The Rotating Gamma System
Gamma ART 6000: a Review of the First 100 Patient Treatments

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Abstract
The Gamma ART 6000 Rotating Gamma System has been used at the Rotating Gamma System Institute since September, 2003. Since then over 120 radiosurgery cases have been performed with the system. This unique device is a hybrid between the older Multisource Cobalt60 Radiosurgery units and LINAC radiosurgical units. The Gamma ART 6000 has features which expand the radiosurgical armamentarium for the neurosurgeon. This is the only Co60 based unit capable of IMRS. Experience with the unit so far has demonstrated that it is capable of treating any targets treatable by the author using the older Multisource Cobalt60 Radiosurgery units. Because of the larger work envelope compared to the older Multisource Cobalt60 Radiosurgery units and better shielding for the patients during treatment, more complex lesions have been treated. This seems to be true particularly for skull base tumors which at times are beyond the work envelope of the older Multisource Cobalt60 Radiosurgery units and mechanical accuracy of the LINAC systems.

Introduction
The author has performed more than 2500 stereotactic radiosurgery procedures with various modalities. These procedures were done with various equipment using: American Radiosurgery Gamma ART 6000 Rotating Gamma System; Elekta Gamma Knife A/U unit; Elekta Gamma Knife B unit; Radionics X-knife system with the floor mount stand; Radionics X-knife system with the couch mount frame holder; Nomos Peacock System with the Leksell stereotactic frame; Nomos Peacock System with custom frames for spine treatment; shaped beam radiosurgery using the BRW frame, ADAC planning system, and custom blocks; BrainLAB M3 collimator with IMRT technique; and Varian multileaf collimator with IMRT technique.

When starting a new radiosurgery center, equipment had to be selected as the main starting point for patient treatments. The American Radiosurgery Gamma ART 6000 was selected for this purpose for various reasons.

The American Radiosurgery Gamma ART 6000 Rotating Gamma System is a hybrid which has features of both Gamma knife and LINAC radiosurgery systems. There is a cleaner energy output due to cobalt 60 radioactive sources compared to LINAC systems. The Gamma ART 6000 is built to match the isocenter tolerance of the Gamma knife. The isocenter location is very precise in stereotactic space. Due to precision bearings, the beam stability within the isocenter is very accurate. Changing collimator sizes is automatically controlled by a computerized motion control system. Therefore, it is not necessary to change helmets in order to change isocenter sizes. Arc motion of the sources simulates an infinite number of sources as in a LINAC system. The source distribution has the effect of delivering each isocenter with the equivalent of 30 table angles when compared to a LINAC system. In terms of LINAC systems, this results in 10,800 arc degrees per isocenter if no blocking is used. The unique design of this machine keeps the beams off after the shielding doors are open until the patient is in the treatment position. This significantly reduces the amount of scattered radiation to the patient as the table moves into the
treatment position. The machine has a capability of providing IMRS treatments. This capability is unique to a cobalt 60 based unit. Since the computer can control turning the beams on and off, active beam blocking is another capability the machine provides to protect critical structures. The Gamma ART 6000 has a larger work envelope than the Gamma Knife, which makes possible treatment of lesions that the former technology could not reach. For these reasons, the Gamma ART 6000 was chosen as the first equipment for the new stereotactic radiosurgery center.

Materials and Methods
The Rotating Gamma System Institute obtained, installed, and commissioned the American Radiosurgery Gamma ART 6000 Rotating Gamma System. This is currently the only machine of this model operating in the world. The machine was delivered with the Explorer 3-D planning system from American Radiosurgery which was written by the Northwest Medical Physics Group. Preplanning for most of the cases performed on the system was done with the author's custom software to expedite and improve patient treatments.

![Rotating Gamma System Institute, Gurnee, IL, USA Gamma ART 6000® First 100 Cases](image1.png)

**Figure 1**

Data and Analysis
During the first two years of operation, 120 cases were performed using the Gamma ART 6000 Rotating Gamma System. The distribution of the first 100 cases by diagnosis is shown in Figure 1. It was felt that all cases previously done by the author with the Gamma knife were able to be treated with the Rotating Gamma System obtaining very similar dose distributions. This would be expected from the work of SJ Goetsch, at al. (1) who previously reported on the physics of the Rotating Gamma System and concluded that "It has similar physical characteristics to those
previously reported for the Leksell model U Gamma Knife unit.”

Figure 2

In the treatment of larger skull base lesions, requiring multiple isocenters and an increased work envelope, the Gamma ART 6000 Rotating Gamma System provided certain advantages. Compared to a LINAC system, there was increased mechanical accuracy to treat the lesions more confidently. Multiple isocenters allowed excellent conformity and more mechanical accuracy than linear accelerator systems. The increased work envelope compared to the Gamma knife allowed complete treatment of portions of these tumors which were previously outside the work envelope of the older units. Figure 2 shows an example of such a tumor. This patient had multiple open surgical procedures, chemotherapy, and radiation therapy. When tumor progression was noted, multiple neurosurgical centers where LINAC and Gamma Knife radiosurgery are routinely performed informed the patient that there was nothing else to offer for the progressive tumor. Figure 2 demonstrates regression of this large skull base carcinoma involving both cavernous sinuses, sellar area, and the right middle fossa after radiosurgery performed using the Gamma ART 6000 Rotating Gamma System.

Conclusion

In the author's experience, the Gamma ART 6000 Rotating Gamma System allowed the treatment of lesions previously treated by Gamma Knife radiosurgery. The increased accuracy compared to previously used LINAC radiosurgery systems and increased work envelope compared to previously used Gamma Knife systems allowed successful treatment of tumors beyond capabilities of the older technologies in selected cases.

References