RECONSTRUCTION OF LARGE ANTERIOR SKULL BASE DEFECTS AFTER RESECTION OF SINONASAL TUMORS WITH INTRACRANIAL EXTENSION BY USING PEDICLED DOUBLE FLAP TECHNIQUES

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ABSTRACT

Background: Surgical resection of a large anterior skull base (ASB) tumor and sinonasal maglinancies with intracranial extension will result a large skull base defect. Reconstruction of large ASB defects by using traditional techniques may result in high risk of postoperative CSF leakage, meningitis and increase mortality rate. The use of pedicled double flap technique to reconstruct the anterior skull base defect may decrease the complications. In this study, we examine the clinical outcomes of patients who underwent this double flap reconstruction technique after the resection of sinonasal malignancies with significant intracranial extension at Cho Ray hospital, Vietnam. **Methods:** Case series study was conducted at Cho Ray hospital from 09/2010 to 09/2020. All patients with large sinonasal malignancies with intracranial invasion underwent combined transbasal - EEA approach. Reconstruction of large skull base defect (> 2 cm) was followed by using the pedicled double flap technique. **Results:** There were 75 patients who underwent the modified multi-layer with double flap reconstruction technique after the resection of ASB tumor from 09/2010 to 09/2020. The skull base defects were commonly seen at the horizontal plate of the ethmoid and the roof of the ethmoid (98.6%). The large skull base defects (> 2cm) accounted for 81.3%. The risk of postoperative CSF leakage after double flap repair was very low. In this study, we had 1 patient with postoperative CSF leakage and 1 patient had postoperative meningitis. **Conclusion:** The use of two vascularize pedicled flap may decrease the incidence of postoperative cerebral spinal fluid (CSF) leakage and meningitis. This technique is an effective method for the reconstruction of the ASB with large defect.

Keywords: *Modified reconstruction of skull base, reconstruction of large anterior skull base defect, reconstruction by using pedicled double flap, multilayer reconstruction for skull base defect.*

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I. INTRODUCTION:

Reconstruction of the large asb defect plays an important role to achieve success in skull base surgery. A large skull base defects was formed after the resection of asb and sinonasal tumors with significant intracranial extension. The reconstruction created a watertight barrier between paranasal sinuses and the intracranial space, precluding the intracranial infection, csf leakage and brain herniation. Repairing the skull base by using the traditional techniques associated with a low success rate and the incidence of csf leakage was 20% - 30% [8]. We apply pedicled double flap for the reconstruction of the asb defect for the first time at cho ray hospital.

II. METHODS:

Methods: We conducted case series study on all patients who underwent the double flap reconstruction technique after resection sinonasal tumors with significant intracranial extension through a combined EES and transbasal approach from 09/2010 till

09/2020 at Cho Ray Hospital. Approval for the study was obtained from the Institutional Review Board of our medical center from 03/2014.

Subjects: All of the patients were performed clinical examination, CT/ MRI and histopathology were studied. Prior to the surgery, consultation with neurosurgeon, radiologist was carried out to evaluate the lesion, planning the treatment and method of reconstruction of skull base. (multilayer reconstruction for skull base defect by using pedicled double flap technique).

Follow - up:

- Merocel or balloon catherter was left for 4 day after the surgery to stabilize the flap inside the nasal cavity. Patietns were followed up for 2 weeks after the operation to assess the condition of the flap and clean up the sinus and nasal cavity.

- A follow up schedule: patients had follow-up every 2 months during the first year. After the second year, patients had follow up every 3 - 6 months depending on the patient's conditions. Assessing the condition of the nasal septum mucosa, the flaps and wound healing.

III. RESULTS:

All 75 patients had the double flap reconstruction technique after resection sinonasal tumors with significant intracranial extension through a combined EES and transbasal approach. The results were following:

Table 1: Site of the skull base defect

Site of the defect	No.	Percentage
Roof of the anterior ethmoid & horizontal plate of the ethmoid	**49**	**65,3%**
Roof the ethmoidal bone & sphenoid bone	**25**	**33,3%**
Sella	1	1,4%

The defects commonly found at the roof of Roof of the anterior ethmoid & horizontal plate of the ethmoid (center of the anterior skull base), accounted for 98.6%

Table 2: Size of the skull base defect

Size of defects	Malignancies (n=59)	Benigns (n=16)	total (n=75)	
≤ 2 cm	11 (18,6%)	3 (18,8%)	14 (18,7%)	
> 2 cm	**48 (81,4%)**	**13 (81,2%)**	61 (81,3%)	
Mean ± SD	**2,2 ± 0,9**	**1.9 ± 0.8**	**2,1 ± 0,7 [1 - 3]**	0,68 T-test

Most of the skull base defects are greater than 2 cm, accounted for 81.3%

Table 3: Postoperative complications

Complications	Malignancies (n=16)	Benigns (n=59)	Frequency (n=75)
None	**14 (87,5%)**	**55 (93,2%)**	**69 (92%)**
Meningitis	0	1 (1,7%)	1 (1,3%)
Flap did not completely cover the defect	1 (6,3)	2 (3,4%)	3 (4%)
Flap covered the anterior surface of sphenoid sinus	0	1 (1,7%)	1 (1,3%)
CSF leakage	1 (6,3%)	0 (0,0)	1 (1,3%)

Most of the cases did not have postoperative CSF leakage and the incidence of not using lumbar drainage was 92%. There was 1 case (1.3%) with large defect after resection of anterior and lateral skull base tumor, patient had posteoperative CSF leakage and lumbar drainage was placed for 2 weeks. One patient had menigitis (1.3%) and was treated with antibiotics. Both two patients felt better after getting the treatment.

IV. DISCUSSION:

Reconstruction of the skull base is still a challenge for ENT surgeon, the incidence of postoperative CSF leakage ranged from 0% to 33% [2],[3],[6],[7]. Many materials, techniques had been recommended to repair the skull base defect, including transnasal endoscopic technique, craniotomy with different materials such as autologous, allogeneic, artificial grafts, or vascularize pedicled flaps [1]. Transnasal endoscopic technique could be utilized to reconstruct small skull base defect (<2cm) with a high success rate of 90% - 97% [3]. However, in case of large skull base defects or defects located at place with high intracranial pressure, the success rate of traditional reconstruction technique was low and the risk of menigitis, brain abscess and mortality rate was high with the rate of CSF leakage was 20% - 30%.

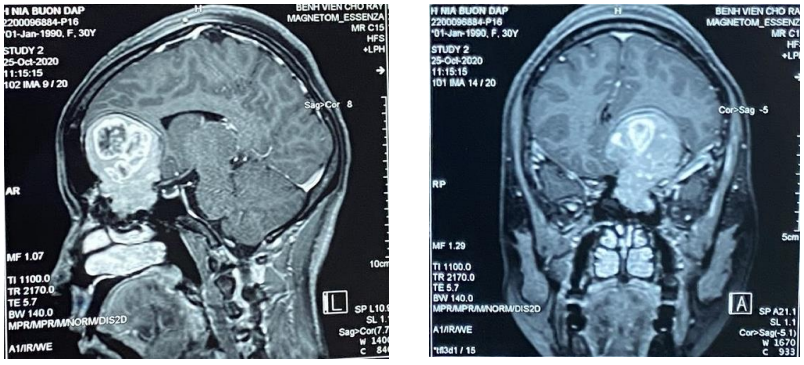


***Figure 1**:* Tumor with intracranial extension

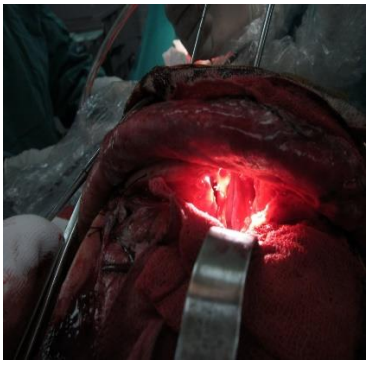


Figure 2: Skull base defect after resection of tumor.

In our study, 75 patients had a combined EES and transbasal approach to resect the sinonasal tumor with significant intracranial extension. After the surgery, the rate of wide anterior skull base defect (>2 cm in anteroposterior direction) was 81.3%. The large ASB defects that extend from the frontal sinus to the planum sphenoidale in the sagittal plane, and from orbit to orbit in the coronal plane, therefore, the horizontal plate of ethmoid, roof of ethmoid, cristal galli and the defective bones of skull base were removed due to the invasion of tumor. To ensure the efficiency of the reconstruction of skull base, we used a multi - layered reconstruction technique with pedicled double flaps that comprised of pericranial flap (PCF), nasoseptal (NSF) flap, temporalis fascia and titanium plate to create a barrier, separating the intracranial space with nasal cavity.

- Multi - layered reconstruction technique with pedicled double flaps**:** [4]

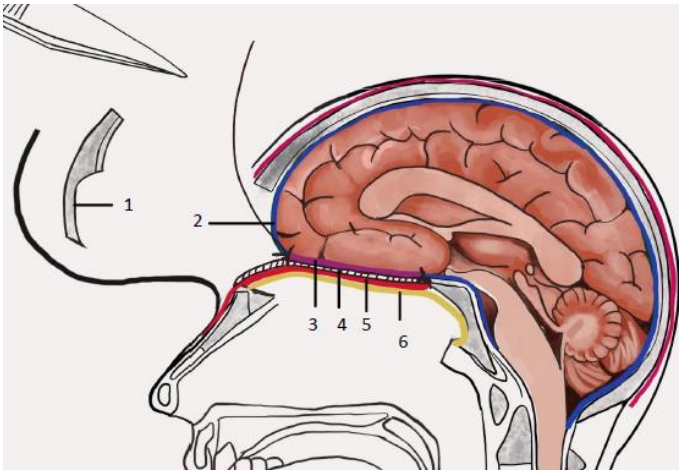


Figure 3: *Illustration (sagittal view) demonstrating the multiple layers reconstruction techniques for repair of large anterior skull base defects: (1) frontal bone flap, (2) dura, (3) temporal fascia , (4) titanium mesh, (5) galeal (pericranial) flap, (6) nasoseptal flap.*

a. First layer: pedicled PCF was havested from the frontal craniotomy, layered the floor of the ASB and overlying the planum sphenoidale. The flap was fixed by biological glue.

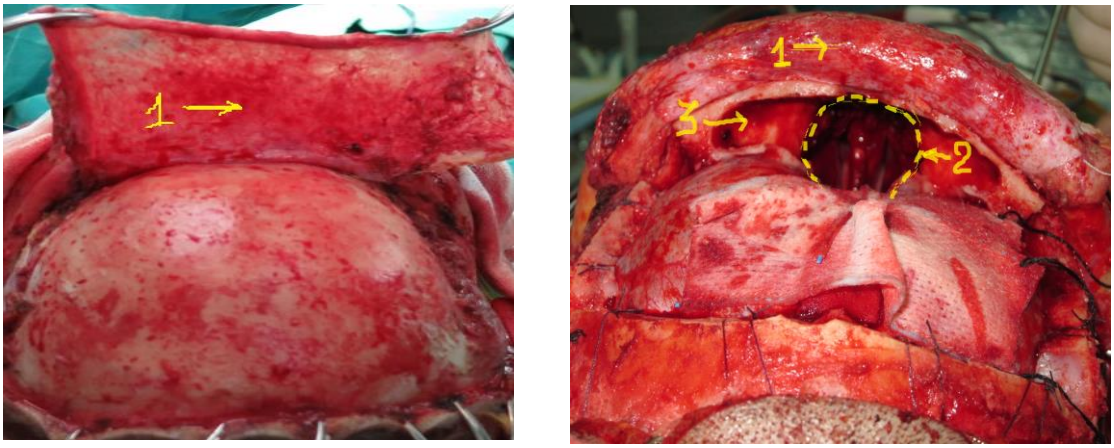


Figure 4: (1) pedicled PCF , (2) large ASB defect connect paranasal sinus with intracranial space, (3) frontal sinus

+ The patient was positioned in the supine position with 15 degrees tilt.

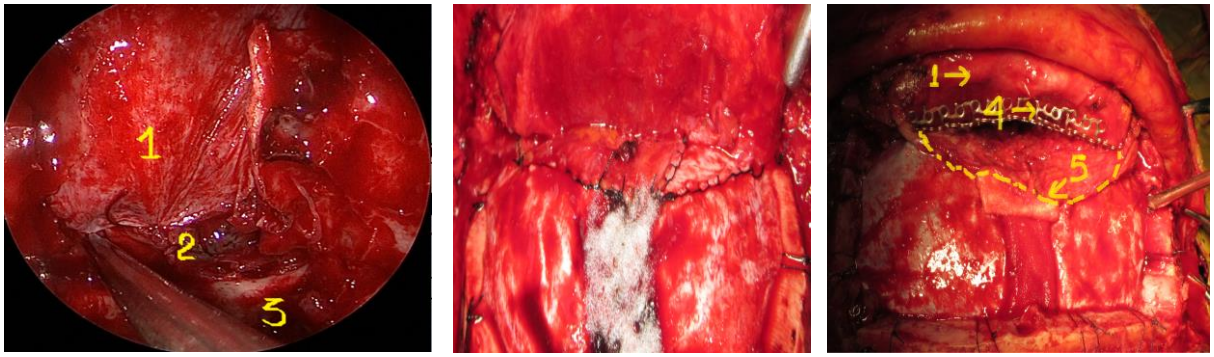
+ Local anesthesia : Adrenalin 1/100.000 mixed with Lidocain 0,5%.

+ Bicoronal scalp incision was placed ear to ear, in front of external ear canal about 1 cm, extending from superior border of the zygomatic arch to the hairline, the scalp flap was reflected anteriorly over the superior orbital rim on both sides to preserve PCF.

+ The PCF is then elevated and reflected anteriorly over the superior orbital rim where it is pedicled.

b. 2nd layer: The titanium mesh layered along the ASB defect, overlying the PCF and fixed with screws to the superior orbital rim to prevent brain herniation.

c. 3rd layer: the meninges invaded by tumor was resected. The meningeal defect was closed by temporalis fascia to avoid contact between the brain and the titanium mesh.



Endoscopic view of the nasal cavity *Superior view (intracranial space)*

Figure 5: Superior view of reconstruction of skull base (1) pedicled PCF overlying the planum sphenoidale, (2) Fixing the PCF to the planum sphenoidale, (3) sphenoid sinus, (4) titanium mesh cover the skull base defect, (5)Suture the temporalis fascia to the meningeal defect

d. 4th layer: the pedicled nasoseptal flap completely covered the ASB defect within the nasal cavity to promote tissues healing and prevent postoperative complications such as CSF leakage and mengitis.

NSF including perichondrium was described by Dr. Hadad and Bassagasteguy in 2006 [6], This flap is fed by the posterior septal artery which is a branch of the sphenopalatine artery to reconstruct the defect after skull base surgery. Pedicled mucosal flap contributes to the success of endoscopic skull base surgery, reducing the risk of postoperative infection and lower the rate of CSF leakge less than 5% [6,8]. Modified pedicled nasoseptal flap technique : prior to the operation, the surgeons could predict the necessity of reconstruction, site and size of the defect, so the harvested flap could be sufficient to cover entire defect of the skull base. In order to increase the size of the NSF for a large defect, we dissected the nasoseptal flap and extend it to the floor of nasal cavity to increase the length and width of the flap.

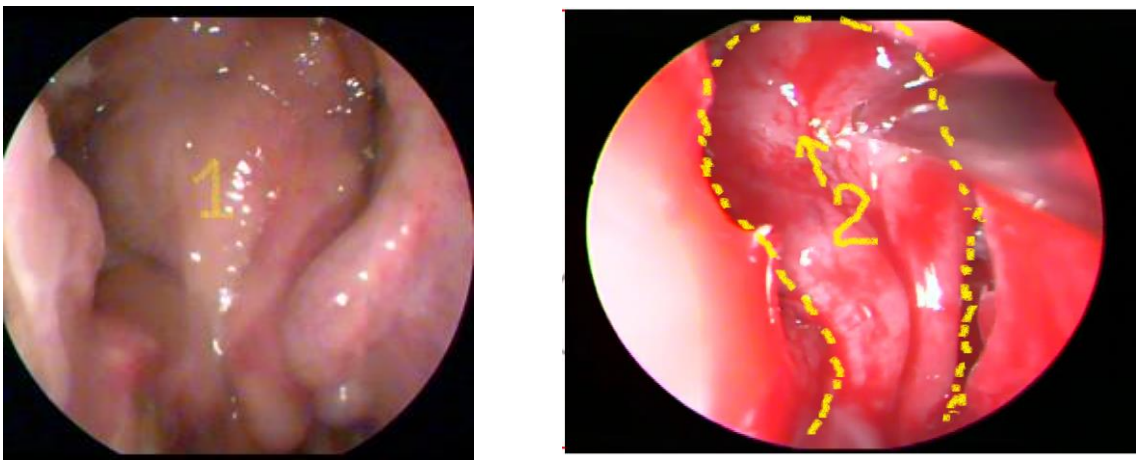


Figure 6: (1) well healed of NSF, (2) pedicle NSF covered the anterior skull base defect

While rotating the NSF, it is important to present its mucosa surface to the exterior, and its perichondrium surface cover the skull base, avoid twisting the pedicle of the flap , because it will casuse mucocele or flap necrosis. Three cases (4%) with incomplete covering of posterior wall of frontal sinus, we used the free flap from conchal mucosa. After 8 - 10 weeks, the flap completely covered the skull base defect. There was 1 case (1.3%) with mucus retention because the pedicle osbtructed the sphenoid ostium, so we had to perform sphenoid sinusostomy for drainage.

The modified multi-layer reconstruction of the skull base has shown good results after surgery. The rate of lumbar drainge was low (1.3%), only 1 case need to have lumbar drainage because of a large defect after resection of anterior and lateral skull base tumor, the time for healing and completely covering the skull base was longer than normal. The patient need an absolute bed rest and lumbar drainage was placed, after 14 days, the CSF rhinorrhea was naturally blocked. Patients were followed up, the NSF healed well, completely covered the defect, and no CSF rhinorrhea was detected. We had 1 case with postoperative mengistis on second day after the surgery, patient had been treated with antibiotics for 2 weeks.

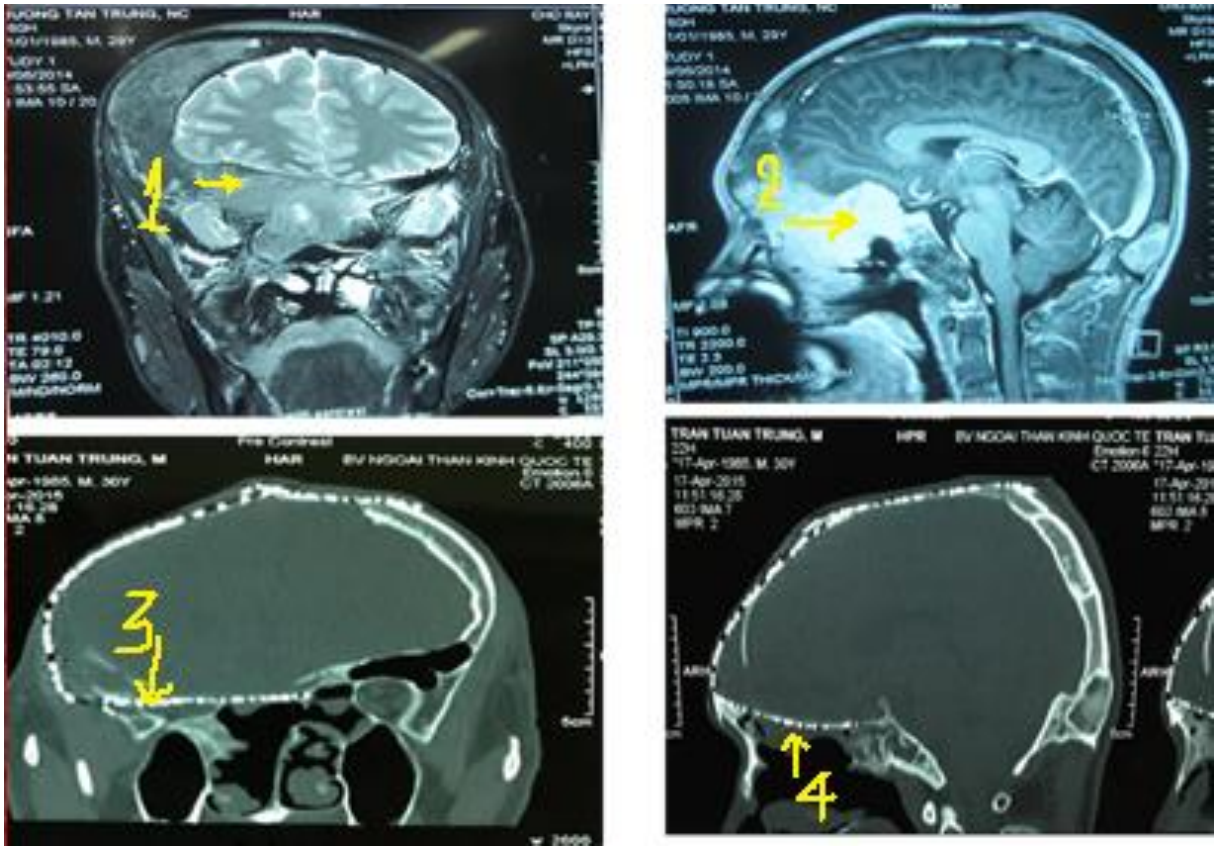


Figure 7: (1) ossifying fibroma invade skull base, sphenoid bone and compress right optic nerve, (2) tumor spread total anterior skull base bone and partial of temporal bone, (3) tumor is completely removed, (4) skull base defect was reconstructed by multiple layer (titanium mesh and 2 pedicle flaps)

Surgical resection of a large sinonasal maglinancies with intracranial extension result a large skull base defect that connect the intracranial space with the nasal cavity. Intraoperative CSF leakage accounts 100% in our study, we had to perform modified muliti-layer with pedicled double flap technique to repair the skull base which significantly decreased the risk of postoperative CSF leakage and meningitis. The reconstruction of the skull base was highly effective in reducing the incidence of postoperative CSF leakage. Thus, the efficacy of modified muliti-layer with pedicled "double flap" for reconstruction of ASB defect was high. This technique is efficient at preventing the CSF leakage and intracranial infection after a large skull base or meninges resection.

IV. CONCLUSION:

The modified muliti-layer with pedicled "double flap" technique for ASB defect can be a safe and effective method for repairing skull base, reducing the risk of postoperative CSF leakage and meningitis... contribute to the success of the skull base surgery. This method is also an effective method to reconstruct a large ASB defect.

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