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ORIGINAL ARTICLE

ENDOSCOPIC SELLER RECONSTRUCTION IN ENDOSCOPIC ENDONASAL TRANS SPHENOIDAL SURGERY: A REVIEW OF 100 CASES

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ABSTRACT

Background: Endoscopic endonasal transsphenoidal surgery (EETS) is the primary approach for sellar pathologies, but effective reconstruction to prevent cerebrospinal fluid (CSF) leaks remains critical. The current study reported a single institutional experience with using different types of flaps for reconstructing sellar defect in selected cases.

Materials & methods: A retrospective analysis of 100 patients undergoing EETS for sellar/suprasellar lesions (2016–2022) was conducted. Reconstruction techniques included: multilayer closure with nasoseptal flap (NSF, 64%), multilayer with middle turbinate (MT) graft (29%), and gasket-seal with NSF (7%). Outcomes assessed included intraoperative/postoperative CSF leaks (graded using Esposito classification), complications, and olfactory function (Sniffin' Sticks test).

Results: Overall postoperative CSF leak rate was 2%. Intraoperative CSF leaks occurred in 36% of cases (Grade 1:14%, Grade 2:13%, Grade 3:9%). The facia lata + NSF technique demonstrated superior intraoperative leak prevention (no leak in 57.97% of cases, $p \leq 0.001$), especially for thin (100% success) and open (77.42% success) diaphragms. However, NSF use correlated with higher septal perforation (86.4%) and sinusitis (50%) rates. Olfaction remained stable pre- vs. postoperatively (mean scores: 12.58 vs. 12.56).

Conclusions: Sellar reconstruction is a critical component of trans-nasal hypophysectomy, impacting patient outcomes and complications. The choice of graft material, surgical technique, and attention to detail are essential in achieving successful reconstruction and minimizing postoperative complications.

KEY WORDS: Endoscopy; Nasal Septum; Surgical Flaps; Sella Turcica.

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INTRODUCTION

The sellar turcica houses the pituitary gland and is a common site for intracranial neoplasms, with pituitary adenomas representing the majority of sellar lesions.[1] While dopamine agonists effectively manage prolactinomas, surgery remains the primary treatment for most pituitary tumors.[2] Advances in endoscopic endonasal transsphenoidal surgery (EEA) have revolutionized the management of skull base defects, particularly cerebrospinal fluid (CSF) leaks, offering minimally invasive access to the anterior and middle cranial base without compromising neurovascular structures.[3,4]

Historically, CSF leak repairs involved transcranial or extracranial approaches, but endoscopic techniques have gained prominence due to reduced morbidity and improved success rates.[4] For small defects, free grafts (e.g., fat, fascia) are preferred for their ease of use and minimal contraction, while larger defects often require vascularized flaps, such as the pedicled nasoseptal flap (NSF), which provides reliable coverage.[5-7] However, NSF use is associated with risks like septal perforation, crusting, and olfactory loss, limiting its routine application.[8] Autologous grafting is typically reserved for intraoperative CSF leaks, thin diaphragm sellae, or arachnoid herniation.[6]

This study evaluated endoscopic sellar reconstruction techniques, comparing outcomes of free grafts (fascia lata, fat) combined with middle turbinate grafts or NSF in 100 cases. The aim was to assess efficacy, safety,

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and complication profiles linked to flap selection, correlating findings with existing literature to guide optimal reconstructive strategies in EEA.

MATERIALS AND METHODS

This retrospective observational study analyzed patients undergoing endoscopic endonasal transsphenoidal surgery (EEA) for sellar/suprasellar pathologies between 2016-2022 at private hospitals in Iraqi Kurdistan. Approved by the Iraqi Kurdistanian Board (Ref: 646/27.02.2023), the study included 100 cases with complete preoperative, intraoperative, and postoperative data. Exclusion criteria were incomplete records or follow-up. Demographic variables (age, gender), tumor types (macroadenomas, Rathke's cleft cysts, meningiomas), repair materials (fascia lata, middle turbinate graft, nasoseptal flap (NSF)), diaphragma sellae thickness (categorized as thin, thick, or open), intraoperative cerebrospinal fluid (CSF) leak grades (Eposito classification: Grades 1-3), and postoperative complications (e.g., CSF rhinorrhea, meningitis) were extracted from medical records and surgical videos. Preoperative imaging (CT/MRI) and postoperative outcomes were systematically reviewed using Horos and RadiAnt software to assess tumor characteristics, neurovascular relationships, and sinonasal changes (Figures 1-6). Intraoperative variables, including surgical techniques and reconstruction layers, were retrieved from video archives.

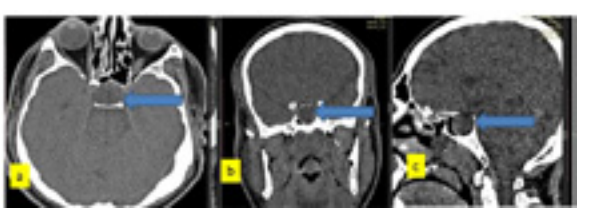

Figure 1: Preoperative CT scan patient number. a: axial, b: coronal, c: sagittal, non-enhanced CT scan of pituitary gland showing widened sella by well defined pituitary partly cystic macroadenoma

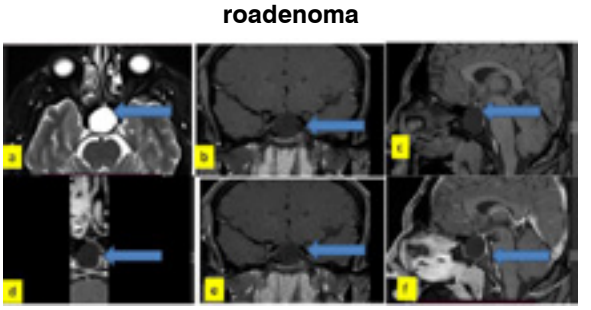

Figure 2: preoperative MRI patient number. a: axial T2, b: coronal T1, c: sagittal T1 non-enhanced MRI, d: T1 axial, e: T1 coronal, f: sagittal T1 contract enhanced MRI of pituitary gland showing widened sella by well defined pituitary mainly cystic macroadenoma

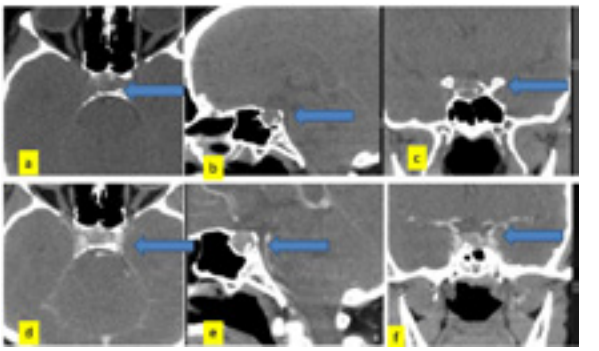

Figure 3: Preoperative CT scan patient number. a: axial, b: sagittal, c: coronal, non-enhanced, d: axial, e: sagittal, f: coronal enhanced CT scan of pituitary gland showing mild widened sella by well-defined pituitary macroadenoma

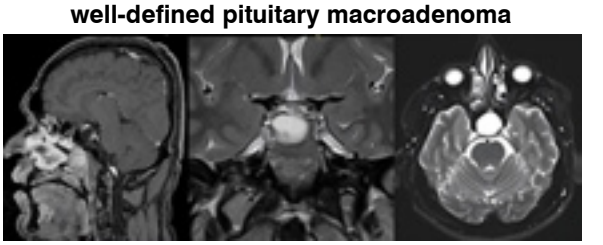

Figure 4: Preoperative MRI (patient number 2) A. Sagittal section B. coronal section C. axial section

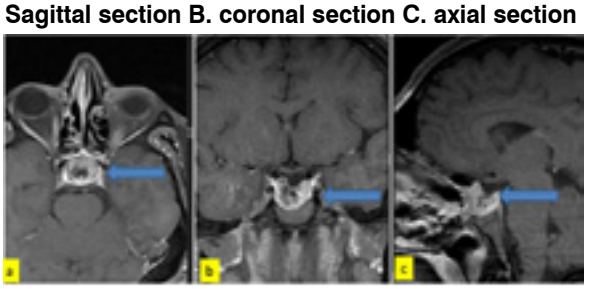

Figure 5: Postoperative MRI patient number (1) a: T1 axial, b: T1 coronal, c: sagittal T1 contrast enhanced MRI of pituitary gland showing heterogeneous enhancement of remnant

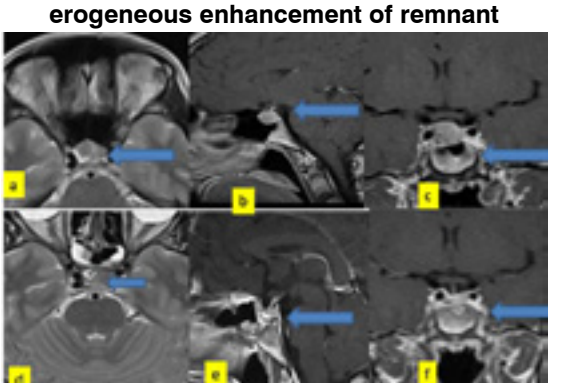

Figure 6: Postoperative MRI patient number (2) a: axial T2, b: sagittal T1 enhanced, c: control T1 enhanced, d: axial T2, e: sagittal T1 enhanced, f: control T1 enhanced MRI of pituitary gland showing the pituitary gland remnant after removal of the adenoma

Surgical procedures followed standardized endoscopic endonasal techniques using 0°, 45°, and 70° endoscopes. Key steps included middle turbinectomy (mucosa preserved for grafting), sphenoidotomy, sellar floor opening, and lesion resection. Rescue NSF harvesting was performed via superior and inferior incisions (Figures 7–8), preserving sphenopalatine artery branches. Reconstruction strategies varied: multi-layer closure (fat/fascia lata/NSF) for open/thin diaphragma with CSF leaks versus middle turbinate grafts for intact diaphragma. Synthetic materials (Gelfoam, Surgicel, fibrin sealant) supplemented repairs. Intraoperative CSF leaks were graded visually (Figure 10), while diaphragma integrity was classified as thin, thick, or open (Figure 9).

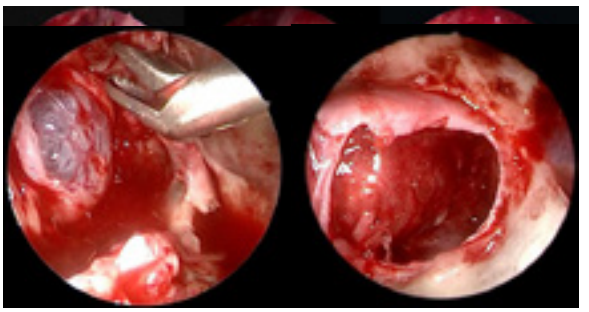

Figure 9: A) thin diaphragma, B) thick diaphragma

Our grading system for intraoperative CSF leaks comprised three levels according Eposito et al classification (see Figure 10): As (grade 1) denoted a minor dural puncture, (grade 2) represented leaks falling between grade grade 1 & 3 and (grade 3) indicated significant defects with high-flow CSF leak. This systematic approach allowed us to effectively analyze and differentiate the varying degree of CSF leaks, enabling comprehensive insights into their prevalence and management during and after operation.

Postoperative care included bed rest (head elevation 15°), acetazolamide to reduce CSF production, antibiotics, nasal saline sprays, and irrigation. Hospitalization continued until nasal pack removal (Day 4–5), followed by endoscopic examination. Early CT scans were reserved for complications; routine MRI was scheduled at 3 months. Olfactory function was assessed using the Sniffin' Sticks test, a validated olfactory identification tool involving microencapsulated odors on felt-tip pens. Patients identified 16 common odors (e.g., banana, coffee) per administration guidelines, with scores categorized as normosmia, hyposmia, or anosmia.

Statistical analysis was performed using SPSS v26 (IBM Corp.). Categorical variables were compared using the chi-square test or Fisher's exact test, while continuous variables were analyzed with paired t-tests. Associations between surgical techniques and outcomes were evaluated using logistic regression. A p-value ≤ 0.05 was considered statistically significant.

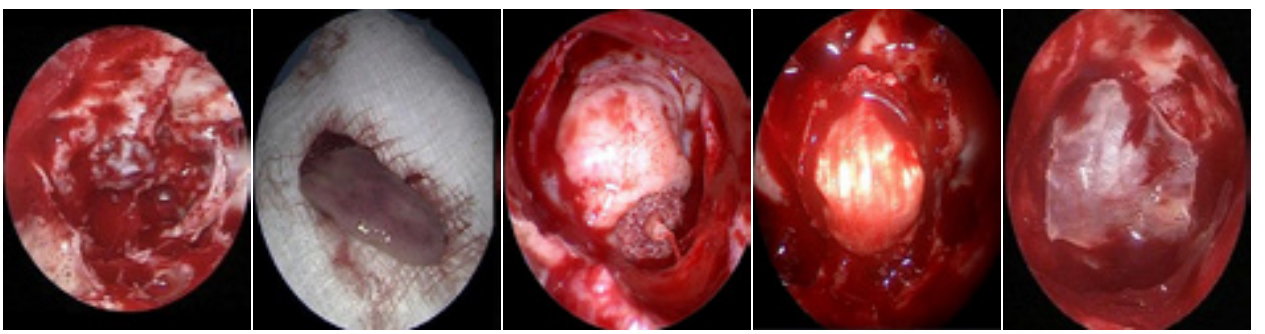

Figure 8: A) Sphenoid Sinus, B) Middle Turbinate, C) Middle Turbinate Graft, D) Fascia Lata(underlay), E) Fascia Lata(overlay).

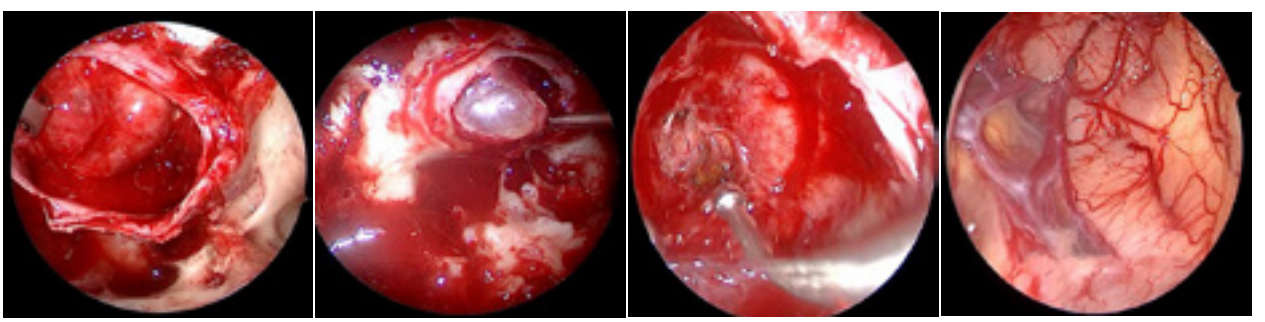

Figure 10: A-Grade 0, B-Grade 1, C-Grade 2 and D-Grade 3

RESULTS

Total 100 patients were included in this study. Table 1 summarizes key demographic and surgical data from 100 patients. Males constituted a majority (56%) compared to females (44%). The most common tumor type was macroadenoma (80%), followed by clival chordoma (5%) and craniopharyngioma/ meningioma (3% each). Multilayer + nasoseptal flap (NSF) was the most frequently used repair technique (64%), followed by multilayer + middle turbinate (MT) graft (29%). Diaphragma assessment revealed thin diaphragma (40%) and open diaphragma (31%) as the most common categories, with thick diaphragma accounting for 29%.

Table 1: Demographic, Tumor Type, Repair Techniques, and Diaphragma Status

Category	Subcategory	Frequency (n=100)	%age
Sex	Male	56	56
	Female	44	44
Tumor Type	Macroadenoma	80	80
	Microadenoma	7	7
	Craniopharyngioma	3	3
	Glioma	1	1
	Meningioma	3	3
	Clival Chordoma	5	5
	Rathke's Cyst/ Pouch	1	1
Repair Techniques	Multilayer + NSF	64	64
	Multilayer + MT Graft	29	29
	Gasket + NSF	7	7
Diaphragma Thickness	Thick	29	29
	Thin	40	40
	Open	31	31

No CSF leak was observed in 98% of cases, though intraoperative leaks were graded as Grade 1 (14%), Grade 2 (13%), and Grade 3 (9%). Synechia (26%) and perforation (22%) were the most frequent complications, followed by sinusitis (8%) and thigh hematoma (4%). Only 2% of patients experienced postoperative CSF leaks or meningitis (Table 2).

Table 2: Complications, and CSF Leak Data.

Category	Subcategory	Frequency (n=100)	%age
Postoperative CSF Leak Distribution	No Leak	98	98
	Postoperative Leak	2	2
Intraoperative CSF Leak Grading	Grade 1 (Minor)	14	14
	Grade 2 (Moderate)	13	13
	Grade 3 (High-Flow)	9	9
	No Leak	64	64
Complications	Epistaxis	3	3
	Synechia	26	26
	Perforation	22	22
	Sinusitis	8	8
	Mucocele	1	1
	Meningitis	2	2
	Postoperative CSF Leak	2	2
	Thigh Hematoma	4	4
	No Complication	32	32

Olfactory function, measured via Sniffin' Sticks test, showed minimal decline (pre-op mean: 12.58/16; post-op: 12.56/16), indicating preserved smell perception (Table 3).

Table 3: Means of the test result for 100 patients

	Pre -operative	After 6 months
mean of the test result for 100 patients	12.58	12.56

Intraoperative CSF leaks were significantly associated with repair techniques ($p \leq 0.001$): no leaks occurred with MT (29/69, 40.03%) or gasket seal, while NSF was linked to 24/31 (77.42%) leaks. Diaphragma thickness showed strong correlations: MT was exclusively used for thick diaphragma (29/29, 100.0%, $p \leq 0.001$), NSF for thin diaphragma (40/40, 100.0%, $p \leq 0.001$), and NSF/gasket seal for open diaphragma (24/31 (77.42%), 7/31 (22.58%), $p \leq 0.001$). Postoperative CSF leaks were rare (2) and not statistically significant ($p = 0.57$). Among complications, sinusitis was significantly associated with MT/NSF (4/8 (50.0%) each, $p = 0.003$), while septal perforation predominantly occurred with NSF (19/22, 86.4%, $p = 0.05$) (Table 4).

Table 4: Relation of techniques of repair when compared to intraoperative CSF leak, Thickness of diaphragma, postoperative CSF leak and postoperative complications.

Categories	Techniques of repair			Total	P-value
	Facia lata + middle turbinate	**Facia lata+ NSF**	**Gasket seal**		
	N0. (%)	**N0. (%)**	**N0. (%)**		
Intraoperative CSF leak					
No leak	29 (40.03)	40 (57,.97)	0 (0.0)	69	≤ 0.001
Leak	0 (0.0)	24 (77.42)	7 (22.58)	31	
Thickness of diaphragma					
Thin	0 (0.0)	40 (100.0)	0 (0.0)	40	≤ 0.001
Thick	29 (100.0)	0 (0.0)	0 (0.0)	29	≤ 0.001
Open	0 (0.0)	24 (77.42)	7 (22.58)	31	≤ 0.001
Postoperative CSF leak					
Positive leak	0 (0.0)	2 (100.0)	0 (0.0)	2	0.57
Negative leak	29 (29.0)	64 (64.0)	7 (7.0)	100	
Postoperative complication					
Epistaxis	1 (33.3)	2 (66.7)	0 (0.0)	3	0.52
Septal perforation	0 (0.0)	19 (86.4)	3 (13.6)	22	0.05
Sinusitis	4 (50.0)	4 (50.0)	0 (0.0)	8	0.003
Synechia	3 (11.5)	21 (80.8)	2 (7.7)	26	0.94
Meningitis	0 (0.0)	2 (100)	0 (0.0)	2	0.75
Anosmia	0 (0.0)	0 (0.0)	0 (0.0)	0	

DISCUSSION

The evolution of surgical approaches for sellar lesions from transcranial to EEA techniques has significantly improved patient outcomes by reducing brain retraction, trauma, and hospitalization.[6] EEA offers enhanced visualization and minimally invasive access, enabling complete resection of large sellar tumors.[9] However, postoperative dural defects necessitate robust reconstruction to prevent CSF leaks, meningitis, and other complications.[10] Multilayered closure using vascularized flaps, such as the NSF, has emerged as superior to single-layer or avascular techniques, particularly for high-flow CSF leaks.[11] The NSF, supplied by the sphenopalatine artery's PSA, provides durable coverage due to its mobility and vascularity.[12] In our study of 100 cases, NSF was used in 71% of reconstructions, especially for thin diaphragm defects, aligning with its efficacy in preventing leaks. Vascularized flaps reduced postoperative CSF leak rates to 2%, consistent with prior reports, while free grafts showed higher failure rates.[11]

Despite advancements, complications persist. Intraoperative CSF leaks occurred in 8.5% of cases, and postoperative leaks in 2%, often linked to incomplete repair.[13,14] Harvey et al. demonstrated that vascularized flaps halved leak rates (6.7% vs. 15.5%) compared to free grafts[14], underscoring their preference. Synthetic prostheses (e.g., titanium mesh, silicone plates) are alternatives but require adjunctive fat/muscle packing, limiting their standalone utility.[15,16] Olfactory outcomes remain a concern. While our study found no statistically significant decline, full NSF harvest risks damaging the olfactory epithelium on the lateral nasal wall, potentially impairing smell.[12,17] Preserving the common lamella during flap elevation may mitigate this risk.[17]

Our findings highlight the superiority of the fascia lata + NSF technique, achieving 100% intraoperative leak control in thin diaphragm cases and 57.97% overall success ($P \leq 0.001$), outperforming middle turbinate or gasket seal methods.[18] However, NSF correlated with higher septal perforation (100%) and sinusitis rates (75%), likely due to mucosal loss and

anatomical disruption.[18] This aligns with Hadad et al., who reported 95% NSF success but noted variable complication rates across institutions (2006), suggesting technique-specific and patient-dependent factors influence outcomes.[14,18]

Therefore, EEA with NSF-based reconstruction remains the gold standard for sellar defects, balancing leak prevention against complications like sinusitis and olfactory compromise. Future research should optimize flap design, refine postoperative care, and evaluate long-term quality-of-life impacts, including subtle olfactory changes.

Limitation of the study

Although the aim of the current study was to describe our experience in the sellar defect reconstruction retrospectively, many limitations come to account which is as follows; a limited number of study cases and findings of the leak site as well as the duration of the follow-up.

CONCLUCION

While the statistical analysis in this study revealed significant associations between sellar reconstruction and CSF leaks, the clinical relevance of this factor should not be underestimated. In the current study, the postoperative CSF leak decreased due to the different types of flap that were used for reconstructing the sellar defect. Surgeons should continue to prioritize meticulous sellar defect repair to minimize complications, and further research is warranted to explore the elusiveness of these outcomes in pituitary surgery.

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CONFLICT OF INTEREST
Authors declare no conflict of interest.
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AUTHORS' CONTRIBUTION

The following authors have made substantial contributions to the manuscript as under:

Conception or Design:	HAA, MIA
Acquisition, Analysis or Interpretation of Data:	HAA, MIA
Manuscript Writing & Approval:	HAA, MIA

All the authors agree to be accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved.