Treatment of Brain Tumors

INTRABEAM 600 from ZEISS

ZEISS

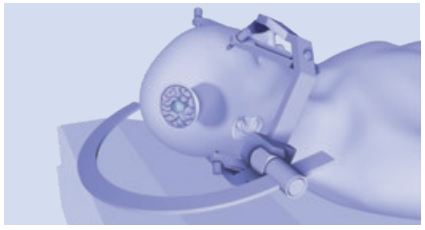
Seeing beyond

Targeted treatment by means of small field irradiation with intraoperative radiation therapy (IORT)

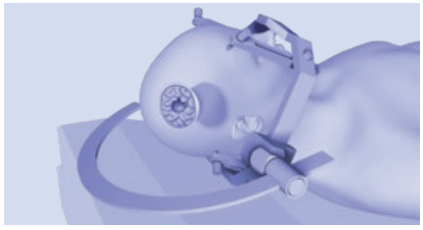
Glioblastoma multiforme (GBM) is the most frequent primary malignant brain tumor in adults. Due to the infiltrative nature of high grade IV gliomas, patients have a median overall survival of 15 months only.[1] Brain metastases are also a common manifestation of systemic cancer with an average survival time for patients of 3-12 months, primarily determined by the status of systemic (non-CNS) disease.[2] The gold standard treatment for brain tumors is based on a multidisciplinary approach applying surgery followed by radiotherapy with or without concurrent and adjuvant chemotherapy.[3,4] IORT is a pragmatic and effective approach to sterilize the margins from persistent tumor cells, abrogate post-injury proliferative stimuli and bridge the therapeutic gap between surgery and radiochemotherapy.[5,6,7]

- IORT is a feasible and tolerable form of radiotherapy added to standard therapy in newly diagnosed GBM.[8,9]
- Immediate irradiation in the tumor cavity after surgical resection can avoid unnecessary time delay with a single fraction.[5]
- Geometry-optimized (spherical) irradiation of the tumor bed can reduce the damage to the surrounding normal brain parenchyma.[8,10]

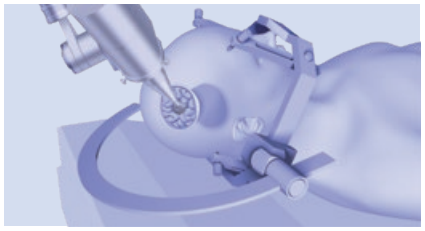
1 *The tumor is located with diagnostic imaging.*



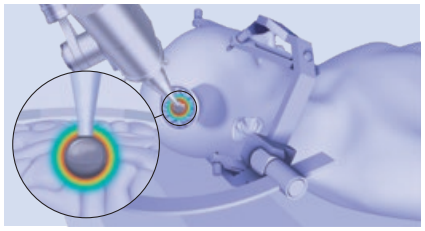
2 *The head of the patient is positioned in a surgical head frame, a skin flap is created and the bone is removed.*



3 *The tumor is surgically removed.*



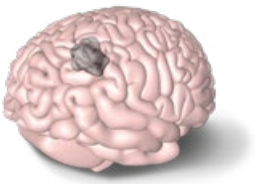
4 *The correct type and size (Ø) of the applicator is selected and the applicator is positioned in the tumor bed.*



5 *The tumor bed is locally irradiated for about 30 minutes.*

6 *The applicator is removed, bone and skin structures are reinstated and the incision is closed.*

Surgery can be mostly considered as a purely debulking procedure with the objective of achieving a maximum and safe resection. The therapy-free interval between surgery and radiotherapy is the problematic issue due to the high local recurrence rate around the glioblastoma cavity (2-3 cm).[8] In terms of time, the solution may be the immediate delivery of intraoperative radiation as a boost into the tumor bed after the surgical resection. IORT targets a small field and can minimize the risk of damage to radiosensitive organs at close proximity. Additionally, low keV-IORT reduces the dose volume by means of low-energy x-rays with a steep dose fall. Isotropic low keV-IORT incorporates a comprehensive way of treatment using the multimodality approach of brain cancer treatment and the choice of personalized care supported by microenvironment processes.[6,11]



The clinical rationale

The treatment workflow implementations are within clinical guidelines.[3,13] Postoperative dose reconstructions demonstrated that in many patients the post-resection cavities are normally of complex shape and the treatment by a spherical applicator with an isotropic dose distribution to avoid angle errors[8] and obtain local tumor control.[12] Initial experiences were gained in this oncological indication 20 years ago, with a revival now being evident.[14,15,16]

Adapt the radiation to the needs of your patients

To irradiate the tumor bed, e.g. in the treatment of brain tumors, ZEISS offers a complete range of applicators in different shapes, sizes and diameters. This versatility enables the physician to exactly adapt the emitted radiation beam to the form and size of the tumor bed.

Literature References

1 *Louis, D. N., Perry, A., Reifenberger, G., von Deimling, A., Figarella-Branger, D., Cavenee, W. K., … Ellison, D. W. (2016). The 2016 World Health Organization Classification of Tumors of the Central Nervous System: a summary. Acta Neuropathologica, 131(6), 803–820.*

2 *Weil, R. J., Mavinkurve, G. G., Chao, S. T., Vogelbaum, M. a, Suh, J. H., Kolar, M., & Toms, S. a. (2015). Intraoperative radiotherapy to treat newly diagnosed solitary brain metastasis: initial experience and long-term outcomes. Journal of Neurosurgery, 122(4), 825–832.*

3 *Niyazi, M., Brada, M., Chalmers, A. J., Combs, S. E., Erridge, S. C., Fiorentino, A., … Belka, C. (2016). ESTRO-ACROP guideline "target delineation of glioblastomas." Radiotherapy and Oncology, 118(1), 35–42.*

4 *Gzell, C., Back, M., Wheeler, H., Bailey, D., & Foote, M. (2016). Radiotherapy in Glioblastoma: the Past, the Present and the Future. Clinical Oncology.*

5 *Giordano, F. A., Wenz, F., & Petrecca, K. (2016). Rationale for intraoperative radiotherapy in glioblastoma. Journal of Neurosurgical Sciences, 60(3), 350–6.*

6 *Sologuren, I., Rodríguez-gallego, C., & Lara, P. C. (2014). Immune effects of high dose radiation treatment: implications of ionizing radiation on the development of bystander and abscopal effects. Transl Cancer Res, 3(1), 18–31.*

7 *Wang, M., Maier, P., Wenz, F., Giordano, F. A., & Herskind, C. (2013). Mitogenic signalling in the absence of epidermal growth factor receptor activation in a human glioblastoma cell line. Journal of Neuro-Oncology, 115(3), 323–331.*

8 *Giordano, F. A., Brehmer, S., Abo-Madyan, Y., Welzel, G., Sperk, E., Keller, A., … Wenz, F. (2014). INTRAGO: intraoperative radiotherapy in glioblastoma multiforme – a Phase I/II dose escalation study. BMC Cancer, 14(1), 992.*

9 *Kalapurakal, J. A., Goldman, S., Stellpflug, W., Curran, J., Sathiaseelan, V., Marymont, M. H., & Tomita, T. (2006). Phase I study of intraoperative radiotherapy with photon radiosurgery system in children with recurrent brain tumors: Preliminary report of first dose level (10 Gy). International Journal of Radiation Oncology Biology Physics, 65(3), 800–808.*

10 *Seddighi, A., Akbari, M. E., Seddighi, A. S., Rakhsha, A., Vaezi, M., & Zohrevand, A. H. (2015). First experience of intraoperative radiation therapy in cerebral high grade glioma in Iran: A report of three cases and literature review. Iranian Journal of Cancer Prevention, 8(5).*

11 *Minafra, L., & Bravatà, V. (2014). Cell and molecular response to IORT treatment. Translational Cancer Research, 3(1), 32–47.*

12 *Han, X., Fu, B., Wu, M., Zhang, H., Li, D., Zhang, J., … Sun, S. (2014). Intraoperative Radiotherapy with INTRABEAM in primary brain tumors after resection: Preliminary reports of 26 cases. Neuro-Oncology, 16.*

13 *NCCN. (2015). NCCN Clinical Practice Guidelines in Oncology - Central Nervous System Cancers.*

14 *Dinsmore, M., Yanch, J. C., Sliski, A. P., & Harte, K. J. (1994). New X-ray generator for interstitial radiotherapy. Transact. Amer. Nuclear Soc., 70, 24–25.*

15 *Cosgrove, G. R., Hochberg, F. H., Zervas, N. T., Pardo, F. S., Valenzuela, R. F., & Chapman, P. (1997). Interstitial irradiation of brain tumors, using a miniature radiosurgery device: initial experience. Neurosurgery, 40(3), 518-23–5.*

16 *Takakura, K., & Kubo, O. (2000). Treatment of malignant brain tumors. Gan to Kagaku Ryoho. Cancer & Chemotherapy, 27 Suppl 2, 449–53.*

Carl Zeiss Meditec AG
Goeschwitzer Strasse 51–52
07745 Jena
Germany
www.zeiss.com/radiotherapy
www.zeiss.com/med/contacts

Carl Zeiss Meditec USA, Inc.
5300 Central Parkway
Dublin, CA 94568
USA
www.zeiss.com/us/radiotherapy
www.zeiss.com/us/med

CAP-en-US_30_020_0003I CZ-IX/2021 Printed in the United States. United States edition. Only for sale in selected countries.