RADIATION ONCOLOGY

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# Stereotactic iodine-125 brachytherapy for brain tumors: temporary versus permanent implantation

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**Abstract**

Stereotactic brachytherapy (SBT) has been described in several publications as an effective, minimal invasive and safe highly focal treatment option in selected patients with well circumscribed brain tumors <4 cm. However, a still ongoing discussion about indications and technique is hindering the definition of a clear legitimation of SBT in modern brain tumor treatment. These controversies encompass the question of how intense the irradiation should be delivered into the target volume (dose rate). For instance, reports about the use of high does rate (HDR) implantation schemes ( >40 cGy/h) in combination with adjuvant external beam radiation and/or chemotherapy for the treatment of malignant gliomas and metastases resulted in increased rates of radiation induced adverse tissue changes requiring surgical intervention. Vice versa, such effects have been only minimally observed in numerous studies applying low dose rate (LDR) regiments (3–8 cGy/h) for low grade gliomas, metastases and other rare indications. Besides these observations, there are, however, no data available directly comparing the long term incidences of tissue changes after HDR and LDR and there is, furthermore, no evidence regarding a difference between temporary or permanent LDR implantation schemes. Thus, recommendations for effective and safe implantation schemes have to be investigated and compared in future studies.

**Keywords:** Stereotactic Brachytherapy, Permanent/Temporary Low Dose Rate Implantation, Brain Tumors

Stereotactic implantation of irradiation sources (so called stereotactic brachytherapy (SBT)) has been applied for intrinsic brain tumors and metastases for more than four decades in numerous patients. The majority of studies reported about the application of high-dose rate (HDR) iodine-125 implants (40-70 cGy/h) for high-grade gliomas, including two prospective randomized trials, which compared standard treatment regiments with/without SBT [1,2]. This approach, however, was associated with high incidence of radiation induced adverse effects requiring repeated surgery and failed to proof any significant oncological benefit as compared to standard treatment regiments. Another approach using SBT was the application of low-dose rate (LDR) implants (3-8 cGy/h) for slow growing low-grade gliomas or brain metastases which demonstrated in several very recent publications to be associated with only little permanent deficits and almost an absence of radiation induced necrosis [3-17].

A recent comprehensive review on SBT for brain tumors by Schwarz et al. [17] summarized almost all published knowledge about this technique with the clear intention to clarify and overcome some of the preconceptions associated with brachytherapy. The authors elucidated in this well written and thoroughly investigated review the rationale, physical and biological characteristics, surgical technique, indications, complications and – most important – evidence in a critical and comprehensive manner. Especially laudable is the authors´ clear recommendation to LDR implantation schemes instead of HDR as used by US groups in treatment protocols for high grade gliomas which caused unacceptable high rates of treatment relevant radiation induced necrosis [1,18,19].

Since over two decades our group also applies stereotactic iodine-125 brachytherapy in now over

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1200 patients for the treatment of - predominantly low-grade - brain tumors. Based on this experience we would like to contribute the following aspects to the discussion:

1. Schwarz et al. mention an increased risk for prolonged edema and late radiation necrosis when using permanent implantation as compared to temporary LDR implanta tion and refer to non human experimental data of the mid 1980´s [20-22].Our applied prospective treatment protocol for low grade gliomas (WHO grades I and II) stipulates permanent implantation of iodine-125 seeds with initial dose rates of 0.02 – 0.03 Gy/h (prescribed surface dose: 50–65 Gy). With this strategy we very rarely observe prolonged edema or late radiation necrosis [3,4,6,7].Interestingly, the rate of surgically relevant cysts after temporary implantation of iodine-125 seeds for low grade gliomas in a pediatric population as reported by Korinthenberg et al. [10] was three times as high (33/94 patients = 35.1 %) as in a similar population treated with permanent implants by our group (16/142 Patients = 11.3 %) [3].
   Furthermore, Kreth et al. evaluated risk factors for SBT in 515 patients with low grade brain tumors and mentioned no significant difference of temporary vs. permanent LDR implantation schemes with regard to complications [23].Thus, our clinical experience as well as the reported findings in the literature does not support at all the authors´ reservation towards permanent implantation SBT.
   However, a critical comparison of long term results with regard to radiation induced tissue changes between permanent vs. temporary LDR implantation schemes is yet not available but necessary to ultimately clarify this controversy [24].
2. To complement the review's physics part we may indicate that the Task Group 43 of the AAPM (American Academy of Physical Medicine) introduced (beginning in 1995) an internationally accepted standard for the dosimetry of iodine-125 seeds allowing to compare dosimetry between different countries and groups [25-30].
3. Further, we concur with Schwarz et al. on the importance of post operative imaging (either by intraoperative X-ray or by postoperative CT scanning) to confirm an accurate location of the implanted seeds, thus allowing a precise comparison with the irradiation plan at any time [31].

Ultimately, publications of this high quality keep one of oldest and most sophisticated neurosurgical technique in a vivid discussion as a minimal invasive, safe, and highly effective neuro-oncological local treatment option for selected patient populations.

**Abbreviations**

SBT: Stereotactic BrachyTherapy; HDR: High Does Rate; LDR: Low Dose Rate; cGy/h: Centigray Per Hour; AAPM: American Academy of Physical Medicine.

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