ENDOSCOPIC REPAIR OF CEREBROSPINAL FLUID (CSF)RHINORRHEA WITH MULTILAYER GRAFTS

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ABSTRACT

Introduction

Endoscopic repair of Cerebrospinal fluid (CSF) rhinorrhea has been the most popular and the most accepted among the Otorhinolaryngologists. The advancement in the endoscopes enable surgeons to manage cerebrospinal fluid rhinorrhea adequately with good result.

Objective

The aim of this study was to evaluate the outcome of endoscopic CSF rhinorrhea repair with multilayer grafts. Outcome was identified in terms of postoperative complications like infection (mainly meningitis), nasal bleeding, graft failure and CSF leak, revision surgery.

Methodology

A retrospective prospective study was conducted in 21 patients who had undergone endoscopic CSF rhinorrhea repair with use of multilayer grafts in a period of January 2016 to December 2018 in Department of ENT and Head and Neck Surgery in MAA ENT HOSPITAL, HYDERABAD, INDIA**.** All the patients were diagnosed according to history, clinical examination, diagnostic nasal endoscopy, CSF fluid analysis and radiological investigation. The materials used for the repair of CSF rhinorrhea were surgicel, temporalis fascia, conchal chondroperichrondrium, middle turbinate free mucoperiosteum graft, thigh fat and fascia lata. The follow up period of patients range from 14-44months. The outcome of endoscopic CSF repair with use of multilayer grafts was evaluated by electronic records regarding recurrence of CSF rhinorrhea post-surgery, hospital admission, revision surgery and digital record of rigid endoscopic findings for the status of graft uptake and CSF leak.

Results

In all patients, CSF leak was successfully repaired with use of multilayer grafts in first attempt without any complication. There was female predominance with male to female ratio of 1:6.The mean age of presentation was 43.09years. All 21 patients were presented with spontaneous CSF leak with unknown cause. In 21 patients only one patient presented with bilateral cerebrospinal fluid leak. Cribri form plate was the commonest site of defect in which defect medial to middle turbinate was the commonest followed by ethmoid roof and lateral wall of sphenoid. None of the patients developed meningitis after surgery. None of the patients required lumbar drain. None of the patients presented with cerebrospinal fluid rhinorrhea postoperatively.

Conclusions

Endoscopic repair of Cerebrospinal fluid rhinorrhea with the use of multilayer grafts is the safer and effective method with good outcome.

KEY WORDS

Cerebrospinal fluid rhinorrhea, endoscopic repair, multilayer grafts

INTRODUCTION

Cerebrospinal fluid (CSF) rhinorrhea is a leakage of CSF as a result of a breakdown of the barrier separating subarachnoid space with the sinonasal cavity following defect in the skull base. The usual symptom is clear watery nasal drainage coming from either side of the nose or both sides. The drainage often aggravates upon bending forward or with strenuous activity.

In 1682, CSF rhinorrhea was first described by Willis and later in 1826, Miller was the first to publish non traumatic CSF rhinorrhea high pressure type due to hydrocephalus, followed by King in 1834 and Thomson in 1899 respectively.[1] Dandy first performed transcranial repair of CSF leak in 1926. Until 1948, the transnasal approach to this problem was limited to cauterization when Dohlman described a transnasal-transethamoid approach that could seal off leak through the cribriform plate with a septal and middle turbinate flap.[2] Hirsch (1952) reported transnasal sphenoid leak repair with septal flap and later demonstrated by Vrabec and Hallberg (1964).[3] In the past CSF rhinorrhea has been taken care surgically by the neurosurgeon. Now with the detail understanding of the anatomy and advancement in endoscopic sinus surgery and advancement in instrumentation, Wigand completed the first successful endoscopic CSF leak repair in 1981.[4,5]

Transnasal endoscopic repair widely gained popularity with success rates varying between 60% and 100%, averaging around 90% to 95 % and with very less morbidity as it is more precise with good magnification, vision and enhanced illumination and more precise in placement of the graft with various angled endoscope.[3,4,6-9] Endoscopic endonasal approach to repair of CSF rhinorrhea has become the common practice in skull base surgery with high success rate with low morbidity in comparison to open craniotomy as it carries high morbidity with risks of anosmia, brain retraction, hematoma, seizure, edema, haemorrhage.[6,10-13]

Etiology of CSF leak is classified into non-traumatic and traumatic. Non-traumatic cause includes spontaneous without identifiable cause or congenital and by intracranial or skull base tumors causing skull base erosion.[6,14] Traumatic cause is more common and can be iatrogenic too. Untreated CSF leaks can represent a potentially life-threatening situation leading to intracranial infection, stroke and death. Thus, timely diagnosis and intervention is required to minimize the risk.

There are various techniques and use of different graft materials are described in different literatures for the reconstruction of skull base defect depending upon the location and size. Different autologous graft materials like temporalis fascia, conchal chondroperichondrium, free mucoperiosteal graft of middle turbinate, fascia lata, fat and vascularized pedicle graft. Surgeons have described single or multilayer grafts accordingly to their preference and experience. The techniques of placement of the graft may be underlay, overlay or partial underlay.

The aim of this study was to evaluate the outcome of endoscopic CSF rhinorrhea repair with multilayer grafts. The outcome of endoscopic CSF repair with use of multilayer grafts was evaluated by electronic records regarding recurrence of CSF rhinorrhea post-surgery, hospital readmission, revision surgery and follow up digital records of rigid endoscopic findings for the status of graft uptake and CSF leak.

METHODOLOGY

A retrospective prospective study was done in department of Otorhinolaryngology, Head and Neck Surgery at MAA ENT HOSPITAL, Hyderabad, India. Twenty-one patients who had undergone endoscopic CSF rhinorrhea repair with use of multilayer grafts in a period of January 2016 to December 2018 in Department of ENT and Head and Neck Surgery at MAA ENT Hospital, Hyderabad, India were enrolled in this study. Ethical clearance was obtained from ethical review committee. The inclusion criteria were primarily diagnosed cases of CSF rhinorrhea who had undergone endoscopic CSF rhinorrhea repair with multilayer grafts and exclusion criteria were patients who had undergone previous surgical intervention or history of recurrent CSF rhinorrhea after surgical intervention. Electronic medical records were reviewed to obtain the following data: age, gender, co morbidities, previous history of sinus or skull base surgery, clinical presentation, site of skull base defect, history of trauma, length of stay, peri- and postoperative morbidity, need for secondary repair for management of CSF leak and clinical follow-up. The electronic medical data were also evaluated for duration of onset, site, past history of trauma, history of previous nasal surgery to determine the onset and duration of symptoms to rule out possible etiological factors. Digital photographs of nasal endoscopic findings and CSF analysis findings were also studied. High resolution computed tomography (HRCT) of nose and paranasal sinuses done with 1mm thickness with navigation protocol and CT cisternography and MRI brain and nose and paranasal sinuses were evaluated to study the location and size of defect. We observed that all the patients had ophthalmological consultation prior to surgery mainly for fundoscopy evaluation. Informed consent was taken in all the patients prior to surgery. All the surgeries were done by experienced senior ENT- Head and Neck Surgeons.

a)

b)

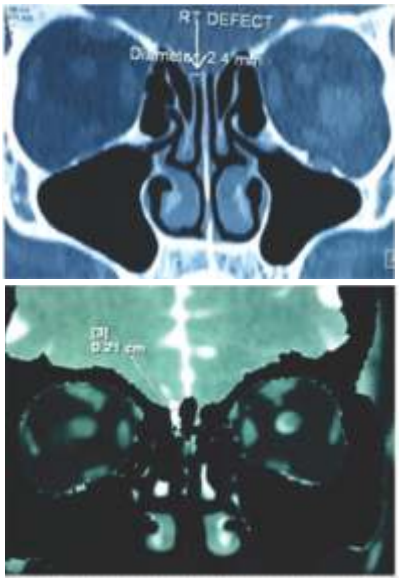

Figure 1: (a) Plain HRCT nose and paranasal sinuses coronal view showing defect in right cribriform plate and (b) C T cisternography showing defect in right cribriform plate

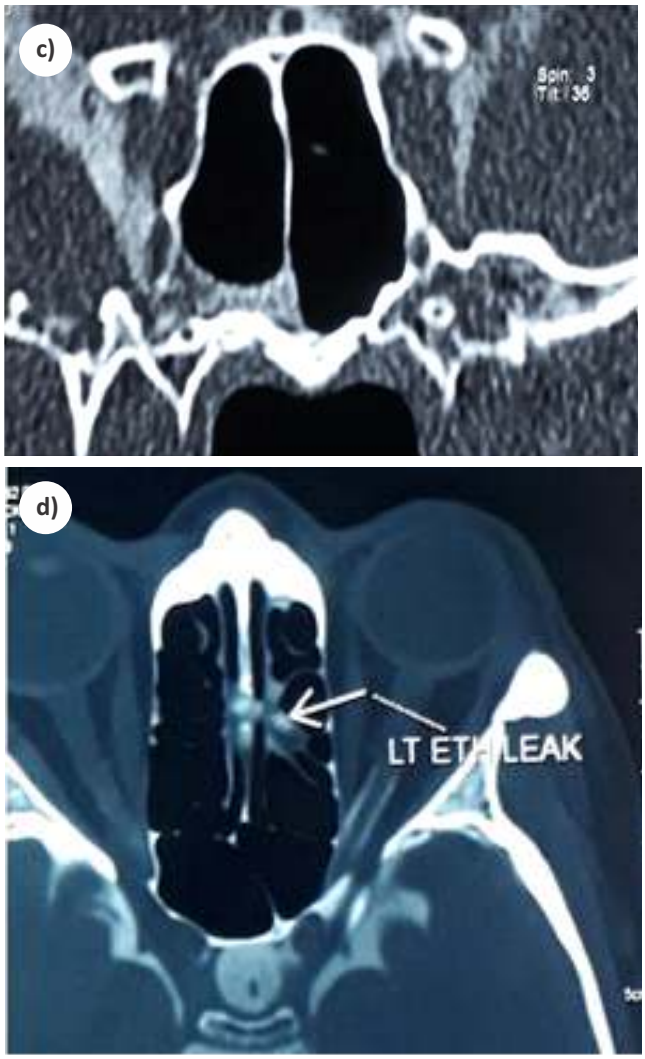

Figure 2: (c) HRCT nose and paranasal sinuses showing defect in the right anterior and inferior aspect of the lateral wall of sphenoid and (d) HRCT nose and paranasal sinuses axial view showing defect in the left roof of ethmoid.

Surgical procedure notes were studied: Equipment used were Karl storz telescopes of 0; 30; 70 degrees; Xomed Soft Tissue Debrider with disposable blades Straight Tricut and Rad 40 & Rad 60 curved blade. Medtronic Fusion–Electromagnetic ENT navigation system. All the patients had undergone surgery under general anesthesia with endotracheal intubation. All the surgeries were done with TIVA (total intravenous anesthesia)to provide bloodless field. Graft materials, temporalis fascia and conchal cartilage with perichondrium were harvested from right post aural incision and fascia lata from the lateral side of left thigh, thigh fat was harvested according to the plan for the repair site of defect. Two percent xylocaine nasal infiltration was given in the site of CSF rhinorrhea. Partial Middle turbinate resection was done on the ipsilateral site of leak and the free mucoperiosteum graft from the partially resected middle turbinate was harvested and its mucosal side was marked with methylene blue so that the mucosal side would be outside while placing the graft. Figure 5 (f) Site, size and number of defects were noted. The extend of the surgery was depended upon the site and size of defect. When the cribriform leak was present. Cribriform plate consists of a medial and a lateral lamella. Middle turbinate was taken as a landmark. If the defect was medial to middle turbinate then middle turbinate was lateralized and if it was lateral to middle turbinate then it was medialized. Uncinectomy was done with microdebrider. Natural ostium of maxillary sinus identified and enlarged at expense of posterior frontonella. Bulla ethmoidalis opened. Anterior ethmoidal cells removed. Ground lamella opened anteriorly, inferiorly and medially. Posterior ethmoidal cells opened. Sphenoid sinus was approached by intermediate approach & sphenoid ostium was widened. The Agger Nasi cell and frontal recess cells were opened, frontal recess surgery was performed depending upon the site of leak. Meningeal sac and defect were identified. Bipolar cautery was applied to cauterize the herniated arachnoid or duramater through a bony defect and graft bed was prepared by removing the mucosa of approximate 5-7 mm surrounding the defect and area was made raw. Size of the defects were measured. Surgicel was first placed to prevent intracranial bleeding. Graft material was prepared. Bony defect repaired by using underlay, overlay or partly underlay technique according to the intra operative situation using surgicel, fat, temporalis fascia, conchalchondroperichondrial graft, free mucoperiosteal graft of middle turbinate, fat or fascia lata were used accordingly. After this Valsalva maneuver was performed to confirm tight seal or any leakage. If there were no signs of leak, then graft was supported by gel foam.

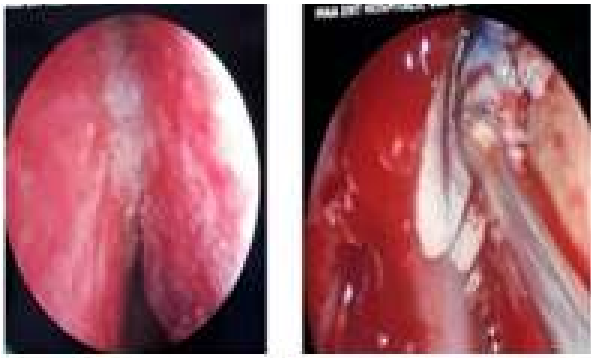

Figure 5: (e) endoscopic detection of cribriform defect and (f) middle turbinate mucoperiosteum graft with mucosal surface stained with methylene blue

Fibrin glue was not used in none of the cases. Finally, nose was packed with antibiotic impregnated ribbon gauze. Patient was advised to avoid bending down, avoid cleaning and nose blowing, cough, avoid constipation and heavy weightlifting. After surgery all the patients were given prophylactic intravenous antibiotic, antitussive, stool softener and acetazolamide with potassium supplement for 10 days. The antibiotic impregnated ribbon gauze nasal pack was removed on fifth postoperative day under general anesthesia and post aural or thigh sutures were removed on tenth postoperative day. CSF lumbar drain was not kept in none of the patients.

76.19 % (16) patients were discharged on fifth postoperative day after the removal of nasal pack and follow up were on tenth postoperative day. 23.80% stayed in hospital for 10

days because their home was too far from the hospital and also due to financial constrain of staying in hotels and were discharged on tenth postoperative day after suture removal from thigh or post aural graft harvested site. Subsequent follow up were on 2 weeks of postoperative day then sixth week, twelve-week, sixth month and one yearly. Rigid nasal endoscopic findings with digital photographic records of all patients were reassessed to evaluate the graft uptake on subsequent visit from sixth week postoperative day onward.

RESULTS

The current study was carried out in 21 patients; there was female predominance with female to male ratio of 6:1.

Table- 1: Gender distribution
There was 85.71% male and 14.28% male

Gender	Number	%
Male	3	14.28
Female	18	85.71
total	21	100

The age of patients ranged from 18 – 68 years. The mean age of presentation was 43.09 years

Table-2: Age group
There was 85.71% male and 14.28% male

Age group	Number of patients
11-20	1
21-30	1
31-40	3
41-50	12
51-60	3
61-70	1

All the patients presented with continuous to intermittent watery nasal discharge which was aggravated more while bending forward. The time of presentation in outpatients varied from 10 days to 3 months. None of the patients had history of trauma. The cause of CSF leaks was idiopathic. Nasal discharge for CSF analysis were sent and noticed positive in all the cases. All the patients had positive CT scan nose and paranasal sinuses and CT cisternography finding to help know the site and size of defect.

The maximum number of patients had right sided defect, only one patient had bilateral side involvement and 7 patients presented with left side rhinorrhea. So, the total number of defects was 22.

Table-3 : Showing cribriform plate defect

Side cribriform plate	Number	side
Unilateral Right-side (Rt)	11	Right (Rt)
Unilateral Left side(lt)	7	Left (Lt)
Rt +Lt	1 +1	bilateral
total	20	Rt: 18, bilateral:1+1

Total cribri form defect was 20 in which 11 were on right side, 7 on left and only 1 on both side in that also 19 were medial to middle turbinate and 1 was lateral to middle turbinate

Table-4: Showing Anatomical Site

Anatomical site	Number of defects	Percentage (%)
Cribriform plate	20(Rt +Lt)	90.90%
Roof of ethmoid	1(Lt)	4.54%
Lateral wall of sphenoid	1(rt)	4.54%
Total number	22	100%

Table 5: Depending upon location of side of defect

Location of defect	RIGHT (Rt)	LEFT (lt)	BILATERAL (Rt + lt)
Cribriform plate	11	7	1+1
Lateral wall of sphenoid	1		
Roof of ethmoid		1	
Total	**12**	**8**	**2**

The site of defect was maximum in cribri form plate.

Table-6: Shows anatomical site, size of defect, use of different graft material, graft placement, follow up and success rate

S.No.	Anatomical site of leak	Size of defect (mm)	Graft material	Placement of graft	FOLLOW UP in months	success
1	Right (Rt) CP medial to MT(M-MT)	8X3	S+TF+CP+MP	UL	44	100%
2	Left (Lt.) CP M-MT	3X4	S+TF+CP+MP	PUL	43	100%
3	Rt. CP M-MT	4X3	S+TF+CP+MP	PUL	43	100%
4	Lt. CP M-MT	5X6	S+TF+CP+MP	UL	43	100%
5	Rt. and Lt. CP M-MT	7X9,1X1	S+FL+S+FL in (Rt+Lt)	PUL	42	100%
6	Lt. CP M-MT	5X3	S+TF+CP+MP	PUL	40	100%
7	Lt. CP M-MT	1X1	S+TF+MP	OL	29	100%
8	Rt. roof of ethmoid	2X2	S+TF+CP+MP	PUL	29	100%
9	Lt. CP L-MT,	6X5	S+TF +MP	OL	25	100%
10	Rt. CP M-MT	2X3	S+TF+MP	OL	25	100%
11	Rt. CP M-MT	2X3	S+TF+MP	OL	23	100%
12	Rt. CP M-MT	8X3	S+TF+CP+MP	UL	23	100%
13	Rt. CP M-MT	4X3	S+TF+CP+MP	PUL	23	100%
14	Rt. lateral wall of sphenoid	3X5	S+FAT+FL+S	PUL	22	100%
15	Lt. CP M-MT	1X1	S+FAT+FL	OL	21	100%
16	Rt. CP M-MT	8X3	S+TF+CP+MP	PUL	18	100%
17	Rt.CP M-MT	4x2	S+TF+CP+MP	UL	17	100%
18	Lt. CP M-MT	15X3	S+TF+CP+MP	PUL	16	100%
19	Rt. CP M-MT	5X3	S+Fat+FL	OL	15	100%
20	Rt. CP M-MT	2.5X2	S+TF+CP +MP	UL	15	100%
21	Lt. CP M-MT	15X10	S+TF+CP+MP	PUL	14	100%

Different graft materials were used during the repair: surgicel(S), fat(F), Temporalis fascia (TF), conchal-chondroperichondrial graft (CP), free mucoperiosteal graft of middle turbinate (MP), Fascia Lata (FL).The placement of the graft was underlay (UL), partly underlay (PUL)and overlay (OL).

The commonest site of defect was cribriform plate followed by lateral wall of sphenoid and roof of ethmoid.

Different graft materials were used during the repair: surgicel(S), fat(F), Temporalis fascia (TF), conchal chondroperichondrial graft (CP), free mucoperiosteal graft of middle turbinate (MP), Fascia Lata (FL). The placement of the graft was underlay (UL), partly underlay (PUL)and overlay (OL). Laterality wise 12(54.54%) on right side, 8(36.36%) on left and one (4.54%) on both (right and left)

side. Total of 22 defects were noted. Out of 22 defects, 20 (90.90%) defects were in cribriform plate, in that also 19 (95%) were medial to middle turbinate and only one (5%) was lateral to middle turbinate. 4.54% one on roof of ethmoid and 4.54 %one in lateral wall of sphenoid.

In all cases the cause of CSF rhinorrhea was nontraumatic and idiopathic. The size of the defect ranged from 1mm to 15mm.All the defects were repaired with multilayer grafts. None of the patients received lumbar drain.

There was no major intra or post-operative complications.

The duration of hospital stays ranged from 5- 10 days. Most of the patients were discharged on fifth postoperative day after the removal of nasal pack. 76.19 % (16) patients were discharged on fifth postoperative day after the removal of nasal pack and follow up were on tenth postoperative day.23.80 % stayed in hospital for 10 days because their home was too far from the hospital and also due financial constrain were discharged on tenth postoperative day after suture removal from thigh or post aural graft harvested site. The follow up duration ranged from 14 months to 44months with 100% success rate.

Figure 6: Follow up endoscopic picture of patient of 43 months of surgery.

DISCUSSION

In the present study we experienced female predominance of 85.71% being more than forty years of age with mean age of 43.09 years.Kim et all found 100% female.[15] Middle aged females are more prone to CSF rhinorrhea. These leaks are may be associated with benign intra-cranial hypertension. The raised intra-cranial pressure is due to poor CSF resorption by the arachnoid villi.[16,17] The continuous rise in pressure weakens and thin the skull base causing CSF leak.

In our study the etiology of CSF rhinorrhea was unknown and none of them had previous history of trauma and surgery, comparable to study done by Deendayal et al.[18] Correct diagnosis of the site of leak is very crucial in management and outcome of the surgical repair. Imaging modalities with high resolution CT scan, MRI and CT-cisternography play important role.[19] CT -cisternography has a success rate of 87%.[20]

In our observation right sided leak were more compare to left side. In a study performed by Mishra et al, left side is more in traumatic CSF rhinorrhea.[21]

In the present study cribriform plate (90.90%) was the commonest site of defect which was similarto the work done by Kirtane et al and Deendayal et al.[18,20,22] However in other literatures anterior spontaneous CSF leak cribriform plate and lateral sphenoid sinus were demonstrated to be the commonest site. However, one study noted the posterior table of the frontal sinus as the most common site of spontaneous CSF leak.[17] The site of defect was identified prior to the surgery by doing high resolution Ct scan and CT-cisternography and studies have shown that even just plain high resolution CT scan has sensitivity of 92 % and a specificity of 100%.[23,24]

The literatures have given hypothesis about congenital defects of cribriform plate, bone erosion by CSF pressure, waves and focal atrophy of the olfactory nerves.[25,26] In our observation cause of CSF rhinorrhea was idiopathic. Literature showed that different factors for cause of spontaneous leak like change in cerebrospinal fluid pressure sneezing coughing can cause raise in intracranial pressure.[3]

Studies have shown use of different types of autologous and synthetic graft material. Autologous graft materials have been found to be easy to access without donor site morbidity and harvest with greater uptake rate. In the present study, multilayer grafts were used. Wig and et al were the first to use free tissue graft.[5] Use of multilayer grafts found to be useful providing strength and reinforcement in repair of defect. Out of 22 defect 59.09% received multilayer grafts in sequence of first layer-surgicel, second layer-temporalis fascia, third layer- conchal perichondrial graft, fourth layer-mucoperiosteal graft of middle turbinate supported by gel foam all around.18.18% received in the sequence of 3 layer graft surgicel, temporalis fascia and mucoperiosteal graft.9.09% received in sequence of surgicel,fat and fascia lata. 9.09 % in sequence of surgicel, fascia lata, surgicel and fascia lata. 4.54% received grafts in a sequence of surgicel, fat, fascia lata and surgicel. The success rate of graft uptake was found to be 100 %. In a meta-analysis done by Hagazy et al[6]and Richard encountered that use of multilayer free grafts in repair skull base defects of less than 1cm have success rate of >90% but in our work the defect size varies from 1mm to 15mm with 100% success rate with the use of multilayer graft.[27] Oskar Hirsch in 1952 was the first to described pedicled nasoseptal flap and later in 2006.[28]

Burns et al and Marks et al used free of middle turbinate with success rates of 83% (35/42) and 94% (16/17), respectively.[29,30] Lanza et al in 1996 used mucoperichondrial and/or mucoperiosteal free grafts with a success rate of 89% (32/36).[31] Hadad-Bassagasteguy reintroduced as the Hadad-Bassagasteguy flap for repair of large skull base defects.[32]

In various literatures mentioned free tissue graft were the common material used in repair of CSF rhinorrhea.[3] In a study performed by Elmorsy and Khafagy demonstrated use of septal graft and a middle turbinate rotational flap in 31 patients with spontaneous CSF rhinorrhea. There was

success of 87.1% in first surgery. There was need of revision surgery in 4 patients and out of 4, one required shunt procedure with overall success rate of 93.5 %.[29] Multilayer repair techniques using different tissue materials were described in literature.[6,7,21,23,33]

In our study fibrin glue was not used during skull base repair and the result was not compromised. Efficacy of use of fibrin is still controversial. Nishihira et al suggested optimal use of fibrin glue in repair of skull base defect and found fibrin glue is effective in small defect in suture line but in large defect autologous tissue should be used in conjunction to tissue glue.[34] Sataywadi Mohindra et al reported no significant difference in endoscopic repair with and without fibrin glue and noted that CSF leak repair without use of fibrin is more cost-effective. There was a 100% success rate in non-fibrin glue used group in contradictory to fibrin used group.[35,36]

Indication of lumbar drain (LD) in postoperative period was not clearly defined in the literatures and use of lumbar drain depends upon the surgeon's preference. This is evident in our study that none had undergone lumbar drain and this had not affected our outcome. Similarly, one randomized study of anterior skull base repairs has showed that the use of LD postoperatively for anterior skull base repairs does not significantly decrease the recurrence rate of CSF leak.[37] Deenadayal et al et al. showed that 7 patients with CSF leak were repaired with lumbar drain placement, fascia lata underlay, and 2 layers of fascia lata overlays, gel foam and found no failures after primary surgery with a mean follow-up time of 14.9 months.[18] The follow up period in the present study was 14months to 44 months. However, Natalie Kim-Orden et al study, all the 20 patients received lumbar drain with success 87.1% (27 of 31 patients) in first attempt with a mean follow-up time of 32.4 months. The complication of use of lumbar drain was 12.3%. The complications are persistent lumbar leak, over drainage and retained catheter. It adds financial burden and length of hospital stay.[15,37] A retrospective study by Casiano et al reported that there was greater than 95% success rate in endoscopic repair of CSF rhinorrhea with defect size varied from a micro to 3-cm defects in first attempt without use of lumbar drain.[38]

CONCLUSION

Endoscopic repair of cerebrospinal fluid rhinorrhea with the use of multilayer grafts is the safer and effective method with good outcome.

LIMITATIONS OF THE STUDY

It is a retrospective prospective study with follow up period of 14months to 44 months. Long follow up period will add more information to the outcome with this technique for CSF rhinorrhea repair.

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CONFLICT OF INTEREST

The author declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

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