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# Tissue Changes after Radiosurgery for Vestibular Schwannomas

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**Abstract**

The specific effects of radiosurgery on brain tumor tissue are not well understood. We review several approaches that have been used to address this issue. Correlating the radiobiology of radiosurgery with the radioclinical outcome may help to understand these tissue changes. In vivo imaging investigations are usually performed with MRI, but the use of functional and metabolic imaging, such MR spectroscopy, positron emission tomography or single-photon emission computed tomography may provide additional information on the effects of radiosurgery. Finally, histological observations represent an invaluable source of information, when systematically analyzed in their clinical context.



The specific effects of radiosurgery on brain tumor tissue still needs better understanding. The concept of radiosurgery developed by Leksell aimed at the precise destruction of a chosen target by ionizing beams delivered in a single session, without significant destruction of the adjacent tissues. In the original conception of radiosurgery, the desired goal was a total destructive effect within the selected target volume. Originally, Leksell developed Gamma Knife as an alternative method to electrode-based lesioning of deep-seated tracts or nuclei for functional neurosurgery. As such, the doses delivered were very high, with the aim of inducing a necrotic lesion at the target point. Since then, several animal studies and clinical observations have validated this effect [1]. However, as stated by Norén [2] in his historical perspective of Gamma Knife radiosurgery for vestibular schwannomas (VSs), 'there is no doubt that Lars Leksell had acoustic neurinomas in mind when he presented the concept of radiosurgery in 1951'. Indeed, in his first paper, Leksell suggested the use of the technique also for the treatment of deep-seated circumscribed tumors. Accordingly, the first patients with VS were also treated with very high doses when compared to current protocols, leading to a high rate of VIIth and Vth cranial nerve neuropathies. In parallel to the advancements in image-based targeting and in the dosimetry techniques, the clinical results also improved thanks to the progressive changes in dose prescription [3]. Indeed, accumulated experience has shown that in tumoral radiosurgery, the use of high doses, aiming at a total tumoral necrotic destruction, are associated with high complication rate. In benign tumors especially, the use of lower doses has shown to provide a high rate of tumoral cell inactivation, yielding high