

# Gamma Knife radiosurgery

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[Gamma Knife radiosurgery](#) is a type of [radiation therapy](#) used to treat tumors and other abnormalities in the brain.

see also [Fractionated Gamma Knife Radiosurgery](#)

## History

In [1951](#), using the [Uppsala](#) University cyclotron, [Lars Leksell](#) and the physicist and radiobiologist Borje Larsson, developed the concept of [Radiosurgery](#). Leksell and Larsson first employed proton beams coming from several directions into a small area into the brain , in experiments in animals and in the first treatments of human patients. Thus, he achieved a new non-invasive method of destroying discrete anatomical regions within the brain while minimizing the effect on the surrounding tissues.

First prototype of Gamma Knife was installed in Sophiahemmet in 1968. Over the rest of his career, Leksell treated 762 patients with the “Gamma Knife”. Throughout this time he would propose improving radiosurgery with modern imaging modalities including CT, MRI and angiography, as is currently used. Today, Leksell's technique is used as an effective treatment for many conditions such as arteriovenous malformations, pituitary tumors, acoustic neuromas, craniopharyngiomas, Meningioma, Matastatic and skull base tumors, and primary brain tumors. The Gamma Knife is manufactured by [Elekta](#) Instruments, Inc.

see [Leksell Gamma Knife Perfexion](#).

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In Gamma Knife radiosurgery, specialized equipment focuses close to 200 tiny beams of radiation on a tumor or other target. Although each beam has very little effect on the brain tissue it passes through, a strong dose of radiation is delivered to the site where all the beams meet.

The precision of Gamma Knife radiosurgery results in minimal damage to healthy tissues surrounding the target. In some cases, Gamma Knife radiosurgery may have a lower risk of side effects compared with other types of radiation therapy. Also, Gamma Knife radiosurgery is often a safer option than is traditional brain surgery.

Gamma Knife radiosurgery is usually a one-time therapy completed in a single day.

## Indications

[Gamma Knife radiosurgery Indications.](#)

## Planning

The [purpose](#) of a [study](#) of Duggar et al. was to compare two [methods](#) of [stereotactic localization](#) in [Gamma Knife](#) treatment [planning](#): [cone-beam computed tomography](#) (CBCT) or [fiducial](#). While the fiducial method is the traditional method of localization, CBCT is now available for use with the Gamma Knife Icon. This study seeks to determine whether a difference exists between the two methods and then whether one is better than the other regarding accuracy and workflow optimization.

Cone beam computed tomography was used to define stereotactic space around the Elekta Film Pinprick phantom and then treated with film in place. The same phantom was offset known amounts from center and then imaged with CBCT and registered with the reference CBCT image to determine if measured offsets matched those known. Ten frameless and 10 frame-based magnetic resonance imaging (MRI) to CBCT patient fusions were retrospectively evaluated using the TG-132 TRE method. The stereotactic coordinates defined by CBCT and traditional fiducials were compared on the Elekta 8 cm Ball phantom, an anthropomorphic phantom, and actual patient data. Offsets were introduced to the anthropomorphic phantom in the stereotactic frame and CBCT's ability to detect those offsets was determined.

Cone beam computed tomography defines stereotactic space well within the established limits of the mechanical alignment system. The CBCT to CBCT registration can detect offsets accurately to within 0.1 mm and 0.5°. In all cases, some disagreement existed between fiducial localization and that of CBCT which in some cases was small, but also was as high as 0.43 mm in the phantom domain and as much as 1.54 mm in actual patients.

Cone beam computed tomography demonstrates consistent accuracy in defining stereotactic space. Since both localization methods do not agree with each other consistently, the more reliable method must be identified. Cone beam computed tomography can accurately determine offsets occurring within stereotactic space that would be nondiscernible utilizing the fiducial method and seems to be more reliable. Using CBCT localization offers the opportunity to streamline workflow both from a patient and clinic perspective and also shows patient position immediately prior to treatment <sup>1)</sup>.

## Books

Berger A. Book Review: Recent Advances and Controversies in Gamma Knife Neurosurgery. Neurosurgery. 2022 Nov 21. doi: 10.1227/neu.0000000000002258. Epub ahead of print. PMID: 36409960.

1)

Duggar WN, Morris B, Fatemi A, Bonds J, He R, Kanakamedala M, Rey-Dios R, Vijayakumar S, Yang C. Gamma Knife(®) icon CBCT offers improved localization workflow for frame-based treatment. J Appl Clin Med Phys. 2019 Oct 6. doi: 10.1002/acm2.12745. [Epub ahead of print] PubMed PMID: 31587520.

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