

## Progress Towards Optimizing and Standardizing Fiducial Placement Geometry in Prostate, Renal, and Pancreatic Cancer

**Authors :** Shiva Naidoo, Kristena Yossef, Grimm Jimm, Mirza Wasique, Eric Kemmerer, Joshua Obuch, Anand Mahadevan

**Abstract :** Background: Fiducial markers effectively enhance tumor target visibility prior to Stereotactic Body Radiation Therapy or Proton therapy. To streamline clinical practice, fiducial placement guidelines from a robotic radiosurgery vendor were examined with the goals of optimizing and standardizing feasible geometries for each treatment indication. Clinical examples of prostate, renal, and pancreatic cases are presented. Methods: Vendor guidelines (Accuray, Sunnyvale, Ca) suggest implantation of 4–6 fiducials at least 20 mm apart, with at least a 15-degree angular difference between fiducials, within 50 mm or less from the target centroid, to ensure that any potential fiducial motion (e.g., from respiration or abdominal/pelvic pressures) will mimic target motion. Also recommended is that all fiducials can be seen in 45-degree oblique views with no overlap to coincide with the robotic radiosurgery imaging planes. For the prostate, a standardized geometry that meets all these objectives is a 2 cm-by-2 cm square in the coronal plane. The transperineal implant of two pairs of preloaded tandem fiducials makes the 2 cm-by-2 cm square geometry clinically feasible. This technique may be applied for renal cancer, except repositioned in a sagittal plane, with the retroperitoneal placement of the fiducials into the tumor. Pancreatic fiducial placement via endoscopic ultrasound (EUS) is technically more challenging, as fiducial placement is operator-dependent, and lesion access may be limited by adjacent vasculature, tumor location, or restricted mobility of the EUS probe in the duodenum. Fluoroscopically assisted fiducial placement during EUS can help ensure fiducial markers are deployed with optimal geometry and visualization. Results: Among the first 22 fiducial cases on a newly installed robotic radiosurgery system, live x-ray images for all nine prostatic cases had excellent fiducial visualization at the treatment console. Renal and pancreatic fiducials were not as clearly visible due to difficult target access and smaller caliber insertion needle/fiducial usage. The geometry of the first prostate case was used to ensure accurate geometric marker placement for the remaining 8 cases. Initially, some of the renal and pancreatic fiducials were closer than the 20 mm recommendation, and interactive feedback with the proceduralists led to subsequent fiducials being too far to the edge of the tumor. Further feedback and discussion of all cases are being used to help guide standardized geometries and achieve ideal fiducial placement. Conclusion: The ideal tradeoffs of fiducial visibility versus the thinnest possible gauge needle to avoid complications needs to be systematically optimized among all patients, particularly in regards to body habitus. Multidisciplinary collaboration among proceduralists and radiation oncologists can lead to improved outcomes.

**Keywords :** fiducial, prostate cancer, renal cancer, pancreatic cancer, radiotherapy

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