Use of polymer gel for bypassing the stereotactic imaging step prior Gamma Knife radiosurgery in small animals

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Object. Accurate targeting is crucial for the irradiation of a small volume in an animal model, such as lesions produced in the rat brain by Gamma Knife. We propose an original method based on a polymer gel dosimeter to determine the accuracy and reproducibility of irradiation using a new stereotactic frame. Methods. A in-house designed rat stereotactic frame compatible with the Gamma Knife Automatic Positioning System was constructed. Initial spatial coordinates to target the right frontal lobe were acquired by X-ray imaging of the rats positioned in the stereotactic frame using the Gamma Knife angiographic fiducial box. The rat brain was then removed through a small burr hole and the intracranial cavity was washed and filled with the polymer gel dosimeter. This "gel brain" was irradiated at a dose of 15 Gy using 4 or 8 mm collimator helmets. The irradiated volumes coordinates were measured non-invasively by magnetic resonance imaging (MRI) or visually after excision of the polymer gel. Results. The position of the polymerized areas revealed that the stereotactic frame is able to accurately reproduce the same position of irradiation in each animal. The average location of the center of the polymerized areas was as follows: X = 3.07 ± 0.31 mm, Y = 5.50 ± 0.26 mm and Z = 0.90 ± 0.45 mm when using 8 mm collimators; and X = 2.86 ± 0.18 mm, Y = 6.00 ± 0.22 mm and Z = 0.58 ± 0.39 mm for 4 mm collimators. The small standard deviation demonstrated that assessment of the irradiated volume performed with the gel dosimeter was highly reproducible. Conclusion. The polymer gel dosimeter confirmed the ability of the rat stereotactic frame to accurately and reproducibly position a small animal for precise radiosurgery procedures. These characteristics eliminate the need of stereotactic imaging before irradiation.

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