Evaluation of Endoscopic Repair of Cerebrospinal Fluid (CSF) Rhinorrhea with Single Layer Graft versus Multilayers Graft

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Abstract

Background: Endoscopic repair of skull base defect is the treatment of choice in cases of CSF rhinorrhea.

Objectives: To evaluate the results of endoscopic repair with single-layer grafting versus multi-layer grafting in cases of CSF rhinorrhea.

Patients and methods : This study included 50 patients with CSF rhinorrhea. They are divided into two groups. Group A included 25 patients who underwent repair of the defect using a single-layer graft. Group B included 25 patients who underwent repair by multi-layer graft. Postoperative follow-up of all cases for one year.

Results: This study included 50 patients: 34 were females (68%) and 16 were males (32%) with the mean age of 39.9 ± 12.03 . Group A included 25 patients. The mean age 39.9 ± 12.95 in comparison to 39.8 ± 11.69 years in Group B showed no significant difference. Group A included 72% females and 28% males compared to 64% females and 36% males in Group B with no significant difference. As regards etiology, the most common cause in Group A is neoplastic, but the most common cause in Group B is spontaneous causes. The comparison between group (A) and group (B) regarding defect data showed no significant differences. Comparison between the two studied groups regarding grafts and flaps showed a highly significant difference was observed between the group (A) and group (B) in the use of autologous fat grafts, fascia Lata grafts, Naso-septal flap, bone grafts, and free mucosal grafts. Comparison between group (A) and group (B) regarding postoperative outcomes revealed no significant differences in all parameters.

Conclusion: Both techniques showed similar outcomes, with no significant differences in complications or CSF leak recurrence.

Keywords: Cerebrospinal fluid (CSF) rhinorrhea; Endoscopic; Single layer graft multilayer graft; Spontaneous leak

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Introduction

Cerebrospinal fluid (CSF) rhinorrhea occurs due to a defect in the skull base, which compromises the integrity of the arachnoid membrane, dura mater, and the overlying sinonasal mucosa. This anatomical disruption enables the continuous egress of CSF, typically manifesting as a clear nasal discharge. Historically, craniotomy was the conventional surgical method employed for the repair of such leaks **(Probst, 1990).**

The most frequently reported clinical manifestation of cerebrospinal fluid (CSF) rhinorrhea is a clear, watery nasal discharge, observed in approximately 82.7% of cases, followed by nasal obstruction in 40.7% of patients. In some instances, seizures and meningitis may present as initial symptoms **(Komotar et al., 2012).**

The underlying cause of a cerebrospinal fluid (CSF) leak is a critical factor in patient assessment. These leaks may result from various etiologies, including traumatic, non-traumatic, congenital, neoplastic, or spontaneous origins. Spontaneous, or idiopathic, CSF leaks are further subcategorized based on intracranial pressure, ranging from normotensive to hypertensive presentations **(Khan et al., 2022).**

The choice between conservative management and surgical intervention for cerebrospinal fluid (CSF) leaks depends on factors such as the anatomical location, underlying etiology, and duration of the leak. Prompt treatment is essential, as delayed management significantly increases the risk of intracranial infections, including meningitis, which can be life-threatening if left unaddressed **(Yadav et al., 2016).**

A variety of surgical techniques and graft materials have been described in the literature for the reconstruction of skull base defects. The choice of reconstruction strategy is primarily influenced by the defect's anatomical location, size, and associated clinical factors. A range of autologous grafts have been employed, including temporalis fascia, conchal chondroperichondrium, free mucoperiosteal grafts from the middle turbinate, fascia lata, autologous fat, and vascularized pedicled flaps. Each material offers unique benefits tailored to the specific demands of the defect. Surgeons generally opt for either single-layer or multilayer grafting based on their expertise and preference. Additionally, grafts may be positioned using various techniques—such as underlay, overlay, or a combined partial underlay method—depending on the defect characteristics and the selected surgical approach **(Manandhar et al., 2021).**

Patients and methods

This prospective study was carried on 50 patients with established diagnosis of CSF rhinorrhea in the otorhinolaryngolgoy departments in Alexandria university hospital and Qena university hospital, Egypt. in the period between January 2022 and December 2024.

Participants were placed into two distinct groups: **Group A**, 25 patients were underwent repair of the defect through the application of a single-layer graft. **In Group B** , 25 patients were underwent the repair of the defect using multilayer graft.

The diagnosis was determined through a comprehensive evaluation of the clinical history, ENT and comprehensive endoscopic examination, chemical analysis of the discharged

fluid, and imaging techniques like computed tomography (CT) and MRI. After a thorough examination of clinical, laboratory, and imaging results**.**

Operative technique

- Preoperative preparation was done by lumbar puncture and measuring CSF pressure in spontaneous cases.
- Intrathecal Fluorescein injection was used. It was injected to localize the site of the defect.
- Harvesting Fat and fascia lata was done via longitudinal incision is made along the lateral thigh.
- The endoscopic evaluation involved the nasal cavity, ethmoid fovea, cribriform plate, sphenoid sinus, and frontal sinus to determine the source of the leakage.
- Partial middle turbinate resection was performed on the ipsilateral side of the leak, and the free mucoperiosteum graft from the partly resected middle turbinate was retrieved
- The approach proceeded from anterior to posterior. Uncinectomy was performed, and an extended maxillary antrostomy to the posterior maxillary wall was carried out.. The frontal sinus was opened. Bulla ethmoidalis was opened. Anterior ethmoidal cells was removed. Ground lamella was opened anteriorly, inferiorly and medially. Posterior ethmoidal cells was opened. Sphenoid sinus was approached and sphenoid ostium was widened. Meningocele and defect were identified and the size of the defects was measured.
- In sphenoid sinus defects, the procedure was adjusted by omitting the exploration of the anterior skull base. Additionally, middle turbinectomy was not performed as a standard practice and was only carried out when the surgical track was little as well as when turbinate bone was required for reconstruction.
- Bipolar cautery was used to cauterise the herniated dura mater via the bone defect, and the graft bed was prepared by removing the mucosa around the defect and leaving the region raw.
- In certain cases, partial inferior turbinate resection was performed on the ipsilateral side of the lesion, and a mucoperiosteum graft was harvested and employed as a single layer graft repair.
- - Nasoseptal flap was harvested as described by **Hadad and his colleagues, 2006**
- The flap was subsequently positioned in the nasopharynx or within the maxillary sinus.and the pedicle was secured by cottonids.
- Bone grafts was harvested from the partially resected middle turbinate and used in the multilayer graft repair over the undelay layers as fat or fascia lata as plug and fix to these layers as gasket seal. **(Fig.1).**

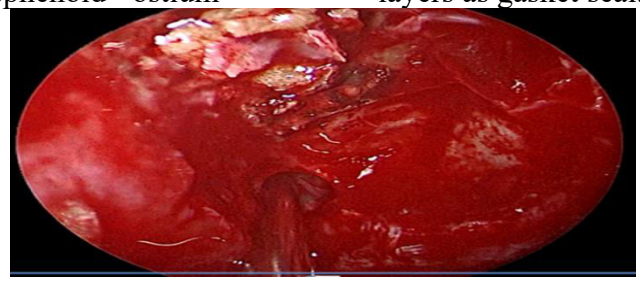

Fig.1. Bone graft pushed over fat graft as a gasket seal

After that the graft was stabilised with gelfoam and surgicel and a separator was inserted to avoid future unintentional graft dislodgement during Merocel® removal.

In Group A : The repair of the defect using single layer graft which cover the bony edge of the defect (onlay technique). We used for the single layer repair mucoperiosteal grafts harvested from the partially resected middle turbinate or inferior turbinate and free mucosal grafts

In group B : The selection of tissue for the multilayer repair was determined by the extent of the defect, the structure of the skull base, and surgical findings. We used for repair fat graft, fascia lata graft, nasoseptal flap, mucoperiosteal grafts harvested from the partially resected middle turbinate or inferior turbinate and bone grafts were utilised to fill and secure the remaining underlay grafts as a gasket seal.

There are two ways to apply multilayered repair: extracranial onlay was used to fill all the defect without the need for an underlay graft. For defects with adequate space for graft implantation, underlay (intracranial or intradural) repair was carried out immediately .**(Fig.2).**

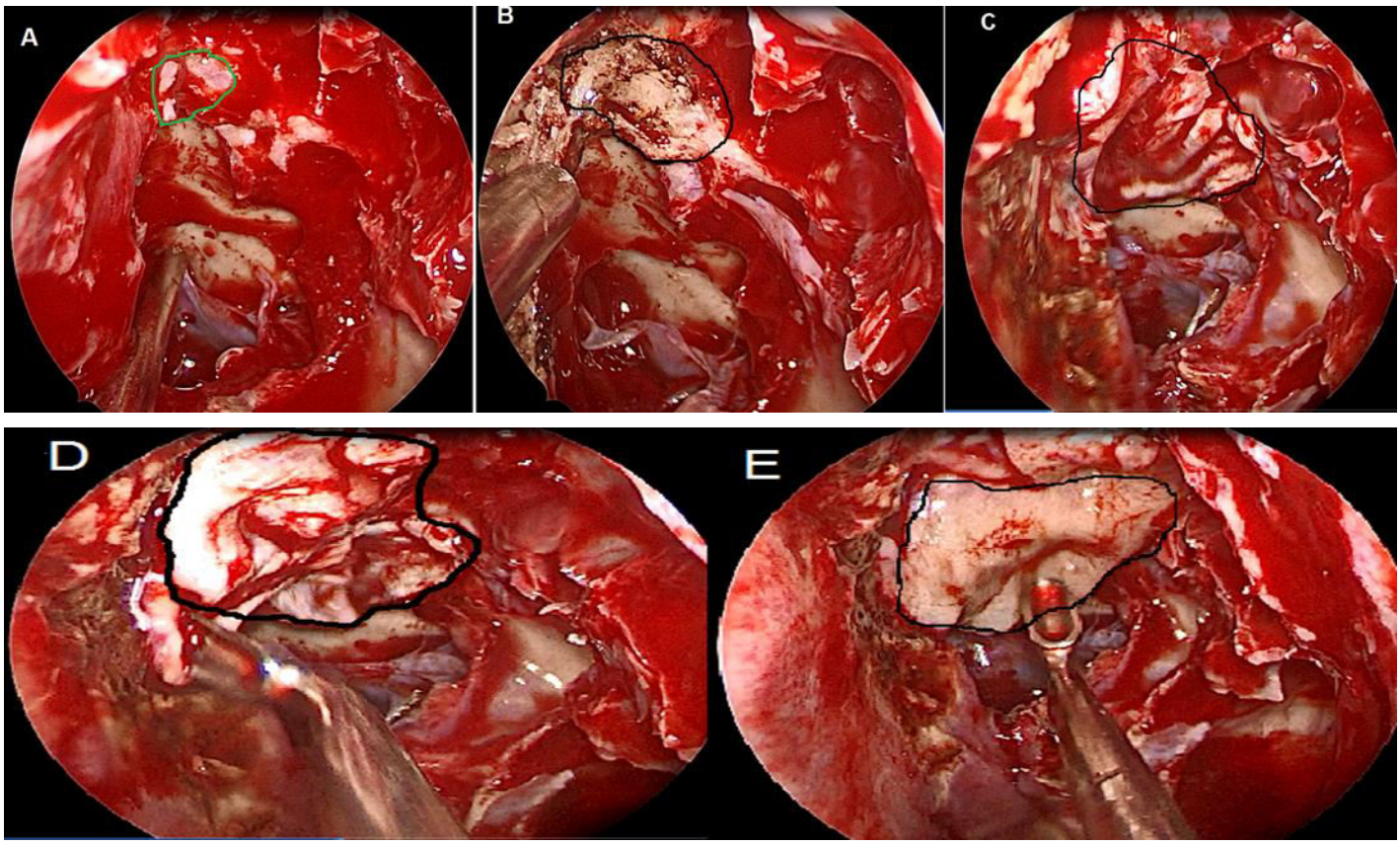

Fig .2. Endoscopic view for a case: (A) the defect is marked with green line in the left cribriform plate. (B) preparation of the defect by cauterization. (C)1st layer overlay fascia lata graft. (D) 2nd layer fascia lata graft. (E) Middle turbinate mucoperiosteum graft.

Postoperative care was done in the Intensive Care Unit for close observation for at least the first 24 hours . and included :-

-Bed rest with head elevated.

- Precautions against venous thromboembolism (Elastic stockings, antiplatelet and anticoagulant medications).
- Antibiotics (Triple therapy for G –ve, G +ve and anaerobes) that cross the blood brain barrier (BBB) started on the day of surgery and continued for 7 days postoperatively.
- Avoid straining, administration of stool softener.
- Administration of diuretics e.g. furosemide (Lasix) ® or Acetazolamide (Cidamex) ® to lower the CSF pressure and decrease the risk of postoperative leak.
- Postoperative lumbar drain or repeated lumbar puncture and drainage was done in high ICP cases.
- Patients with secondary hydrocephalus or chronic symptomatic intracranial hypertension that failed to get better with treatment or resulted in a return of CSF rhinorrhea, ventriculo-peritoneal shunting was implanted.
- Nasal packing was removed in the 2nd-5th postoperative day.
- Clinical postoperative assessments for leak and/or complications were done weekly at 1st month, and then monthly for one year.

Patients were instructed not to strain or bend down, not to wipe their noses, blow their noses, or cough, and not to engage in constipation or excess weight lifting.

Patients were discharged on the fifth postoperative day after the nasal pack was removed. A follow-up assessment was scheduled for the tenth postoperative day to monitor recovery and address any potential complications.

Ethical consideration

- The protocol was applied for approval of Research Ethics Committee of SVU in date.
- The approved code of ethics is SUV/ MED/ENT030-2-21-12-288.
- Participants were educated about the study's purpose, benefits, and community impact.
- Written consent was taken from all participants before including them in the study and they have the right to refuse without effect on their management.
- All data obtained from participants was used for scientific purposes only.
- Confidentiality of the collected data was ensured and obtained data were not used outside this study without personal approval.
- Researcher's possible communicating methods was identified to the participants to ask for any explanation.
- All participants were announced by results of the study.
- All participants have the right to withdraw from the study at any time without giving any reason.

Statistical analysis

Data were reviewed, submitted, and processed with SPSS version 23. For qualitative variables, data were reported as a number and a percentage, and for quantitative variables, as a mean plus standard deviation (SD).

The Chi-square test, the student "t" test, and the Mann Whitney test were employed to evaluate qualitative variables. P-value of less than 0.05 indicates statistical significance.

Results

The study included 50 patients with a mean age of 39.9 ± 12.03 years. Age

distribution was as follows: 9 patients (18%) were aged 16 -29 years, 18 patients (36%) were aged 30-39 years, 11 patients (22%) were aged 40-49 years, 8 patients (16%) were aged 50-59 years, and 4 patients (4%) were aged 60 years or older. Regarding sex distribution, 34 patients (68%) were female, and 16 patients (32%) were male. (**Table.1)**

Table 1. Demographic data among included cases

Variables	**Value (N=50)**
Age (Years)	39.9 ± 12.03
• **16-29**	9 (18%)
• **30-39**	18 (36%)
• **40-49**	11 (22%)
• **50-59**	8 (16%)
• **>=60**	4(8%)
Sex	
• **Female**	34 (68%)
• **Male**	16 (32%)
Etiology of the lesion	
• **Spontaneous**	25 (50%)
• **Neoplastic**	19(38%)
• **Accidental trauma**	2 (4%)
• **Iatrogenic trauma**	4 (8%)
Site of defect	
• **Cribriform Plate of the Ethmoid Bone**	22 (44%)
• **Sphenoid Sinus**	20 (40%)
• **Ethmoidal Fovea**	5 (10%)
• **Frontal Sinus**	3 (6%)

The etiology of conditions among the patients was categorized as follows: spontaneous conditions in 25 patients (50%), neoplastic causes in 19 patients (38%), accidental trauma in 2 patients (4%), iatrogenic trauma in 4 patients (8%), (**Table .1)**

In the 25 spontaneous cases, cerebrospinal fluid (CSF) pressure was normal in 10 subjects (27.77%) and elevated in 15 subjects (41.66%).(**Table .2),** while we found normal CSF pressure in all traumatic and neoplastic cases.

Among the 50 patients, the defects were most commonly located in the Cribriform Plate of the Ethmoid Bone in 22 patients (44%), followed by the Sphenoid Sinus in 20 patients (40%), 14 cases of them with sellar defect following pituitary surgery. Defects in the Ethmoidal Fovea were observed in 5 patients (10%), and in the Frontal Sinus in 3 patients (6%). (**Table.1)**

Table 2. CSF pressure in spontaneous cases

Variables	**Value (N=25)**
Normal (<18 cm H2o)	**10 (27.77%)**
High (> 18 cm H2O)	**15 (41.66%)**

The study compared 25 patients in group (A) to 25 patients in group (B). The average age was 39.9 ± 12.95years for group (A) and 39.8 ± 11.69 years for group (B), with no significant difference (P = 0.991). Age distribution did not show significant differences between groups: 16-29 years (16% in group A, compared to 20% in group B), 30-39 years (36% in both groups), 40-49 years (24% in group (A) vs. 20% in group (B)), 50-59 years (12% in group (A) vs. 20% in group (B)), and ≥60 years (12% in group (A) vs. 4% in group (B)), with a p-value of 0.823. Sex distribution showed 72% females and 28% males in group (A), compared to 64% females and 36% males in group (B), with no significant difference (P =0.544). (**Table.3)**

Table 3. Comparison between demographic data of both studied groups

Variables	**Group A (N = 25)**	**Group B (N = 25)**	**P. Value**
Age (Years)	39.9 ± 12.95	39.8 ± 11.69	0.991(1)
• **16-29**	4 (16%)	5 (20%)	0.823(2)
• **30-39**	9 (36%)	9 (36%)	
• **40-49**	6 (24%)	5 (20%)	
• **50-59**	3 (12%)	5 (20%)	
• **>=60**	3 (12%)	1 (4%)	
Sex			
Female	18 (72%)	16 (64%)	0.544(2)
Male	7 (28%)	9 (36%)	

Comparison between the two studied groups regarding the etiology of the lesion shows a statistically significant difference between the two studied groups, 64% of Group (A) had a neoplastic lesion, compared to 12% in group (B), 36% of Group (A) had spontaneous lesion compared to 64% in group (B), 0% of group (A) had iatrogenic trauma, compared to 16% in group (B), and 0% in group (A) had an accidental trauma, compared to 8% in group (B), with a p-value of less than 0.001. **(Table.4)**

Table 4. Comparison between both studied groups regarding the etiology of lesion

Variables	**Group A (N = 25)**	**Group B (N = 25)**	**P value**
Spontaneous	9 (36%)	16 (64%)	**<0.001***
Neoplastic	16 (64%)	3 (12%)	
Accidental trauma	0 (0%)	2 (8%)	
Iatrogenic trauma	0 (0%)	4 (16%)	

In spontaneous cases, cerebrospinal fluid (CSF) pressure was measured in both group A (N = 9) and group B (N = 16). Within group (A), 4 patients (44.4%) had normal CSF pressure, while 5 patients (55.5%) exhibited high CSF pressure. In group (B), 6 patients (37.5%) had normal CSF pressure, whereas 10 patients (62.5%) had high CSF pressure. There was no significant difference (P =0.734). **(Table.(5)**

Table 5. CSF pressure in spontaneous cases in both studied groups

Variables	Spontaneous Cases		P. Value
	Group A (N = 9)	Group B (N = 16)	
Normal (<18 cm H2o)	4 (44.4%)	6 (37.5%)	0.734*
High (> 18 cm H2O)	5 (55.6%)	10 (62.5%)	

The comparison of defect site between group A and group B revealed no significant differences (p-value = 0.682). The distribution of defects by site was as follows: 40% in the cribriform plate of the ethmoid bone for group A compared to 48% for group B; 8% in the ethmoidal fovea for group A compared to 12% for group B; 4% in the frontal sinus for group A compared to 8% for group B; and 48% in the sphenoid sinus for group A compared to 32% for group B. **(Table.6)**

Table 6. Comparison between both studied groups regarding defects site

Variables	Group A (N = 25)	Group B (N = 25)	P value
Site of defect			
• **Cribriform Plate of the Ethmoid Bone**	10 (40%)	12 (48%)	0.682*
• **Sphenoid Sinus**	12 (48%)	8 (32%)	
• **Ethmoidal Fovea**	2 (8%)	3 (12%)	
• **Frontal Sinus**	1 (4%)	2 (8%)	

In this study most cases (96%) in group (A) had a defect size between one and 4.99 mm, compared to 80% in group (B), while only 4% of cases in group (A) had a defect size of 5 to 9.99 mm, compared to 12% in group (B), with an insignificant difference at p-value of 0.221. (**Table.7**).

Table 7. Comparison between both studied groups regarding the size of the defect.

Size of defect (mm)	Group A (N=25)	Group B (N=25)	P-Value
1-4.99	24(96%)	20(80%)	0.221*
5-9.99	1(4%)	3(12%)	
≥10	0(0%)	2(8%)	

Comparison between two studied groups regarding grafts and flaps showed a highly significant difference was observed between the group (A) and group (B) in the use of autologous fat grafts, fascia Lata grafts, Naso-septal flap, bone grafts, and free mucosal grafts. Autologous fat grafts were not used in the group (A) compared to 88% in the group (B) (P <0.001). Similarly, fascia Lata grafts were not used in group (A) but used in 96% of the group(B) (P <0.001). Naso-septal flap was not used in the group (A), compared to 24% in the group (B), with a p-value of 0.009. Bone graft was utilized in 0% of the group (A), compared to 20% in the group (B), with a p-value of 0.018. The free mucosal graft was utilized in 20% of group (A), but were not used in group (B), with a p-value of 0.018. Middle turbinate mucoperiosteum was used in 52% of the group (A) compared to 60% of the group (B), showing no significant difference (P

=0.569). Inferior turbinate mucoperiosteum was used in 28% of the group (A), compared to 12% in group (B), with no significant difference (p-value =0.157). **(Table.8, Fig.3).**

Table 8. Comparison between both studied groups regarding grafts and flaps

Variables	Group A (N = 25)	Group B (N = 25)	P. Value
Autologous Fat Graft	**0 (0%)**	**22 (88%)**	**<0.001***
Bone Graft	**0 (0%)**	**5 (20%)**	**0.018***
Middle Turbinate Mucoperiosteum	**13 (52%)**	**15 (60%)**	**0.569***
Naso-septal Flap	**0 (0%)**	**6 (24%)**	**0.009***
Fascia Lata Graft	**0 (0%)**	**24 (96%)**	**<0.001***
Inferior turbinate mucoperiosteum	**7(28%)**	**3(12%)**	**0.157***
Free mucosal graft	**5(20%)**	**0(0%)**	**0.018***

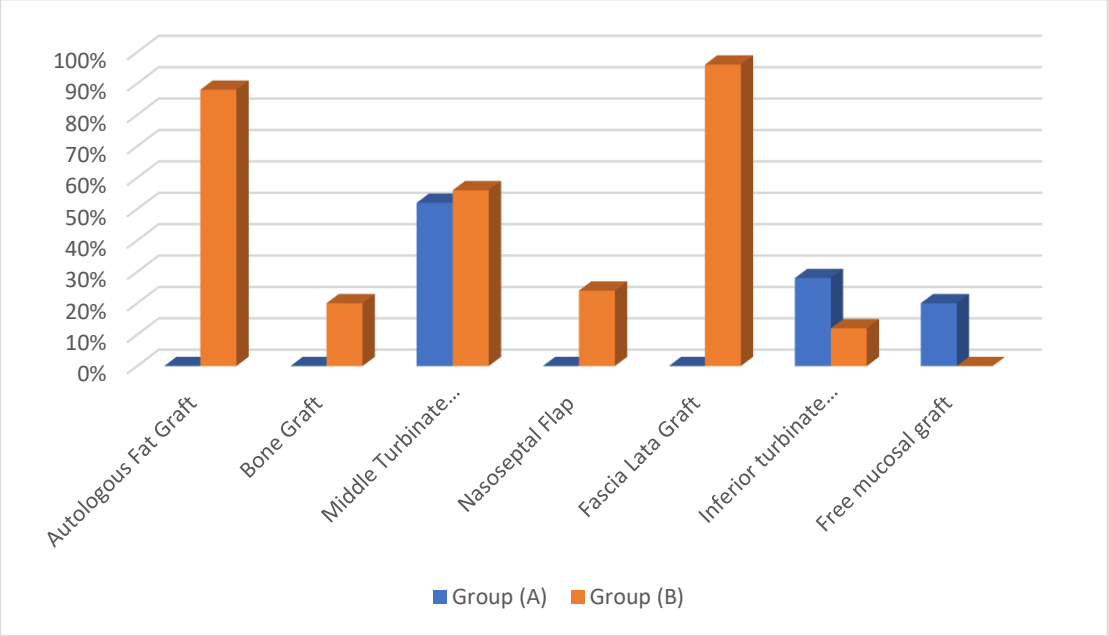

Fig.3. Grafts and Flaps among included patients in both studied groups

Comparison between group (A) and group (B) regarding postoperative outcomes revealed no significant differences in all parameters. Persistent postoperative CSF leak was observed in 4% of group (A) compared to 8% in group (B), with no statistically significant difference (P =0.552). Postoperative headaches occurred in 72% in group (A), compared to 76% in group (B), with an insignificant difference at a p-value of 0.747. Postoperative anosmia was noted in 48% of group (A) compared to 60% of group (B), with no significant difference (P =0.395). Postoperative fever occurred in 44% of group (A), compared to 28% in group (B), with an insignificant difference (P =0.239). Postoperative fever was mild and relieved in short duration and none of the cases developed meningitis. Postnasal nasal discharge occurred in 80% in group (A), compared to 88% in group (B), with an insignificant difference (P =0.440), which was

transient and relieved in 4-8 weeks.). (**Table.9, Fig.4**). Post-operative follow up showed that the incidence of postoperative revision of endoscopic repair was 0% in group (A) compared to 4% in group (B), demonstrating a non-significant difference (P =0.312). Postoperative shunt placement occurred in 4% of group (A) and 4% of group (B), with no significant difference observed (P >0.999). Recurrence occurred in only one case in Group B, which was among the spontaneous cases. The initial repair was performed using a multi-layer technique, and the revision surgery—also utilizing a multi-layer repair—was successful in preventing cerebrospinal fluid (CSF) leakage.(**Table.10)**

Table 9. Comparison between post-operative follow-up Complications in both studied groups

Variables	Group A (N = 25)	Group B (N = 25)	P. Value
Persistent Postoperative CSF Leak	1 (4%)	2(8%)	0.552*
Postoperative Headache	18 (72%)	19 (76%)	0.747*
Postoperative Anosmia	12(48%)	15 (60%)	0.395*
Postoperative postnasal discharge	20(80%)	22 (88%)	0.440*
Postoperative Fever	11(44%)	7(28%)	0.239*

Table 10. Post-operative follow up Interventions in both studied groups

Variables	Group A (N = 25)	Group B (N = 25)	P. Value
Postoperative Revision of Endoscopic Repair	0 (0%)	1 (4%)	0.312*
Postoperative Shunt	1 (4%)	1 (4%)	>0.999*

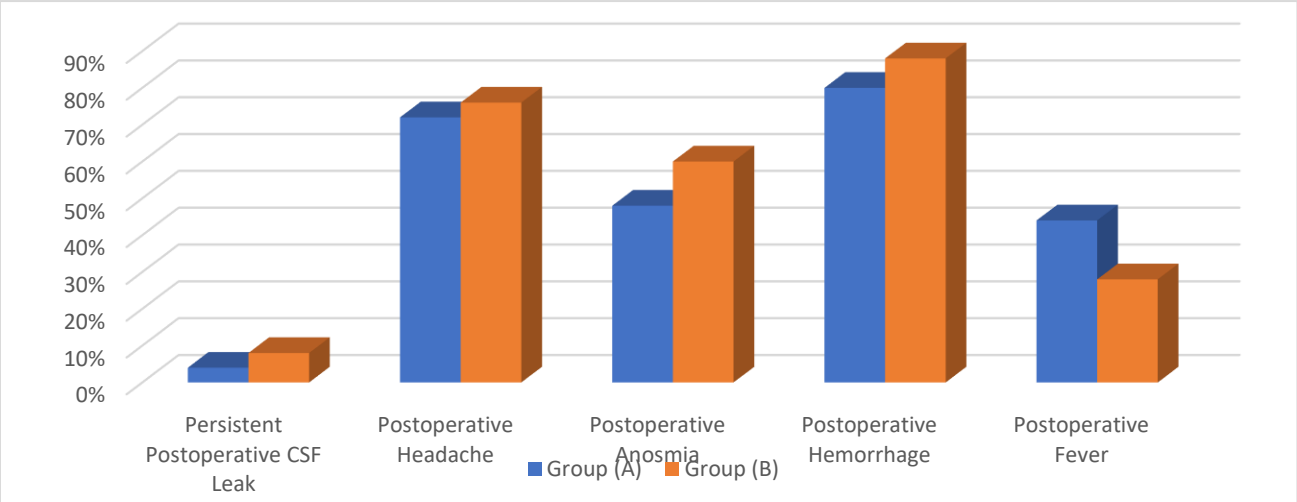

Fig.4. Postoperative Complications among included patients in both studied groups.

Discussion

Endonasal endoscopic repair is associated with a high success rate—approaching 90%—in the management of primary cerebrospinal fluid (CSF) leaks and is generally accompanied by a low incidence of complications. This technique

provides notable advantages, including superior visualization, precise identification of the defect site, and reduced risk of graft displacement. However, potential drawbacks include the possibility of hemorrhage, infection, and graft failure **(Mohanty, 2016).**

In this study involving 50 participants, the mean age was 39.9 ± 12.03 years, with a female predominance of 68% compared to 32% male. These findings are consistent with those of **Jiang et al., (2018)**, who reported a higher mean age of 51.4 years and an even greater female predominance at 94%.

In this study, the most prevalent etiologies of cerebrospinal fluid (CSF) rhinorrhea were spontaneous in origin (50%), followed by neoplastic causes (38%), iatrogenic trauma (8%), and accidental trauma (4%). These findings align with those reported by **Mishra et al., (2016**), who observed spontaneous CSF rhinorrhea in 61% of cases, with the left cribriform plate identified as the most frequent site of leakage.

In this study, 25 cases were identified as spontaneous in origin, with 9 cases in Group A and 16 in Group B. Among the patients in Group A, 44.4% demonstrated normal cerebrospinal fluid (CSF) pressure, while 55.5% exhibited elevated CSF pressure. Similarly, in Group B, 37.5% had normal CSF pressure and 62.5% presented with high CSF pressure. Statistical analysis revealed no significant difference between the two groups (P = 0.734). These findings are consistent with those of **Lobo et al., (2017),** who reported a strong association between spontaneous CSF leaks and factors such as female sex, obesity, elevated intracranial pressure, and obstructive sleep apnea.

Among the 50 participants in this study, the most frequent site of cerebrospinal fluid (CSF) leakage was the cribriform plate of the ethmoid bone, accounting for 44% of cases. This was followed by the sphenoid sinus (40%), with the majority of these cases occurring post-pituitary surgery. Additional sites included the ethmoidal fovea (10%) and the frontal sinus (6%). These findings are consistent with those of **Keshri et al., (2019),** who reported the cribriform plate as the most common site of CSF leak (74.4%), followed by the fovea ethmoidalis (16.3%) and the sphenoid sinus (6.9%).

In this study, a significant differences in graft material utilization between the single-layer and multilayer repair groups likely reflect the inherent technical demands of each approach. The single-layer technique, characterized by its relative simplicity, typically necessitates fewer graft components, thereby resulting in reduced use of autologous fat, bone grafts, and fascia lata. In contrast, the multilayer technique is designed to provide a more robust and watertight reconstruction, often requiring a combination of multiple graft materials to ensure structural integrity and prevent recurrence. This accounts for the higher prevalence of autologous fat, bone, and fascia lata grafts in this group. Furthermore, the exclusive application of nasoseptal flaps within the multilayer group highlights the need for enhanced reinforcement in cases involving larger or more complex defects. Overall, the observed disparity in

graft usage underscores the greater complexity and material requirements associated with the multilayer technique. **(Bailey & Le, 2023; Kassam et al., 2005; Kim et al., 2021; Uz et al., 2020)**.

In this study, Comparison between group (A) and group (B) regarding postoperative outcomes revealed no significant differences in all parameters. Postoperative shunt placement occurred in 4% of group A and 4% of group B, no statistically significant difference was observed between both groups as regard to the outcomes measured. (P >0.999).The incidence of postoperative revision of endoscopic repair was 0% in group A compared to 4% in group B, demonstrating a non-significant difference (P =0.312). Recurrence occurred in only one case in Group B, which was among the spontaneous cases. The initial repair was performed using a multi-layer technique, and the revision surgery—also utilizing a multi-layer repair—was successful in preventing cerebrospinal fluid (CSF) leakage. These results are also in agreement with **Hegazy et al.,(2000)**, their study suggested that size, site, and cause of the defect, as well as the placement and type of material used during the repair, do not seem to influence the outcome as long as the repair is performed using sound surgical principles. Also these results can be supported with **(Chaskes et al., 2020)** who reported that patients with an intraoperative CSF leak can be safely and effectively repaired using only a simple and single layer reconstruction with an inlay graft of synthetic dural substitute and dural sealant glue without the addition of packing or lumbar drainage. Also these findings are consistent with those of **Saafan et al. (2014),** in which forty patients with CSF rhinorrhea were treated endoscopically with two layers of facia lata (underlay and onlay) separated by a layer of septal cartilage or conchal bone (sandwich approach) for healing. They obtained a 95% success rate in controlling CSF leaks in 40 patients on the first try repair and a 100% success rate on the second attempt repair.

In this study, the defect size ranged from 1 to 4.99 mm in 96% of cases in Group A and 80% of cases in Group B. Additionally, cerebrospinal fluid (CSF) pressure was normal in all cases associated with traumatic or neoplastic etiologies, as well as in 10 cases with spontaneous etiology. These factors likely contributed to the absence of significant differences between the two groups regarding clinical outcomes and postoperative complications. Furthermore, the decision not to use a nasoseptal flap may have been influenced by the relatively small defect sizes and the normal CSF pressures observed in both groups, as smaller defects may not require the added reinforcement provided by a nasoseptal flap. Additionally, surgeon preference and experience play a crucial role in surgical decision-making; some surgeons may opt for simpler grafting techniques based on their expertise and familiarity with specific repair methods, which could explain the lack of nasoseptal flap usage in this study.

Conclusion

Endoscopic techniques are the preferred approach to repair skull base defects. It offers better lightening, magnification and visualization. The surgeons can use several techniques as single layer graft or multilayer graft, but no

difference between these techniques in the outcome, complications or CSF leak recurrence.

Abbreviations: CSF: cerebrospinal fluid; ICP: intracranial pressure; CT: computed tomograghy; MRI: magnetic resonance imaging; BBB: blood brain barrier

Competing interests

The authors have declared that they have no conflicts of interest relevant to the content of this study.

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