Letter to the Editor

Principles of Stereotactic Radiation Treatment

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In the management of many brain tumors and lesions, several modalities – including surgery, conventional radiotherapy and stereotactic radiotherapy – are used. Any of these modalities are sometimes used as the only treatment or combined with other modalities.

Radiotherapy techniques have evolved significantly; 2-Dimensional technique gradually changed to 3-Dimensional Conformal (3DC) technique. Based on new progressions in softwares and hardwares, today Intensity Modulated Radiation Treatment (IMRT) is performed as a precise and sophisticated raditherapy technique. Of course, IMRT has different subtypes – including step & shoot, sliding window, IMAT, VMAT and Tomotherapy – which are beyond the goal of this article.

In radiotherapy the optimal goal is that the region to be treated (known as Target Volume) receives tha maximum part of the prescribed dose and meanwhile, the normal tissues and OrgansAt Risk (OARs) be spared and receive the least part of the delivered radiation; so that we will see the most therapeutic effects of treatment and the least possible side-effects. Radiotherapy techniques have evolved to reach this goal better.

In brain, the most important OARs – that their damages induced by radiation, are serious and sometimes irreversible – include optic pathway and brainstem. Cognitive impairment after radiotherapy is directly related to the dose received by the Hippocampi.

In Stereotactic radiotherapy (Stx), Target Volume is shot very precisely from several directions; so that a very high dose can be delivered in a focal and concentrated way in order to stop a tumoral growth or to obliterate a vascular lesion.

Usually, the term SRS or Stereotactic Radio-Surgery is used when all radiation dose is irradiated to the target in one treatment session. But when it becomes necessary, radiation therapy is irradiated in several sessions instead of one session; and the term FSRT or Fractionated Stereotactic Radiation Treatment is used. Of course, in different sources and articles, these terms sometimes overlap; In other words, when the treatment is performed in several sessions, it does not mean that radiosurgery is not performed.

Various devices and instruments are capable of performing stereotactic treatment. The most famous device - especially among colleagues of

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Received: 01/06/2026
Accepted: 23/08/2026

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Please Cite this Article as:
Farzin M. Principles of Stereotactic Radiation Treatment. Iranian Journal of Surgery. 2026; 34 (3): 123-125. doi:

neurosurgeons - is the Gamanaife device. But other devices - which are based on linear accelerator technology - can also provide this treatment; including the Cyberknife device, tomotherapy, radiotherapy linear accelerators (equipped for this treatment) and also new devices such as ZAP. Even the treatment devices with charged particles (such as proton therapy device and carbon ion therapy device) have the ability to perform stereotactic treatment if the necessary facilities are provided.

The initial versions of the Gamma Knife device performed the treatment only in frame-based form; This means that a metal frame is fixed on the patient's head with the help of four screws, and thus the treatment is performed with maximum accuracy and errors of less than one millimeter; Although it is a relatively invasive method. With the help of this frame, the patient's head is placed in a hemispherical chamber, and the therapeutic target is targeted by dozens of radioactive sources located in the wall of this hemisphere.

In line with the move towards non-invasive treatments in radiotherapy, the possibility of frameless stereotactic treatment using fixators similar to radiotherapy fixators, using devices other than Gama Knife - which were mentioned above - became available. Besides, the manufacturing company of Gamanaife has finally made the possibility of stereotactic treatment with and without frame with the Gamanaife device by producing a new version called "icon". Of course, it should be noted that the maximum accuracy with an error of less than a millimeter is still with frame-based treatment, and this method is used in single-session treatments, especially in cases where high doses are required. Another point is that Gama Knife treatment can be performed exclusively for the brain and the beginning of the cervical spinal cord (up to the alignment of the C2 vertebra), but stereotactic treatment for other parts of the spinal cord is possible with other devices.The smaller the volume of the treatment target, the more possible it is to prescribe higher doses (in order to meet the tolerance limit of the normal tissues around the target); And on the contrary, in high target volumes, if high doses are prescribed, the possibility of exceeding the limit of normal tissues and damaging them increases. On the other hand, administration of higher doses per treatment session will increase the probability of response – whether in vascular lesions, benign tumors or even malignancies. In this way, by respecting both sides of the case, one should move towards the most effective and least complicated treatment.

In performing stereotactic radiotherapy, criteria have been established to determine suitable cases; For example, size below 3 cm or volume below 10-15 cc to perform radiosurgery; Or prohibition of treatment for lesions that are less than 2-3mm away from the chiasma or brain stem. But in daily practice, these criteria can be adjusted to a large extent, and the decision to treat each case is made individually based on the decision of a group of specialists.

There is a long list of tumors and vascular lesions as well as functional neurological diseases in the brain that can be candidates for treatment with stereotactic radiotherapy; As examples, we refer to cases such as AVM, cavernoma, meningiomas, pituitary adenomas, brain metastases, vestibular schwannoma and trigeminal neuralgia.

The last point is that sometimes in the first few months after the stereotactic treatment of some brain tumors (such as meningiomas and vestibular schwannoma), not only should we not expect tumor shrinkage, but we should not worry about a "slight" increase in the size of the lesion. Edema and inflammation caused by radiation sometimes cause such a condition. In this situation, the lesion should be given time for a few months and after re-imaging, make a conclusion about the success or failure of the treatment.

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