Radiosurgical Management of Brain Metastases

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KEYWORDS

• Brain • Management • Metastasis • Metastases
• Radiation • Radiosurgery

Stereotactic radiosurgery (SRS) has been established as an excellent treatment option for a large subset of patients with metastatic brain disease. Evidence-based practice guidelines have recently been published attempting to consolidate the wide variety of data available regarding when and how to implement SRS in the comprehensive treatment of this heterogeneous patient population.[1] Although class I evidence is sparse in the current literature, many effective treatment paradigms have evolved centered around SRS.

STEREOTACTIC RADIOSURGERY—OVERVIEW

SRS is a technique for treating lesions with a high dose of ionizing radiation, usually in a single session, using a stereotactic apparatus for accurate localization and patient immobilization.[2] Unlike whole-brain radiation therapy (WBRT), SRS is designed to deliver a high amount of radiation to a focal target while minimizing the dose to surrounding brain tissue.[3] The radiation dose within the target (ie, tumor) is much higher than that of surrounding tissue because of the sharp dose gradient achieved by multiple intersecting beams of radiation.[3] Pathophysiological mechanisms behind the tumor-killing effects of SRS are not well established but likely involve endothelial cell damage, microvascular dysfunction, and the immune response.[4–7]

SRS is currently performed with 3 modalities: protons and heavier charged particles, linear accelerator–produced bremsstrahlung x-ray beams, and the ^{60}Co Leksell Gamma Unit (LGU) (**Fig. 1**).[2] Proton-beam SRS uses a cyclotron-based device capable of precisely controlling the depth of proton penetration at the target, thereby depositing most of its energy within the tumor. Few institutions use this technology because of expense and space constraints. Linear accelerators (LINAC) are used to generate a high-energy x-ray beam by accelerating an electron at a metal target. These beams are sequentially directed at the tumor from multiple static beams or arcs through multileaf collimators. LINAC technology is versatile in that it can be modified to perform a variety of radiation procedures in multiple anatomic locations and its utility is not limited to cranial applications. Gamma knife radiosurgery (GKRS) is a technology dedicated to cranial and upper head and neck disease processes. The

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GKRS unit is composed of 192 individual ^{60}Co-based sources arranged in a conical tungsten shell designed to focus convergent gamma-ray beams at the target under control of a treatment computer. As a dedicated cranial unit, newer versions of this technology are designed to rapidly and efficiently treat multiple intracranial targets in a single planning session. Randomized trials comparing the efficacy of one SRS technology to another have not been performed. As a result, the decision to use one technology over another is subjective and based on physician preference and machine availability.[3]

CLINICAL EVIDENCE

Many questions remain unanswered in terms of the best and most appropriate treatment strategy for any one particular patient with metastatic brain