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Case report

Endoscopic transsphenoidal surgery using pedicle vascularized nasoseptal flap for cholesterol granuloma in petrous apex: A technical note

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ABSTRACT

Background: Compared with surgical resection, endoscopic transsphenoidal surgery (TSS) for cholesterol granuloma (CG) in the petrous apex (PA) is associated with local recurrence due to obstruction of the drainage route. We present a detailed procedure of an endoscopic TSS using pedicle vascularized nasoseptal flap (PVNF).

Methods: A 40-year-old woman with a history of repeated surgery for left tympanitis was referred to our institution. Neurological examination revealed severe hearing loss in the left ear. Radiologic examination presented a round mass in the left PA and significant fluid collection in the mastoid air cells of the left temporal bone. CG was strongly suspected, and endoscopic TSS using PVNF was performed. Prior to endoscopic drainage, a PVNF was harvested from the mucosa of the ipsilateral nasal septum, with an attempt to preserve the sphenopalatine artery in the flap. Following this, puncture and adequate irrigation of the lesion was performed by endoscopic TSS, with neuro-navigation system assistance; the apex of PVNF was then placed into the lesion to prevent the obstruction of the drainage route. An absorbable polyglycolic acid sheet and fibrin glue were applied on the flap to prevent spontaneous deviation from the lesion.

Results: The patient was discharged without any further neurological complications. Eight-month postoperative computed tomography images showed no recurrence; the drainage route was patent and the fluid collection in the left mastoid air cells was resolved. Moreover, hearing loss was improved.

Conclusions: Endoscopic TSS using PVNF may be one of available surgical options for PACG.

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Abbreviations: CG, cholesterol granuloma; CT, computed tomography; MRI, magnetic resonance imaging; PA, petrous apex; PACG, petrous apex cholesterol granuloma; PVNF, pedicle vascularized nasoseptal flap; SPA, sphenopalatine artery; TSS, transsphenoidal surgery.

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1. Introduction

Cholesterol granuloma (CG) in the petrous apex (PA) is a rare and benign neoplasm caused by foreign body giant cell reaction to cholesterol deposits, with associated fibrosis and vascular proliferation [1]. Patients presenting with symptoms, such as dizziness, pressure sensation, tinnitus, hearing loss, otalgia, or headache, are treated by surgery, but the optimal surgical strategy is still controversial [2]. Direct resection using a middle fossa approach would yield relatively few recurrences, but it is quite invasive and has a risk of severe postoperative complications [3–6]. Recently, many reports on endoscopic transsphenoidal surgery (TSS) for PACG drainage have been published [7–26]. Although it is a less invasive approach, the frequency of recurrence is high compared with direct resection. Therefore, the surgery for PACG is aimed at less invasiveness and lower recurrence.

Here, we present the endoscopic TSS for PACG using pedicle vascularized nasoseptal flap (PVNF), with an objective of lower recurrence.

2. Materials and methods

2.1. *Surgical indication for endoscopic TSS*

Preoperative magnetic resonance imaging (MRI) and computed tomography (CT) are quite important to assess whether TSS is suitable, based on the location of the lesion, anatomy of the sphenoid sinus and nasal septum, and the positional relationship between the lesion and normal structures, such as the petrous portion of the internal carotid artery (ICA). If it is difficult to access the lesion by TSS, another approach should be considered.

2.2. *Harvesting of PVNF*

Prior to endoscopic drainage, a PVNF is harvested from the mucosa of the ipsilateral nasal septum, with an attempt to preserve the sphenopalatine artery (SPA), in order to obtain a well-vascularized flap. Doppler blood flow meter is sometimes useful to confirm the route of SPA (Fig. 1A). A strip pedicle flap surrounding the SPA is separated from the nasal septal

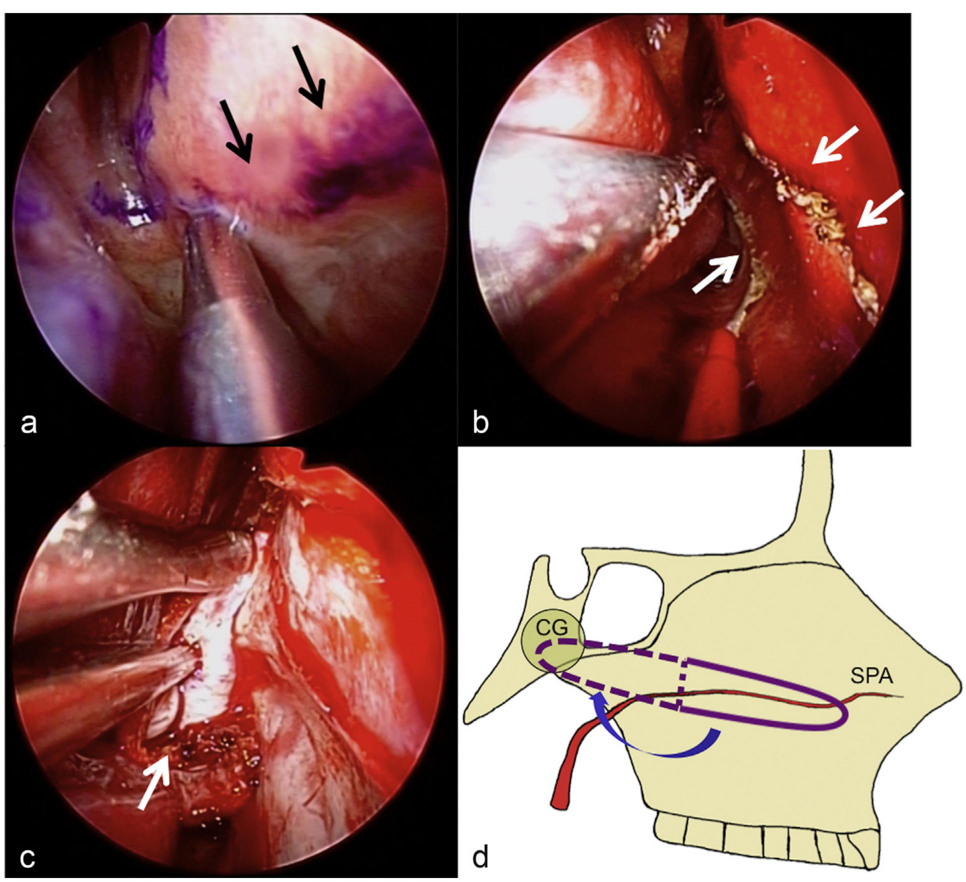

Fig. 1 – (a) Confirming the route of SPA (black arrows) by Doppler blood flow meter. (b) The strip pedicle mucoseptal flap (white arrow) surrounding SPA is trimmed using monopolar scalpel. (c) The flap (white arrow) is dissected from the nasal septum. (d) Schematic image of endoscopic TSS for PACG using PVNF. The pedicle flap surrounding the SPA is placed into the lesion.

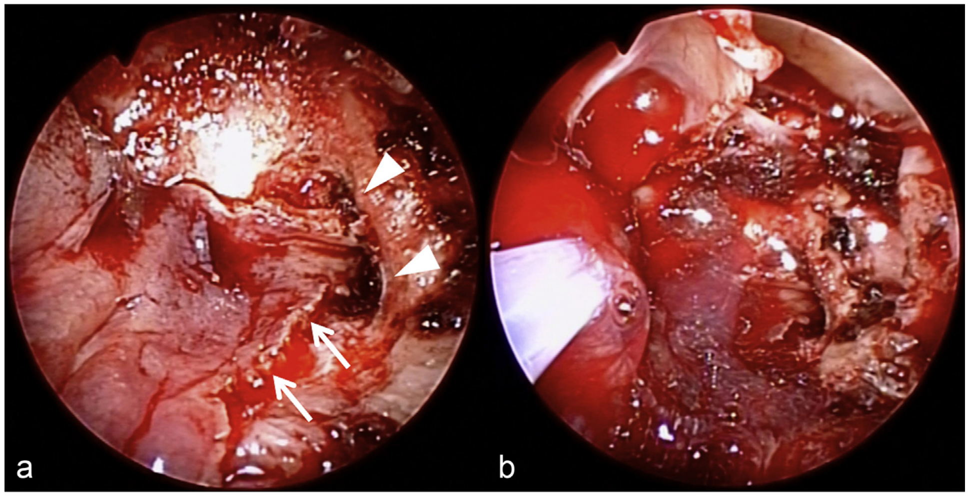

Fig. 2 – (a) After the puncture of CG, the apex of pedicle flap (arrows) is placed into the inner side of CG (arrow heads). (b) Absorbable polyglycolic acid sheet and fibrin glue are applied on the flap.

mucosa using monopolar electric scalpel and dissector (Fig. 1B and C). This flap should be long enough to reach the lesion through the sphenoid sinus. To prevent the damage to the flap from the high-speed drilling during opening of the sphenoid sinus, it is recommended to put the flap in the epipharynx. A schematic image is presented in Fig. 1D.

2.3. *Endoscopic drainage of PACG and placement of PVNF*

After harvesting PVNF, the sphenoid sinus is opened. The anterior wall of the sphenoid sinus should be shaved as wide as possible to obtain a sufficient operating field. It is necessary to confirm the location of the lesion by neuronavigation system if the petrous bone covering CG is not destructed completely and the lesion is not exposed in the sphenoid sinus. Doppler blood flow meter is also useful to identify the route of ICA. Puncture of the lesion should be extended as wide as possible, and the inner side of the lesion should be adequately washed with saline. The apex of PVNF is placed into the lesion with careful attention to avoid twisting of the flap (Fig. 2A). An absorbable polyglycolic acid sheet (Neoveil; Gunze Ltd, Kyoto, Japan) and fibrin glue are applied to fix the flap to prevent its spontaneous deviation (Fig. 2B).

3. Results

3.1. *Illustrative case*

A 40-year-old woman presented with a headache and had undergone repeated tympanostomy for recurrent left tympanitis at another otorhinolaryngology hospital since the age of 20. Neurological examination revealed severe hearing loss in the left ear. MRI revealed a round mass in the apex of the left petrous bone (Fig. 3A–C). The T1- and T2-weighted images showed a high intensity, while the diffusion-weighted images showed a low intensity lesion; these findings were suggestive of a PACG. MRI also revealed fluid collection in the left mastoid air cells. Although a contrast-enhanced CT (Fig. 3D) showed the left ICA to be running just near the lesion, the endoscopic TSS avoiding ICA was deemed possible.

Endoscopic TSS (EndoArm; Olympus, Tokyo, Japan) was performed through the right nasal cavity. PVNF was harvested by the aforementioned procedure and SPA was also preserved in the flap. The wall of CG was confirmed by endoscopic transsphenoidal approach (Fig. 4A). Immediately after puncturing the wall of CG, a brown, turbid fluid came out (Fig. 4B). The internal cavity of the lesion was washed with saline before placing PVNF in it; fibrin glue was used for flap fixation.

The patient had no neurological deficit except for left hearing loss and was discharged on the seventh postoperative day. An 8-month postoperative CT scan (Fig. 5) showed no recurrence of CG; the cavity of CG was covered with regenerated mucosa and the drainage route was patent. Fluid collection in the left mastoid air cells was resolved, and hearing loss was also improved. The patient presented no evidence of recurrence for 30 months after the surgery.

4. Discussion

The surgical strategies for PACG are divided into two categories: resection and drainage. The surgical resection includes the middle fossa [4–6], translabyrinthine, or and infratemporal type B approaches [3]. The most important advantage of surgical resection is a lower recurrence rate than the drainage surgery [4,5]. Furthermore, it is advantageous for lateral lesions that are difficult to observe with TSS. To prevent recurrence, some neurosurgeons recommend an additional pedicle flap using *galea aponeurotica*, temporal fascia, or temporal muscle [4,5]. However, the disadvantage of surgical resection is its invasiveness, which might result in fatal complications, such as ICA injury [5].

The drainage surgery for PACG includes the transsphenoidal, infralabyrinthne, or and infracochlear approaches [1,3], and endoscopic TSS has been included among them recently.

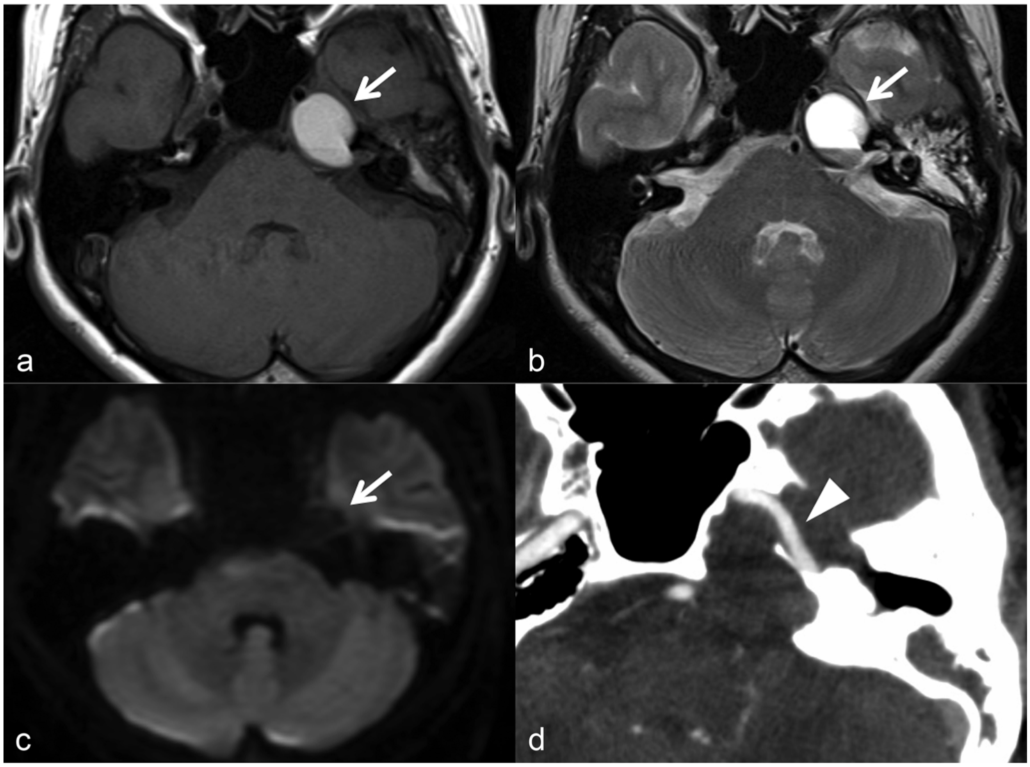

Fig. 3 – Radiologic imaging of the illustrative case. (a) Preoperative T1 weighted magnetic resonance image (WI) showing a high-intensity round mass (arrow) in the apex of the left petrous bone. (b) T2 weighted magnetic resonance image (T2WI) showing a low-intensity lesion (arrow) in the left petrous bone. Fluid collection in the left mastoid air cells is also demonstrated. (c) Diffusion weighted image (DWI) showing low-intensity lesion (arrow) in the left petrous bone. (d) Contrast-enhanced computed tomography showing internal carotid artery running just near the lesion (arrow head).

In general, TSS is indicated for lesions that abut the posterior wall of the sphenoid sinus [19]. Before the advent of endoscopic surgery, the recurrence rate following microscopic TSS for PACG was quite high [27]. In recent years, however, the recurrence rate of endoscopic TSS has extremely reduced [10,12,16,22]. Compared with microscopy, endoscopy can achieve a wide operative field, enabling a maximum puncture of CG. Case reports or series of PACG treated by endoscopic TSS is summarized in Table 1 [7–11,13–16,18–26].

The technique involving nasoseptal flap is unique technique and has been used in extended TSS to prevent postoperative cerebrospinal fluid leakage [28]. Similar to our case, endoscopic TSS using pedicle flap for PACG has been reported to achieve good outcomes [10,11,14,22]. Although the obstruction of the drainage route is a major cause of recurrence [27], post-operative CT in our case revealed a regenerated mucosa covering the inner side of CG, probably because PVNF was able to prevent the obstruction. Some

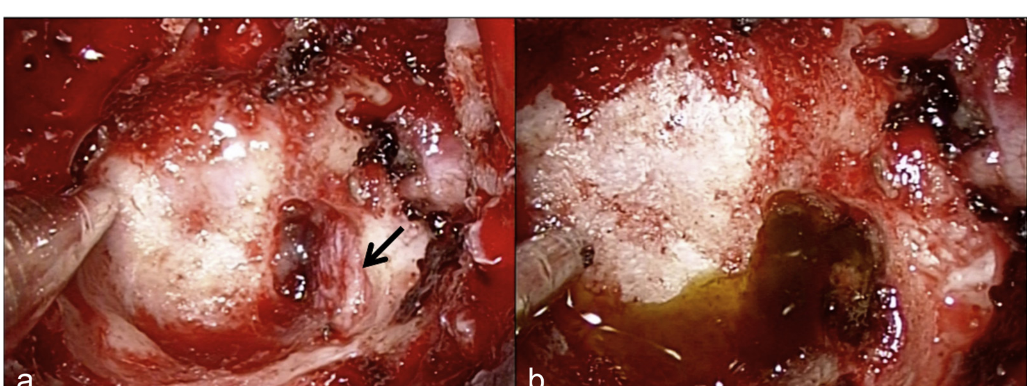

Fig. 4 – Intraoperative findings in the illustrative case. (a) The wall of CG (arrow) is exposed by endoscopic transsphenoidal approach. (b) After puncturing the wall of CG, a brown, turbid fluid came out.

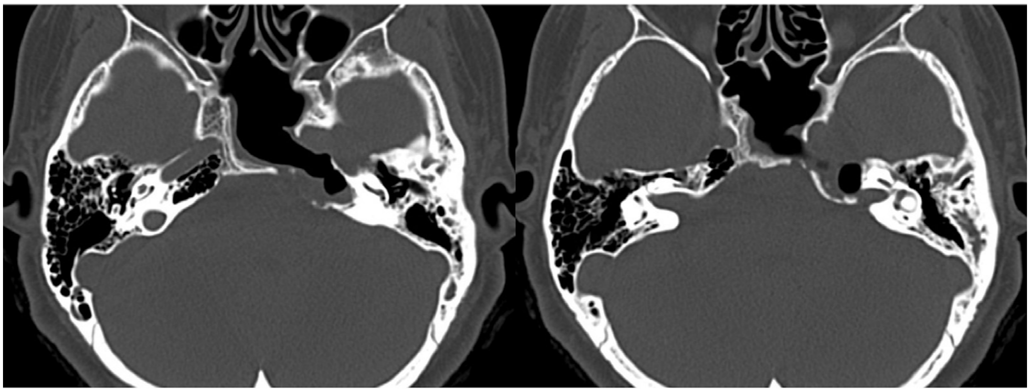

Fig. 5 – CT evaluation at 8 months postoperatively shows disappearance of the CG contents. There is no obstruction in the drainage route and the inner side of the lesion is covered by the regenerated flap. Fluid collection in the mastoid air cells is significantly improved.

reports recommend additional use of artificial material, such as silastic stent [10,11], to prevent restenosis of the drainage route. A previous systematic review [12] reported the rate of symptomatic recurrence as 10.7% in cases without the use of stent and 4.3% in cases with stent placement. The use of silastic stent would be effective in prevention of recurrence, but its removal would need additional surgery under local anesthesia, or general anesthesia in some cases [10]. Moreover, the 13 of 14 (92.9%) reported cases of PACG treated by pedicle flap without stent did not present with recurrence [12,14,22], suggesting non-inferiority of the pedicle flap technique compared with the use of silastic stent. Although the combined use of pedicle flap and stent was also recommended [11], we consider the use of pedicle flap without stent as an optimum and less invasive procedure for PACG.

We consider that preparing a vascularized, pedicle nasoseptal flap is better for graft survival. We attempt to preserve SPA during every endoscopic TSS, if a pedicle nasoseptal flap is necessary. To identify SPA, Doppler blood flow meter is sometimes useful. We consider that postoperative complications, such as, would be more frequent if the flap is too wide. Because placing the apex of the flap into the lesion would be

Table 1 – Summary of case reports or series of PACG treated by endoscopic TSS.

Authors & year	Number of cases	Use of nasoseptal flap	Other intervention	Number of recurrence
Fucci et al., 1994 [8]	1	–	Tube	0
Griffith et al., 1996 [10]	2	–	–	2
Michaelson et al., 2001 [17]	1	–	–	0
DiNardo et al., 2003 [4]	1	–	–	1
Oyama et al., 2007 [18]	1	–	–	0
Georgalas et al., 2008 [9]	3	–	–	2
Edkins et al., 2010 [5]	2	–	Stent	0
Jaberoo et al., 2010 [12]	2	–	–	0
McLaughlin et al., 2011 [16]	1	–	Doyle splint[a]	1
Paluzzi et al., 2012 [19]	10	–	Stent	0
	3	+	–	0
	1	+	Stent	0
	3	–	–	2
Park et al., 2012 [20]	1	–	–	1
Prabhu et al., 2012 [21]	2	–	–	0
Sade et al., 2012 [22]	2	–	Stent	1
	1	–	–	0[b]
Terranova et al., 2013 [27]	1	+	–	0
Tomazic et al., 2013 [29]	4	–	–	0
Karligkiotis et al., 2015 [13]	10	+	–	1[c]
Samadian et al., 2015 [23]	2	–	–	0
	1	–	Tube	0
Shibao et al., 2015 [26]	2	+	T-tube	0
Present case	1	+	–	0

[a] The intervention was performed at the additional surgery.
[b] The patient underwent additional surgery because of restenosis of drainage.
[c] The recurrence was because of inadequate placement of the flap.

enough for this treatment, we advocate that PVNF should be as narrow as possible to prevent postoperative olfactory dysfunction in the surgery for PACG. We prefer to use monopolar electric scalpel during the dissection of the flap from the nasal septum, while some surgeons recommend the use of cold knife to prevent tissue damage and for better olfactory function [29].

5. Conclusion

Although more cases are needed in order to certify its efficacy, endoscopic TSS using PVNF may be one of available surgical options for PACG.

Conflict of interest

None declared.

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None declared.

Ethics

The work described in this article has been carried out in accordance with The Code of Ethics of the World Medical Association (Declaration of Helsinki) for experiments involving humans; Uniform Requirements for manuscripts submitted to Biomedical journals.

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