Bilateral occipital metastases: Visual deficits and management considerations

Mark M. Zaki¹, Saksham Gupta¹, Blake Hauser¹, Kyle C. Wu¹, Robert M. Mallery², Sashank Prasad², Ayal Aizer³, Wenya Linda Bi¹, Ian F. Dunn⁴

Departments of ¹Neurosurgery, ¹Neurology, ²Radiation Oncology, Brigham and Women’s Hospital, Dana-Farber Cancer Institute, Boston, Massachusetts, ³Department of Neurosurgery, University of Oklahoma Health Sciences Center, Oklahoma, United States.

E-mail: *Mark M. Zaki - mark_zaki@hms.harvard.edu; Saksham Gupta - sgupta@bwh.harvard.edu; Blake Hauser - blake_hauser@hms.harvard.edu; Kyle C. Wu - kwu@bwh.harvard.edu; Robert M. Mallery - rmallery@bwh.harvard.edu; Sashank Prasad - sprasad2@bwh.harvard.edu; Ayal Aizer - ayal_aizer@dfci.harvard.edu; Wenya Linda Bi - wbi@bwh.harvard.edu; Ian F. Dunn - ian-dunn@ouhsc.edu

*Corresponding author: Ian F. Dunn, MD, FAANS, FACS, Department of Neurosurgery, University of Oklahoma Health Sciences Center, HHDC Suite 4000, 1000 N. Lincoln Blvd, Oklahoma City, OK 73104, Phone: 405-271-4912
ian-dunn@ouhsc.edu

Received : 03 August 2020
Accepted : 24 November 2020
Published : 11 December 2020

DOI
10.25259/SNI_487_2020

Quick Response Code:

INTRODUCTION

Brain metastases are the most common intracranial tumors in adults, with a rising incidence as systemic disease control improves patient survival and screening increases with readily available imaging modalities. The decision to treat brain metastases balances the benefits of tumor control, symptom alleviation, and survival with the risks of functional impairment and reduced quality of life.
The nuanced impact of the treatment of brain metastases is highlighted in the scenario of metastases involving bilateral occipital lobes, which pose heightened risk to vision loss with or without intervention. As patients with metastatic brain metastasis have a poor prognosis, understanding risk of visual deterioration is vital in considering treatment. We, thus, sought to analyze the rates of visual change following radiation and/or surgery in patients with bilateral occipital metastases to abet decision-making in these challenging cases.

MATERIALS AND METHODS

Data source and study design

We conducted a retrospective cohort study of brain metastases patients treated at a single institution from 2008 to 2017 to identify cases affecting both occipital lobes. We reviewed imaging, patient demographics, histology of the primary tumor, surgical details, visual symptoms, and volume of tumor and edema before and after therapy. The study design was reviewed and approved by the hospital’s Institutional Review Board (IRB). Patient consent was waived for retrospective chart review research, within the scope of IRB approval by our institution.

Inclusion and exclusion criteria

We included adult patients (age >18 years) diagnosed with bilateral occipital brain metastases (located between the occipital pole and parieto-occipital sulcus) who received radiation or surgical resection plus radiation treatment. We excluded patients if either occipital metastasis had a diameter under 1 cm at presentation to assess tumors for which surgery would be considered a treatment option. Following radiological review, 18 patients were included for analysis.

Statistical analysis

The volumes of enhancing tumor and associated peritumoral edema were independently segmented (Brainlab, Munich, Germany) for analysis before and following treatment using T1 postcontrast and T2 fluid attenuation inversion recovery (FLAIR) MRI sequences [Figure 1]. Descriptive statistics and unadjusted linear regression analyses were conducted using the R package version 3.3.3.

RESULTS

Patient characteristics

Eighteen patients (13 women and 5 men) with bilateral occipital metastases were identified [Table 1], with a median age of 64 years (range 27–89 years). The most frequent primary cancers were lung (n = 10), melanoma (n = 3), and breast (n = 2). The 10 lung cancers included 3 adenocarcinomas, 2 large cell neuroendocrine tumors, 2 poorly differentiated tumors, 1 small cell lung cancer, and 2 with unknown histopathology. Both breast cancer metastases were triple-positive tumors, with immunopositivity for estrogen receptor, progesterone receptor, and herceptin-2 (HER2).

| Table 1: Patient characteristics. | Median | IQR |
|----------------------------------|--------|-----|
| Age                                             | 64     | 55–69|
| Gender                                          | n      | Percent |
| Female                                         | 13     | 72   |
| Primary histology                            | n      | Percent |
| Lung                                           | 10     | 56   |
| Melanoma                                       | 3      | 17   |
| Breast                                         | 2      | 11   |
| Other: synovial, endometrial, and appendical   | 3      | 17   |
| Prior chemotherapy                            | n      | Percent |
| Any visual deficit                             | 12     | 67   |
| Contralateral field cut*                       | 10     | 83   |
| Diplopia*                                      | 2      | 17   |
| Loss of acuity*                                | 2      | 17   |
| Treatment                                      | n      | Percent |
| Radiation alone                                | 5      | 28   |
| Both: surgery + radiation                      | 13     | 72   |

*Percent calculated from total of 12
| Case | Age | Sex | Primary cancer | Prior chemo | Prior radiation to occipital lobe (s) | Diagnosis to development of BOMs (years) | Intracranial metastases (n) | Pretreatment visual symptoms | Treatment for BOMs | Posttreatment new visual symptoms | Involves primary visual cortex (L) | Involves primary visual cortex (R) | Tumor extends to surface (R) | Tumor extends to surface (L) | GTR achieved |
|------|-----|-----|----------------|-------------|--------------------------------------|------------------------------------------|---------------------------|-----------------------------|-------------------|-----------------------------------|-------------------------------|-------------------------------|-------------------------------|-------------------------------|------------------|
| 1    | 63  | Female | Lung, NOS      | No          | No                                   | 3.8                                      | 8                         | No symptoms                 | Radiation, WBRT | No symptoms                      |                  |                              |                      |                              | No              |
| 2    | 73  | Female | Endometrial adenocarcinoma | Yes         | SRS (L)                             | 1.2                                      | 33                        | No symptoms                 | Radiation, 20 Gy SRS (L) | Blurry vision                  |                  |                              |                      |                              | Yes             |
| 3    | 54  | Female | Lung, NOS      | No          | SRS (L)                             | 0.2                                      | 5                         | No symptoms                 | Radiation, 16 Gy SRS (L) | Visual field cut               |                  |                              |                      |                              | No              |
| 4    | 67  | Female | Breast, ER/PR/HER2 triple positive | Yes         | WBRT                                | 3.8                                      | 3                         | Blurry vision               | Radiation, 17 and 20 Gy SRS (L, R) | Improved          |                  |                      |                              | Yes             |
| 5    | 75  | Female | Lung, large cell neuroendocrine | Yes         | WBRT                                | 3.7                                      | 10                        | Visual field cut, blurry vision | Radiation, 18 and 20 Gy SRS (L, R) | Improved          |                  |                      |                              | Yes             |
| 6    | 64  | Male   | Lung, small cell | No          | No                                   | 0.1                                      | 10                        | Diplopia, visual field cut | Both: R occipital craniotomy and WBRT | Improved          | No                       | Yes                       | No                      | No              |
| 7    | 63  | Female | Lung, adenocarcinoma | No          | WBRT                                | 1.5                                      | 2                         | Blurry vision               | Both: bilateral occipital craniotomy and WBRT | Improved          | No                       | No                       | Yes                      | Yes             |
| 8    | 70  | Male   | Lung, poorly differentiated | No          | No                                   | 0.5                                      | 12                        | Visual field cut            | Both: L occipital craniotomy and WBRT | No change         | Yes                       | No                       | No                      | Yes             |
| 9    | 80  | Female | Lung, adenocarcinoma | No          | WBRT                                | 1.9                                      | 21                        | Visual field cut, hemispatial neglect | Both: L occipital craniotomy and WBRT | Improved          | No                       | Yes                      | Yes                      | Yes             |
| 10   | 27  | Female | Synovial sarcoma | Yes         | No                                   | 1.7                                      | 4                         | Visual field cut            | Both: bilateral occipital craniotomy and WBRT | Improved          | Yes                       | Yes                      | Yes                      | Yes             |
| 11   | 35  | Female | Breast, ER/PR/HER2 triple positive | Yes         | No                                   | 1.9                                      | 3                         | No symptoms                 | Both: R parieto-occipital craniotomy and bilateral 24 Gy SRS | No change         | No                       | Yes                      | Yes                      | Yes             |
| 12   | 67  | Male   | Lung, large cell neuroendocrine | No          | No                                   | 0.8                                      | 90                        | Diplopia                    | Both: R occipital craniotomy and WBRT | No change         | No                       | Yes                      | No                      | No              |
| 13   | 52  | Female | Appendical adenocarcinoma | Yes         | No                                   | 8.3                                      | 3                         | Visual field cut            | Both: R parieto-occipital craniotomy and WBRT | Improved          | Yes                       | No                       | Yes                      | Yes             |
| 14   | 76  | Female | Lung, NSCLC     | Yes         | No                                   | 0.6                                      | 2                         | No symptoms                 | Both: L occipital and R parietal craniotomy, bilateral 18 Gy SRS preoperative, WBRT postoperative | No symptoms       | Yes                       | No                       | Yes                      | Yes             |
| 15   | 89  | Male   | Melanoma, NOS   | No          | No                                   | 1.9                                      | 10                        | Visual field cut            | Both: L occipital craniotomy and bilateral 20 Gy SRS | No change         | Yes                       | No                       | No                      | Yes             |
| 16   | 44  | Female | Melanoma, NOS   | Yes         | No                                   | 4.3                                      | 8                         | Visual field cut            | Both: R occipital craniotomy and WBRT | Improved          | No                       | Yes                      | Yes                      | No              |
Clinical presentation

Visual symptoms were present in 12 patients (67%) at time of presentation with bilateral occipital metastasis. These patients exhibited visual field deficit (67%), diplopia (17%), and visual acuity deficit (17%) on neurologic examination [Table 2].

Visual symptoms before and after treatment

In patients with pretreatment visual deficits, no visual deficits worsened following treatment with either radiation or surgical resection plus radiation. Three patients remained with a stable deficit, whereas 9 of 12 patients improved. Of the three that did not improve, one patient had a biopsy rather than a gross total resection and presented with diplopia which was presumed secondary to a cavernous sinus metastasis [Table 2]. Of those that improved, approximately half showed signs of visual improvement by day 7 posttreatment, and all the patients who did improve showed signs of improvement by day 30 [Table 3a].

In patients without pretreatment visual symptoms, half remained at baseline and half worsened throughout treatment. Of three patients who received radiation alone, one patient remained at baseline, one developed blurry vision which resolved within 1 week of treatment, and one developed a visual field cut within 1 day of treatment and subsequently died or was lost to follow up. Of three patients who received surgery plus radiation, two remained at baseline, whereas one patient developed a contralateral field cut, optic ataxia, and simultanagnosia (Balint’s syndrome) following 24 Gy of fractionated SRS. The patient then underwent surgical resection approximately 18 months later, and his visual deficits showed only miniscule improvement at 90 day follow-up [Table 3b].

Volumetric analysis

Nine of 18 patients had imaging pre- and postintervention available for volumetric analysis. Surgical resection showed greater reductions in postcontrast T1 volumes than radiation alone. Changes in FLAIR signal were variable across treatment modalities [Table 4].

Mortality

Patients who underwent surgical selection plus radiation tended to have a higher likelihood of survival than those who underwent radiation alone at various follow-up times [Figure 2]. In this cohort, median overall survival was 38 (range: 6–371) versus 387 (range: 43–1918) days for patients undergoing radiation alone versus surgical resection plus radiation, respectively (P = 0.15).
Zaki, et al.: Bilateral occipital metastases

Table 3: Visual symptoms following treatment.

| Treatment                  | Worsened | No change (%) | Better at day 1 | Better at day 7 (%) | Better at day 30 (%) | Better at day 90 (%) |
|----------------------------|----------|---------------|-----------------|---------------------|----------------------|----------------------|
| Radiation                  | 0        | 0             | 2/2 (100)       | 1/1 (100)*          | 1/1 (100)            |                      |
| Surgery + radiation        | 0        | 3/10 (30)     | 5/10 (50)       | 7/10 (70)           | 6/9 (67)*            |                      |
| Total                      | 0        | 3/12 (25)     | 7/12 (58)       | 8/11 (73)*          | 7/10 (70)*           |                      |

b. Patients without pretreatment visual symptoms

| Treatment                  | Stable (%) | Worse at day 1 (%) | Worse at day 7 (%) | Worse at day 30 (%) | Worse at 90 (%) |
|----------------------------|------------|--------------------|--------------------|---------------------|----------------|
| Radiation                  | 1/3 (33)   | 2/3 (67)           | 0/2*               | 0/2                 | 0/2            |
| Surgery + radiation        | 2/3 (67)   | 1/3 (33)           | 1/3 (33)           | 1/3 (33)            | 1/3 (33)       |
| Total                      | 3/6 (50)   | 3/6 (50)           | 1/5 (20)*          | 1/5 (20)            | 1/5 (20)       |

*Decrease in denominator indicates patient death or lack of follow-up

Table 4: Percent change in volume of tumor and surrounding edema for patients with available follow-up imaging.

| Case number | Treatment for BOMs                  | L T1 | L FLAIR | R T1 | R FLAIR |
|-------------|------------------------------------|------|---------|------|---------|
| 4           | Radiation, 17 and 20 Gy SRS (L, R) | −54.3| −71.5   | −81.1| −85.8   |
| 5           | Radiation, 18 and 20 Gy SRS (L, R) | −30.1| 22.2    | 76.9 | 382.0   |
| Average radiation |                     | −42.2| −24.6   | −2.1 | 148.1   |
| 6           | Both: R occipital craniotomy and WBRT | 13.9 | 6.7     | −93.8| −31.0   |
| 7           | Both: bilateral occipital craniotomy and WBRT | −78.0| −46.8   | −94.4| −55.0   |
| 8           | Both: L occipital craniotomy and WBRT | −93.8| 300.9   | −2.3 | −49.9   |
| 9           | Both: L occipital craniotomy and WBRT | −73.4| 6.4     | 13.5 | 27.6    |
| 10          | Both: bilateral occipital craniotomy and WBRT | −100.0| −95.3   | −100.0| −62.3   |
| 12          | Both: R occipital craniotomy and WBRT | −38.9| 423.9   | −97.3| −100.0  |
| 18          | Both: L occipital craniotomy and 18 Gy SRS (R) + WBRT | −100.0| −97.2   | −8.7 | 55.6    |
| Average surgery + radiation |                     | −67.2| 71.2    | −54.7| −30.7   |
| Average total |                                      | −61.6| 49.9    | −43.0| 9.0     |

A major risk of treating these patients is iatrogenic visual deficits, including cortical blindness, weighed against deficits conferred by the disease itself. In the setting of patients presenting with bilateral occipital metastases and unilateral visual field deficit, the decision to undergo bilateral treatment depends on extent of intracranial and extracranial tumor burden. In those with more severe tumor burden, unilateral treatment is favored to avoid unnecessary morbidity without a mortality benefit. When the bilateral occipital metastases are present in the setting of stable primary disease, treatment – especially surgical resection – may be safely conferred.

In our study, no patients who presented with visual deficits exhibited worsening of symptoms following treatment with any modality. Patients who presented with visual field deficit or blurry vision treated with surgical resection tended to gradually improve over days to weeks, likely due to relief of mass effect and reduction of edema. Diplopia is unlikely related to tumor in the occipital lobe and does not appear to improve following treatment aimed at the occipital lobes.

DISCUSSION

There is an absence of published experience in the management of patients with tumors involving bilateral occipital lobes.

Figure 2: Kaplan–Meier curve showing percent of patients alive through 12-month follow-up stratified by treatment cohort.
within the 1st month of treatment were unlikely to show improvement at 90-day follow-up.

In patients without pretreatment visual deficits, the risk of iatrogenic visual deficits is an important consideration. In our cohort, one patient’s vision worsened months after radiation therapy which did not improve following surgical resection, and two patients’ vision worsened acutely following radiation alone. In terms of visual complications that may arise during treatment, one patient developed Bálint syndrome months following SRS. This may have been related to radiation, but could also have been tumor progression. Interestingly, the patient’s visual status did not improve following surgical resection.

Functional preservation is essential in patients with metastatic brain tumors to maximize quality of life. For patients who undergo surgical resection, meticulous care to preserve functional brain parenchyma, including selection of natural anatomic corridors to the surface of the tumor when subcortical, offers promising results in improving visual deficits in patients with bilateral occipital metastases. As subtotal resection is associated with decreased survival compared to a gross total resection, a gross total resection should be achieved when safely possible.[9]

Patients in our cohort who underwent surgical resection followed by radiation had markedly improved prognosis compared to radiation alone, which likely reflects selection bias in those patients deemed suitable for surgery. Our results appear consistent with literature in brain metastasis indicating improved survival benefit with surgical resection plus radiation compared to radiation alone.[9][13] In addition to treatment type, other considerations that have been shown to be significant risk factors for mortality are systemic tumor burden, intracranial tumor volume, and number of intracranial metastases.[8][11][12]

CONCLUSION

The management of bilateral occipital metastases involves consideration of symptomatology, disease burden, and goals of care. Patients often present with visual symptoms, which may improve following treatment, especially surgical resection. However, newly developed visual symptoms, including cortical blindness, are a potential consequence of surgical resection. In addition to treatment type, other considerations that have been shown to be significant risk factors for mortality are systemic tumor burden, intracranial tumor volume, and number of intracranial metastases.[8][11][12]

Declaration of patient consent

Institutional Review Board permission obtained for the study.

Financial support and sponsorship

Nil.

Conflicts of interest

There are no conflicts of interest.

REFERENCES

1. Achrol AS, Rennert RC, Anders C, Soffietti R, Ahluwalia MS, Nayak L, et al. Brain metastases. Nat Rev Dis Primers 2019;5:5.
2. Aldrich MS, Alessi AG, Beck RW, Gilman S. Cortical blindness: Etiology, diagnosis, and prognosis. Ann Neurol 1987;21:149-58.
3. Fox BD, Cheung VJ, Patel AJ, Suki D, Rao G. Epidemiology of metastatic brain tumors. Neurosurg Clin N Am 2011;22:1-6.
4. Lee CH, Kim DG, Kim JW, Han JH, Kim YH, Park CK, et al. The role of surgical resection in the management of brain metastasis: A 17-year longitudinal study. Acta Neurochir (Wien) 2013;155:389-97.
5. Nayak L, Lee EQ, Wen PY. Epidemiology of brain metastases. Curr Oncol Rep 2012;14:48-54.
6. Owonikoko TK, Arbiser J, Zelnak A, Shu HK, Shim H, Robin AM, et al. Current approaches to the treatment of metastatic brain tumours. Nat Rev Clin Oncol 2014;11:203-22.
7. Palmer JD, Trifiletti DM, Gondi V, Chan M, Minniti G, Rusthoven CG, et al. Multidisciplinary patient-centered management of brain metastases and future directions. Neurooncol Adv 2020;2:vdaa034.
8. Park YH, Kim TH, Jung SY, Kim YE, Bae JM, Kim YJ, et al. Combined primary tumor and extracranial metastasis status as constituent factor of prognostic indices for predicting the overall survival in patients with brain metastases. J Korean Med Sci 2013;28:205-12.
9. Patchell RA, Tibbs PA, Walsh JW, Dempsey RJ, Maruyama Y, Kryscio RJ, et al. A randomized trial of surgery in the treatment of single metastases to the brain. N Engl J Med 1990;322:494-500.
10. Posner JB. Brain metastases: 1995. A brief review. J Neurooncol 1996;7:287-93.
11. Sharma M, Jia X, Ahluwalia M, Barnett GH, Vogelbaum MA, Chao ST, et al. Cumulative intracranial tumor volume and number of brain metastasis as predictors of developing new lesions after stereotactic radiosurgery for brain metastasis. World Neurosurg 2017;106:666-75.
12. Sperduto PW, Kasend N, Roberge D, Xu Z, Shanley R, Luo X, et al. Summary report on the graded prognostic assessment: An accurate and facile diagnosis-specific tool to estimate survival for patients with brain metastases. J Clin Oncol 2012;30:419-25.
13. Suh JH, Kotecha R, Chao ST, Ahluwalia MS, Sahgal A, Chang EL. Current approaches to the management of brain metastases. Nat Rev Clin Oncol 2020;17:279-99.
14. Team RC, R: A Language and Environment for Statistical Computing. Vienna, Austria: R Foundation for Statistical Computing; 2017.
15. Yaeger KA, Nair MN. Surgery for brain metastases. Surg Neurol Int 2013;4 Suppl 1:S203-8.