic and non-traumatic categories. Spontaneous or congenital CSF leaks, leaks brought on by intracranial or skull base malignancies, and erosion of the skull base ahre examples of non-traumatic causes [(1)]. Traumatic leaks are more frequent and can result from non-iatrogenic skull base trauma or be caused by iatrogenic anterior skull base and endoscopic sinus surgery (ESS). CSF rhinorrhea complicates less than 1% of ESS cases, however it is a major source of traumatic CSF leaks [(2)].

The risk of meningitis, which has been reported to vary from 10% to 37% under conservative care, makes surgical intervention necessary once a persistent leak has been verified and localised with the appropriate diagnostic methods [(3)].

Endonasal endoscopic methods have essentially replaced open intracranial approaches for the repair of cerebrospinal fluid leaks in recent years due to their high success rate and minimal morbidity profile [(4)].

A variety of methods, such as fat grafts [(5)], fascia lata [(6)], a multi-layered "gasket seal" closure [(7)], and a variety of locally harvested soft tissue flaps, which are often divided into free flaps or pedicled flaps, were developed for endoscopic skull base repair [(8-10)].

Non-vascularized procedures may be used to treat smaller lesions and those without a clear intraoperative cerebrospinal fluid (CSF) leak. Vascularized reconstruction may be advantageous for more complicated defects and those with high-flow intraoperative CSF leaks [(11)].

The introduction of the nasoseptal flap (NSF) provided a reliable technique for endonasal re-construction of complex skull base defects. The NSF is a regional flap with blood supply pedicled on the posterior septal branches of the sphenopalatine artery [(12)]. The pedicled middle turbinate flap (MTF) is one of the vascular nasal flaps used for reconstructing skull-base defects after an expanded endonasal approach. The middle turbinate receives most of its blood supply from the middle tur-binate artery, which arises from the posterolateral branch of the sphenopalatine artery [(13)].

So we aimed in this study to compare results of using nasoseptal versus middle turbinate flaps in skull base reconstruction.

PATIENT AND METHODS

This interventional cohort study included a total of 24 patients with CSF leaks of variable reasons, attending at Department of Otorhinolaryngology, Head and Neck Surgery, Zagazig University Hospitals. during the period from Augustus 2019 to Augustus 2021. The patients were 15 males and 9 females; and their ages ranged from 12 to 67 years.

Inclusion criteria: All patients with CSF leaks of variable reasons (congenital, traumatic, spontaneous) who required surgical repair with either vascularized nasoseptal mucosal flap or vascularized middle turbinate mucosal flap and fit for general anesthesia were included in the study.

Exclusion criteria: Previous posterior septectomy and involvement of septum &sphenoid rostrum by malignant tissue, previous MT resection and tumors encroaching on MT, contraindications for general anesthesia, cases which were repaired with grafts alone whether single or multiple layers were excluded from the study.

All patients were subjected to:

Detailed history taking with stress on clear nasal discharge and headache, skull base surgery, skull base trauma. Clinical examination including endoscopic

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endonasal examination, routine pre-operative laboratory investigations including complete blood count, liver function tests, kidney function tests, random blood sugar, coagulation profile and viral markers. Also, specific hormonal studies were done for sellar and parasellar lesions. Pre-operative radiological evaluation including high resolution computed tomography scanning (HRCT scan) of PNS & skull base (1mm sections) were obtained. CT with radioisotope contrast cisternography were done in some selected cases. MRI with contrast evaluation was added for meningoencephaloceles or tumors. It was acquired in axial, coronal and sagittal planes. Septic foci or nasal allergy were adequately treated. Ophthalmology evaluation was obtained for patients with spontaneous CSF leak to rule out benign intracranial hypertension. Visual field and visual acuity were assessed in cases of sellar, suprasellar and parasellar lesions. All other comorbidities were managed appropriately and brought under control.

The choice of the method of repair was determined intraoperatively according to the size of the defect, its site and grade of CSF leak. In general the middle turbinate flap was used for repair of anterior skull base defects, while the NSF was used for repair of middle and posterior fossa skull base defects.

According to the method of repair, patients were divided into 2 groups: Group A: consisted of 12 patients who were treated by endoscopic closure of skull base defects using vascularized nasoseptal mucosal flap, and **Group B:** consisted of 12 patients who were treated by endoscopic closure of skull base defects using vascularized middle turbinate mucosal flap. In both groups the visualized flap was a part of multi-layer repair.

Postoperative Management:

Established general principles of managing a CSF fistula are followed postoperatively to facilitate the healing. These include avoidance of nose blowing and activities that raise the intracranial pressure such as straining, leaning forward, or lifting weights greater than 15 pounds. Other measures include stool softeners and sneezing with an open mouth. The use of prophylactic antibiotics for the prevention of meningitis in patients with CSF fistulas is controversial; however, we used a perioperative third-generation cephalosporin until the packing is removed. Stents were left for 4 weeks in nasoseptal flap. We did not use lumbar drains in any of our patients. Acetazolamide was added temporarily for cases of spontaneous CSF rhinorrhea and for cases with supra sellar extension.

Patients follow –up:

All patients were followed up once weekly in the first month postoperatively, then once monthly for 6 months then after one year. The duration of follow up ranged from 8 to 17 months. The follow up was achieved through: symptomatic assessment and nasal endoscopic examination.

Ethical consent:

An approval of the study was obtained from Zagazig University Academic and Ethical Committee. Every patient signed an informed written consent for acceptance of participation in the study. This work has been carried out in accordance with The Code of Ethics of the World Medical Association (Declaration of Helsinki) for studies involving humans.

Statistical analysis

The collected data were coded, processed and analyzed using the SPSS (Statistical Package for Social Sciences) version 22 for Windows® (IBM SPSS Inc, Chicago, IL, USA). Data were tested for normal distribution using the Shapiro Walk test. Qualitative data were represented as frequencies and relative percentages. Chi square test ($\chi 2$) to calculate difference between two or more groups of qualitative variables. Quantitative data were expressed as mean ± SD (Standard deviation). Independent samples t-test was used to compare between two independent groups of normally distributed variables (parametric data). P value < 0.05 was considered significant.

RESULTS

There were no significant differences between both groups regarding demographic data **(Table 1).**

Table (1): Demographic data of studied groups

Variables	Studied groups		Test sig	p-value
	Nasoseptal flap intervention group (n.12)	Middle turbinate flap intervention group (n.12)		
Age (years) • **Mean ±SD** • **Range**	38.25±18.47 12-65	41±16.8 18--67	U 0.491	0.623
Sex • **Males** • **Females**	8(66.7%) 4(33.3%)	7(58.3%) 5(41.7%)	f	0.99

U=Mann Whitney -U test f=Fisher exact test p>0.05 non significant

Regarding the causes of the CSF leak, the main etiology of skull base lesion, among nasoseptal flap intervention group was removal of pituitary adenomas (50%); while among middle turbinate flap intervention group was spontaneous CSF leakage (41.7%). The differences between two groups were statistically highly significant **(Table, 2).** The main clinical manifestation among the MTF intervention group was unilateral watery nasal discharge in 9 patients; three of them had history of trauma. In the-remaining three cases of MTF, the leak was secondary to excision of skull base lesions with no CSF rhinorrhea preoperatively. On the other hand, the clinical manifestation among the NSF intervention group was different according to the site and nature of the middle skull base lesion such as headache, visual deterioration, cranial nerve affection, but no CSF rhinorrhea reported preoperatively, and CSF rhinorrhea developed after removal of skull base lesions.

Table (2): Etiology of skull base lesion of studied groups

Etiology of skull base lesion		Studied groups		P
		Nasoseptal flap intervention group (n.12)	Middle turbinate flap intervention group (n.12)	
Pituitary adenoma	N	6	2	<0.001
	%	50%	16.7%	
Chordomas	N	3	1	
	%	25%	8.3%	
Iatrogenic CSF leak (post ethmoid)	N	1	1	
	%	8.3%	8.3%	
Meningioma	N	2	0	
	%	16.7%	0%	
Spontaneous CSF leak	N	0	5	
	%	0%	41.7%	
Post Traumatic CSF leak	N	0	3	
	%	0%	25%	

f=Fisher exact test p>0.05 non-significant

The differences between both groups were statistically significant regarding sellar and supra sellar, and cribriform and fovea, while there was no statistically significant difference regarding clival (Table 3).

Table (3): Defect site of skull base lesion among studied groups

Defect area		Studied groups		fp
		Nasoseptal flap intervention group (n.12)	Middle turbinate flap intervention group (n.12)	
Sellar and suprasellar	N	8	2	0.036
	%	66.7%	16.7%	
Cribriform and fovea	N	1	9	0.002
	%	8.3%	75%	
Clival	N	3	1	0.5
	%	25.0%	8.3%	

f=Fisher exact test p>0.05 non-significant

Regarding postoperative complications of nasoseptal flap intervention group, all the patients (100 %) suffered from prolonged crusting which persisted from 2 to 4 months postoperatively, and one patient with large supra sellar meningioma suffered from temporary CSF leakage which responded to conservative treatment 2 weeks after surgery. Regarding to middle turbinate flap intervention group, 6 patients (50%) suffered from postoperative crusting that disappeared after 2 weeks to one month postoperatively. The difference was statistically significant between the 2 groups regarding crusting, while it was not significant regarding CSF leak **(Table 4).** There was no nasal bleeding, intracranial hemorrhage, permanent anosmia, sinusitis, cranial nerve deficit or meningitis in any patient of both groups.

Table (4): Postoperative complications of studied groups

Complications			Studied groups		p
			Nasoseptal flap intervention group (n.12)	Middle turbinate flap intervention group (n.12)	
Complication	yes	N	12	6	0.03
		%	100%	50%	
	no	N	0	6	
		%	0.0%	50%	
Crusting		N	12	6	0.03
		%	100%	50%	
CSF leak		N	1	0	1.0
		%	8.3%	0.0%	

f=Fisher exact test p>0.05 non-significant

The difference was statistically non-significant between both groups regarding follow up periods (Table 5).

Table (5): Follow up period per months of studied groups

	Studied groups		t	p
	Nasoseptal flap intervention group (n.12)	Middle turbinate flap intervention group (n.12)		
Follow up period/m Mean ±SD	12.42±3.10	12.58±2.71		
Median	12	13	0.138	0.89
Range	8-18	8-17		

t=t- test p>0.05 non-significant

Incidence rate of operation failure that was temporary (8.3%) in NSF group (Table 6).

Table (6): Post -operative outcome of studied groups

Outcome		Studied groups		p
		Nasoseptal flap intervention group (n.12)	Middle turbinate flap intervention group (n.12)	
success	N	11	12	1.0
	%	91.7%	100%	
Failed	N	1	0	
	%	8.3%	0.0%	

DISCUSSION

In the present study, the main etiology of skull base lesion among nasoseptal flap intervention group was pituitary adenoma (50%), followed by gchordomas 25%, meningioma 16.7% and iatrogenic CSF leak 8.3%. While among middle turbinate flap intervention group, was spontaneous CSF leak (41.7%), followed by post traumatic CSF leak (25%), pituitary adenoma (16.7%), chordoma and iatrogenic CSF leak 8.3%. The difference between two groups was statistically significant.

This came in agreement with **Riley *et al.*** [14] who revealed that main etiology of skull base lesion, among nasoseptal flap intervention group was pituitary adenoma (57.8%), followed by craniopharyngioma (20.0%), meningioma (13.3%), meningoencephalocele (4.4%), Rathke's cleft cyst (2.2%), metastatic lesion (2.2%), chordoma (2.2%).

In the same manner, **Roca *et al.*** [15] reported that, pathological diagnoses and indications for surgery among nasoseptal flap intervention group included 275 (72.4%) pituitary adenomas, 50 Rathke cleft cysts (13.2%), 12 craniopharyngiomas (3.2%), 10 arachnoid cysts (2.6%), 4 chordomas (1.1%), 3 inflammatory/ autoimmune etiologies (0.8%), 4 other tumors of the sellar region (1.1%).

In the present study, the MTF was used only in 3 cases of middle skull base lesions, 2 cases with CSF after pituitary adenomas and one case of clival chordoma. In the two cases of pituitary adenoma, the blood supply of NSF was questionable due to the very wide sphenoidotomy and uncertainty of flap survival

and the MTF was used. The 3rd case was recurrent chordoma where NSF was used to repair the defect in the 1st surgery and the NSF was not used again because it was invaded by the tumor.

In our study the main clinical manifestation among the MTF intervention group was unilateral watery nasal discharge in 9 cases. The other three cases of middle skull base lesion, MTF was used for repair of the defect and CSF leakage resulting from the surgery with no CSF rhinorrhea preoperatively.

This coincided with **George *et al.*** [16] who revealed that the most common clinical presentation in middle turbinate flap intervention group was unilateral watery nasal discharge (n=13[65%]). Of these 10 patients had spontaneous CSF rhinorrhea while 3 had history of trauma.3 patients presented as recurrent meningitis, 2 following trauma and 1 after spontaneous CSF rhinorrhea. CSF leak was a retrospective diagnosis in all 3 patients during investigations for recurrent meningitis.3 patients had post-operative CSF fistula following pituitary tumor surgery and 1 patient with meningocele presented as unilateral nasal mass noticed in early childhood.

The current study showed that the defect site of skull base, among nasoseptal flap intervention group was Sellar and suprasellar in 66.7%, Cribriform and Fovea in 8.3% and clival in 25%. On the other hand, the site of the defect of the skull base among middle turbinate flap intervention group was Sellar and suprasellar in 16.7% of patients, cribriform and fovea in 75% and clival in 8.3%. The difference between the two groups was statistically significant regarding sellar, suprasellar and Cribriform and fovea while there was no statistically significant difference regarding clival.

This came in agreement with **Riley *et al.*** [14] who revealed that the tumor location among nasoseptal flap intervention group Sella + suprasellar 20 (43.5%), Sellar + suprasellar + cavernous sinus 20 (43.5%), Suprasellar 2 (4.3%), Clivus 2 (4.3%), Anterior cranial fossa 1 (2.2%), Anterior and middle cranial fossa 1 (2.2%).

Our study showed that the main postoperative complication of nasoseptal flap intervention group was temporary nasal crusting which occurred nearly in all the patients. In addition, one patient suffered from transient CSF leakage 2 weeks after surgery which responded to conservative treatment. Regarding middle turbinate flap intervention group, only (50.0%) of patients suffered from nasal crusting which was milder and lasted for a shorter period. The difference was statistically significant among both groups. In bothe groups, there were no major intraoperative or postoperative complications regarding bleeding, intracranial injury, meningitis or cranial nerve deficits.

These results were agreed with **Roca *et al.*** [15], **Al Melesy** [17], **Munich *et al.*** [18], **Gaynor *et al.*** [19] **and Park *et al.*** [20] who reported a comparable rate of complications in their work.

Al Melesy [17] revealed that vascularized postoperative nasoseptal flap group complications (16.7%); (21.9%) of patients had CSF leakage, (6.2%) had epistaxis and sinusitis, (9.4%) had pneumocephalus, and the overall complications rate was (34.4%).

Munich *et al.* [18] reported that, one postoperative CSF leak happened in a patient with a pituitary adenoma, one in a patient with a craniopharyngioma, and one happened in a patient with a tuberculum sella meningioma.

Gaynor *et al.* [19] reported that, CSF leak was observed postoperatively in 18 cases (3.9%). Of the 291 cases without postoperative CSF leak, there were 3 (1%) postoperative leaks. Of those 3 patients, 1 had no repair, 1 had fat graft, and 1 had AlloDerm.

Regarding middle turbinate flap complications, **George *et al.*** [16] reported 1 patient who developed aseptic meningitis, presenting as fever, headaches and nuchal rigidity on the first post-operative day; recovered fully with conservative management. Sinusitis was observed in 1 patient in the second week and needed added antibiotics. Other observed complications included transient crusting in 1 patient, synechiae and minor nasal bleeding.

The mean follow up period in our study of nasoseptal flap intervention group was 12.42±3.17 months and ranged from (8—18). While the mean of Middle turbinate flap intervention group was 12.58±2.71 and ranged from (8—17), the difference was statistically non-significant.

This goes hand in hand with **Dolci *et al.*** [21] who reported that the mean follow-up period of nasoseptal flap intervention group of 12.2 months. And with **Wu *et al.*** [22] who reported that the follow-up time of Middle turbinate flap intervention group from one month to five years (median 14 months). Of course, longer follow up periods are required to assess the recurrence of CSF leaks especially in spontaneous cases as most of these patients may have elevated intracranial tension with tendency of recurrence of the leak. However, these periods are sufficient to judge the success of repair in traumatic and iatrogenic case of CSF leaks as in many of our cases.

In this study, the success rate of repair was comparable between the 2 groups with no statistically significant difference. Also, it was comparable to other previously mentioned studies. However, there are some limitations which make this comparison accurate. These limitations are due to the mismatch between the 2 groups regarding the site, size and cause of the defect which was difficult to unify between the 2 groups. Also, the choice of the method of repair among the 2 flaps may reflect a personal or a literature-based experience. However, both flaps proved to be extremely successful in repair of most skull base defects and can be used and interchanged with minimal morbidity.

CONCLUSION

There are no significant differences in results of using nasoseptal versus middle turbinate flaps in skull base reconstruction.

With substantial advancements ensuing in the field of skull base surgery, the nasoseptal flap has become an invaluable tool to surgeons faced with the arduous task of repairing large skull base defects with minimal failure rates. Adherence to standard recommendations and use of meticulous technique during flap placement, avoiding ostial obstruction along its course is imperative in reducing post-operative complications.

The pedicled middle turbinate mucosal flap to reconstruct skull base defects after endoscopic endonasal surgery also has multiple advantages. It allows for a larger surgical field at the start of the surgery, fast healing, and in experienced hands can reduce surgical time.

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