

Endoscopic Endonasal Approach for Optic Canal Dural Metastasis in a Patient with Progressive Visual Dysfunction: A Case Report

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Abstract

To improve optic nerve function in a patient with progressive visual dysfunction, performing early decompressive and debulking surgery for a metastatic tumor located in the optic canal is essential. The endoscopic endonasal approach could be a practical and effective alternative for lesions in the inferomedial part of the optic canal. A 66-year-old man with a right visual eye field deficit had multiple lesions in the pineal gland, occipital lobe, and right inferomedial optic canal. The optic nerve was distorted by a tumor compressing against the falciform ligament. Although a systemic examination suggested the presence of primary lung cancer, the patient only complained of progressive visual impairment in the right eye. We planned surgery with endoscopic transthemoidal and transsphenoidal approaches to restore visual function and make a pathological diagnosis. During the procedure, we drilled the sella floor, tuberculum sellae, and optic canal and successfully removed the tumor underneath the dura mater. The patient's visual function improved rapidly following surgery, and no complications were observed, such as cerebrospinal fluid leakage. After confirming the pathological diagnosis, the patient subsequently received whole-brain radiotherapy. The endoscopic endonasal skull base approach to the optic canal region could be a practical alternative for treating symptomatic metastatic tumors.

Keywords: dural metastasis, endoscopic endonasal approach, metastatic brain tumor, optic canal region, progressive visual dysfunction

Introduction

Transcranial and endonasal approaches are frequently used for lesions around the optic canal. However, endonasal surgery is considered adequate for lesions in the inferomedial part of the optic canal. Although few studies have reported metastatic tumor removal around the optic nerve via the transcranial approach,^{1,2)} no studies have discussed endonasal approaches. The surgical strategy for metastatic tumors is to avoid irreversible brain or nerve dysfunction and improve visual function. Thus, neurosurgical treatment's significance, invasiveness, and complications should be considered. When a patient presents with visual dysfunction due to perioptic nerve lesions, the findings of visual field testing can provide valuable insights into the relationship between the optic nerve and tumor. If

the tumor exerts pressure on the optic nerve, early decompression via surgery may improve visual function.^{1,2)} This report describes a patient with rapid and progressive visual dysfunction due to a metastatic tumor on the inferomedial side of the optic canal region.

Case Report

A 66-year-old man presented with dizziness, blurred vision, and right visual field defect for several weeks. Gadolinium-enhanced brain magnetic resonance imaging (MRI) revealed the presence of multiple tumors in the pineal gland, left temporal lobe, and inferomedial optic canal (Fig. 1A-D). He was subsequently referred to our department for further evaluation and treatment. Although he presented with a normal visual acuity of 1.2 without cor-

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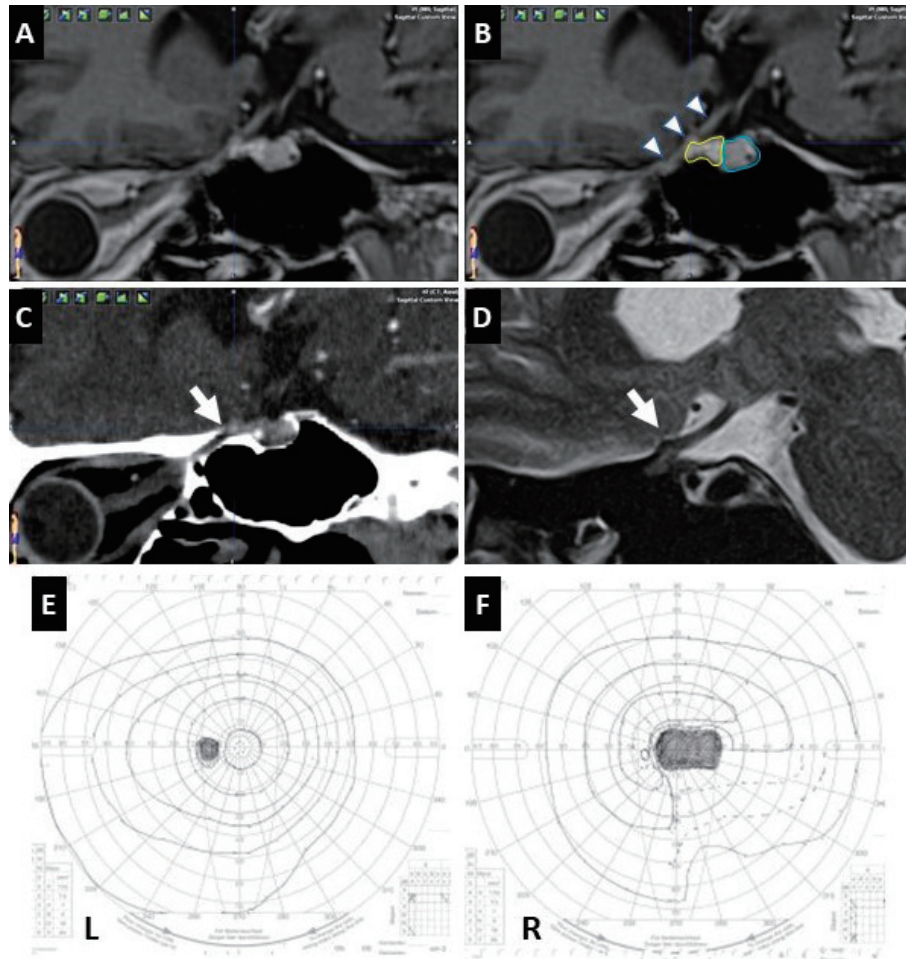


Fig. 1 Preoperative magnetic resonance imaging (MRI) and computed tomography (CT). Gadolinium-enhanced MRI and CT showing cross-sectional views along the long axis of the right optic nerve at the entrance of the optic canal (A, B, and C). An enhanced lesion (B yellow line) located anterior to the pituitary gland (B blue line) compressed the optic nerve upward (arrowhead). CT revealed the optic nerve compression against the falciform ligament by the tumor (C arrow: upper wall of the optic canal). A sagittal T2-weighted image showing the tumor causing a dorsal bend of the optic nerve (D arrow: upper wall of the optic canal). Preoperative Goldmann visual field test revealing a central scotoma enlargement and lower lateral quarter blindness (E, F).

reception before this event, his right visual acuity rapidly deteriorated to 0.15 within a week. Visual field examination demonstrated enlarged central darkening and vision loss in the lower lateral quarter (Fig. 1E and F). He had no papilledema, with normal pupillary light reflexes in both eyes. Although he had no smoking history, chest computed tomography (CT) revealed a suspected mass indicative of primary lung cancer. Furthermore, whole-body fluorodeoxyglucose-positron emission CT revealed multiple metastases in the vertebral bodies. Thus, we assumed these intracranial lesions to be metastatic tumors. MRI showed that the optic nerve was displaced upward by the tumor. The visual dysfunction was due to optic nerve compression by the tumor against the falciform ligament (Fig. 1A and B). The patient only complained of visual impairment, with a Karnofsky Performance Scale (KPS) score of 80. His family history showed that his father and mother

had colon and lung cancer, respectively.

We expected that early optic nerve decompression could restore his visual function and facilitate tumor specimen collection for pathological diagnosis. Accordingly, we planned to perform endoscopic endonasal decompression of the optic nerve canal within a few days after MRI.

We performed endoscopic transethmoidal and transsphenoidal surgery to achieve a wide exposure of the sphenoid sinus, including opening the right anterior and posterior ethmoidal sinuses via both nostrils. Subsequently, we gently peeled off the mucosa on the posterior wall of the sphenoid sinus inferiorly while preserving it. Next, we created a lateral extended surgical field by drilling the sella floor, tuberculum sellae, right optic canal, and medial optocrotid recess (Fig. 2A). We made a longitudinal incision in the dura mater in front of the superior intercavernous sinus, followed by an incision along the long axis of the

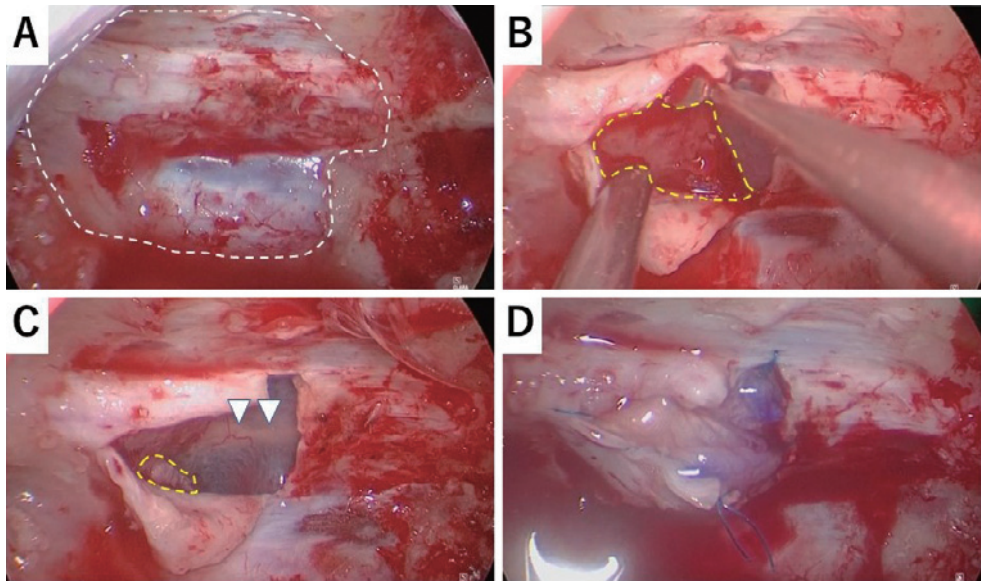


Fig. 2 Intraoperative endoscopic images. An endonasal approach was used to remove the bone of the sella turcica, tuberculum, planum sphenoidale, right optic canal, and medial opticocarotid recess (white dotted line), creating a laterally extended surgical field (A). After incising the dura, a grayish tumor mass (yellow-dotted line) appeared in the subdural and epiarachnoid space (B). The tumor was carefully removed by detaching it from the arachnoid membrane to prevent any damage to the optic nerve. Consequently, a part of the tumor was left (yellow-dotted line). After tumor removal, the optic nerve was observed through the arachnoid (arrowhead) (C). The rectus abdominis fascia was placed under the dura mater, and the dura was reconstructed using the continuous suture technique with 6-0 PROLENE (D).

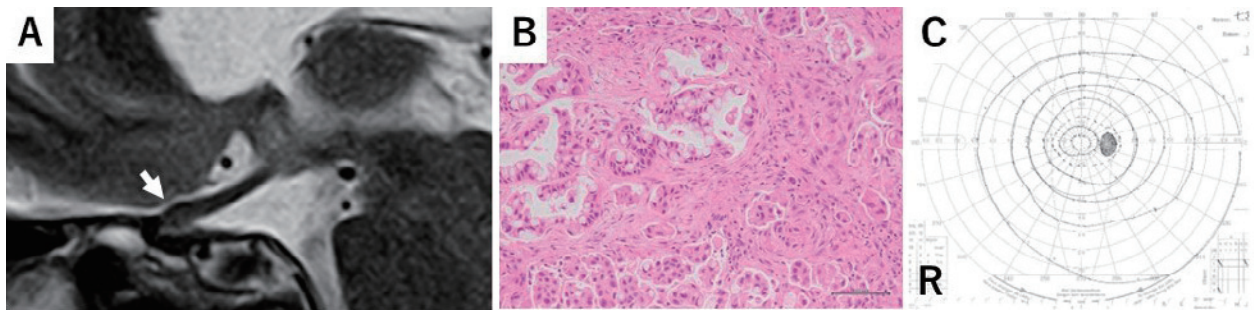


Fig. 3 Postoperative sagittal T2-weighted image (A) showing a successful optic nerve decompression. Pathological diagnosis confirmed that the tumor had metastasized from the lung (B). The Goldmann visual field test (C) also demonstrated significant improvements in the patient.

right optic canal. We identified a grayish tumor located in the subdural epiarachnoid space that compressed the right optic nerve upward (Fig. 2B). Owing to the tumor's hard composition and adherence to the arachnoid membrane around the optic nerve, a gross total removal was inevitable to prevent ischemic damage. Therefore, we carefully detached the tumor from the arachnoid and debulked it as much as possible (Fig. 2C). Frozen section examination confirmed adenocarcinoma metastasis. To reconstruct the dura, we used the rectus abdominis fascia, which was placed beneath the dura, and sutured it continuously (Fig. 2D). Further, we applied Duragen (Integra Japan, Tokyo, Japan) on the dura and placed the nasal septum bone over

it. The preserved sphenoid sinus mucosa was used as a local mucosal flap to cover the bone. Finally, we applied fibrin glue and secured it with sinus balloons.

Postoperative MRI revealed successful decompression of the optic nerve, except for a small remnant tumor located between the optic nerve and internal carotid artery (Fig. 3 A). The pathological diagnosis indicated an adenocarcinoma, which was suspected to be a tumor that had metastasized from the lung (Fig. 3B). The patient's right eye vision notably improved the day after surgery. Additionally, his visual acuity recovered to normal, and the visual field constriction disappeared (Fig. 3C). One month after surgery, he received intensity-modulated radiotherapy, with 54

Table 1 Previously reported cases with metastatic tumors around the optic canal presenting with visual defects

| No. | Author (year) | Age/sex | Metastatic region | Treatment | Preoperative visual function | Postoperative visual function |
|-----|-------------------------------|---------|---|---|--|--------------------------------|
| 1 | Tamai H ¹⁾ (2013) | 60/F | Left subdural optic nerve | Transcranial partial resection | 20/200 | 20/200 (Visual field recovery) |
| 2 | Tamai H ¹⁾ (2013) | 73/F | Left subdural optic nerve | Transcranial biopsy | Counting finger | 20/200 |
| 3 | Masuda Y ²⁾ (2021) | 78/F | Dura mater of left anterior clinoid process | Osimertinib (80 mg/day) SRT (50 Gy/25 fr) | Visual loss | 20/32 |
| 4 | Current | 66/M | Dura mater of right optic canal | Endonasal partial resection | 20/125 (lower lateral quarter blindness) | 20/12 (No blindness) |

Gy/30 fr targeting the area surrounding the right optic nerve and 30 Gy/5 fr targeting the pineal body lesions. Throughout the treatment, cerebrospinal fluid (CSF) complications leakage were absent. Furthermore, an anticancer treatment plan was designed by a pulmonologist based on the results of multigene panel testing, revealing a mutation in the human epidermal growth factor receptor-2 gene.

Discussion

Intracranial dural metastases are rare, accounting for approximately 5% of all metastatic brain tumors.^{2,3)} In a systematic review of 227 cases of ocular or orbital region metastases, the incidence of metastases to the optic nerve or optic sheath was 1.3%.⁴⁾ Thus, no treatment strategy has been established for such metastases. In patients whose metastatic tumor did not invade the optic nerve, tumor removal may restore visual function.^{1,5)} However, when the tumor directly invades the nerve, the functional prognosis is often poor.^{6,7)} In the current case, the tumor was inferior to the optic nerve, whereas the visual field defect was observed in the lateral lower quadrant. Therefore, we inferred that the patient's symptom was not due to direct tumor invasion but rather due to the compression against the falxiform ligament superiorly. Furthermore, the patient did not present any symptoms of intracranial hypertension, such as headache or papilledema, and meningeal carcinomatosis was ruled out based on head MRI. Consequently, despite the risk of complications, such as CSF leakage, we decided to perform surgery before radiotherapy, and the patient showed excellent improvement in nerve function.

Despite the absence of direct tumor invasion of the optic nerve, three cases of metastatic tumors located around the optic canal presenting with visual defects have been reported previously (Table 1). The decompression of the optic nerve resulted in the restoration of visual function in all reported cases. In two of these cases, the tumor mass surrounding the optic nerve necessitated a transcranial approach for its removal.¹⁾ In the third case, the metastasized

tumor was located on the dura near the anterior clinoid process; the tumor was subjected to radiotherapy and treated with osimertinib (80 mg/day), an epidermal growth factor receptor (EGFR) tyrosine kinase inhibitor.²⁾ Recently, osimertinib has emerged as a promising treatment alternative for patients with nonsmall cell lung cancer with EGFR mutation, an oncogenic driver of this disease. This is attributed to its ability to effectively penetrate the blood-brain barrier, making it a viable treatment option for intracranial tumors.^{8,9)} In this case, the patient initially experienced progressive visual field defect; however, a definitive diagnosis of lung cancer metastasis was not achieved. Consequently, we decided to perform surgery, although radio and anticancer therapies were potential alternatives based on the patient's compromised general condition, including KPS, or if obtaining a specimen from a less risky part of the body is feasible.

Tuberculum sellae meningiomas are another example of tumors compressing the optic nerve from the inferomedial aspect. In a meta-analysis comparing endonasal and transcranial approaches for treating tuberculum sellae meningiomas with visual dysfunction, the endonasal approach was associated with a higher incidence of CSF leakage than the transcranial approach. However, the endonasal approach showed a superior postoperative visual improvement rate.¹⁰⁾ When a tuberculum sellae meningioma extends into the optic canal, it can compress the optic nerve from the inferomedial to superolateral aspect. In our case, the tumor was in the inferomedial part of the optic canal, compressing the optic nerve dorsally. Owing to this location, an endoscopic endonasal approach was considered a good indication.

In a report of 11 cases of visual dysfunction caused by optic nerve compression by tumors, such as meningiomas, the optic canal was released in all cases to prevent CSF leakage. Despite this, 54% of the patients demonstrated improved visual function during follow-up, with 18% of them showing complete visual recovery.¹¹⁾ However, in the current case, visual function was improved by opening the

optic canal, incising the dura mater, and removing the tumor despite the potential risk of CSF leakage.

Conclusions

We presented the case of a patient with a metastatic tumor in the inferomedial aspect of the optic canal who underwent optic nerve decompression via the endoscopic endonasal approach to improve visual function. In cases of optic nerve dysfunction due to compression extending from the inferior to superior aspect, surgical decompression with the endoscopic endonasal approach can rapidly improve visual function.

Abbreviations

CSF: cerebrospinal fluid
 CT: computed tomography
 EGFR: epidermal growth factor receptor
 MRI: magnetic resonance imaging
 KPS: Karnofsky Performance Scale

Informed Consent

Informed consent was obtained from all participants.

Conflicts of Interest Disclosure

The authors have no conflicts of interest. All authors have registered self-reported COI Disclosure Statement Forms online.

References

- 1) Tamai H, Ishida K, Murakami K, Narita N, Tominaga T, Fuse N: Compression neuropathy caused by cancer metastasis to the optic nerve canal. *BMC Res Notes* 6: 546, 2013
- 2) Masuda Y, Iyama S, Ishizuka S, et al.: A case of advanced non-small cell lung cancer with visual impairment due to dural metastasis. *Jpn J Lung Cancer* 61: 423-428, 2021
- 3) Rodriguez AAO, Haro MC, Cardera JLC, Toorta CJ, Muñoz JMR: Dural metastasis from breast carcinoma mimicking subacute subdural hematoma: a case report. *Indian J Surg Oncol* 12: S197-S200, 2021
- 4) Fox B, Pacheco P, DeMonte F: Carcinoma of the breast metastatic to the optic nerve mimicking an optic nerve sheath meningioma: case report and review of the literature. *Skull Base* 15: 281-289, 2005
- 5) Kim SM, Lee J, Joe SG, Kim JS, Kwon SU: Acute-onset altitudinal visual field defect caused by optic canal meningioma. *J Clin Neurol* 11: 404-406, 2015
- 6) Fukuda A, Kobayashi N, Kitahara I, Mizutani T: Cyberknife stereotactic radiotherapy for metastatic optic chiasm tumor: a case report. *Showa Igakkai Zasshi* 73: 397-402, 2013
- 7) Taniguchi H, Abo H, Miyata S, Miyazawa H, Noto H, Izumi S: A case of metastasis from small cell lung cancer to the spinal cord and the optic chiasm. *Jpn J Lung Cancer* 44: 179-182, 2004
- 8) Yang JCH, Kim SW, Kim DW, et al.: Osimertinib in patients with epidermal growth factor receptor mutation-positive non-small-cell lung cancer and leptomeningeal metastases: the BLOOM study. *J Clin Oncol* 38: 538-547, 2020
- 9) Soria JC, Ohe Y, Vansteenkiste J, et al.: Osimertinib in untreated *EGFR*-mutated advanced non-small-cell lung cancer. *N Engl J Med* 378: 113-125, 2018
- 10) Clark AJ, Jahangiri A, Garcia RM, et al.: Endoscopic surgery for tuberculum sellae meningiomas: a systematic review and meta-analysis. *Neurosurg Rev* 36: 349-359, 2013
- 11) Berhouma M, Jacquesson T, Abouaf L, Vighetto A, Jouanneau E: Endoscopic endonasal optic nerve and orbital apex decompression for nontraumatic optic neuropathy: surgical nuances and review of the literature. *Neurosurg Focus* 37: 1-9, 2014

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