

# Gamma Knife® radiosurgery

## Medically Refractory

## Essential Tremor



### Introduction

Tremor is a common movement disorder that can have disabling effects on daily living, impact employment, and reduce quality of life. Medical management strategies are helpful for some patients, but many patients either become unresponsive to medication or derive no benefit. As the population ages, tremor patients with high surgical risk comorbidities such as long term anticoagulation have been deemed ineligible for invasive surgical procedures. Stereotactic radiosurgical Gamma knife® thalamotomy (GKSRS) is an important option for tremor patients ineligible for other types of thalamic surgery because of advanced age or surgical comorbidities.

### Gamma Knife Radiosurgery Technique for Essential Tremor

A contrast-enhanced volume acquisition MRI (with images at 1mm intervals) is performed for stereotactic targeting through the thalamus and midbrain in order to identify the anterior and posterior commissures (AC, PC) and the third ventricle. An axial fast inversion recovery sequence is then obtained to better identify the internal capsule and differentiate gray and white matter structures. The 20% isodose line of the 4mm collimator is kept medial to the internal capsule. A maximum dose of 130–140Gy is the most common dose, delivered with a single 4mm isocenter.

The radiobiological effect of the radiosurgical lesion is unique. The effect consists of a limited central target necrosis (3-4mm in diameter) where the highest dose is delivered. This central zone is surrounded by a non-necrotic peripheral or halo effect that may also provide therapeutic benefit to thalamic cells generating tremor.

### Clinical Results

In 70 patients out of 86 from a 2013 series, at least one of the 8 assessed scores was improved following Gamma Knife® Thalamotomy. Of these 70 patients, the median followup time before improvement was demonstrated was 4 months. A recent prospective multicenter study from Japan with 72 patients (PD or MS) found that 81% of patients had

excellent or good results. In a University of Pittsburgh series, in each disease subset, GKSRS provided statistically significant improvements in FTM writing, tremor and drinking scores.

Detailed below are specific outcomes (Fahn-Tolosa-Marin clinical tremor rating scale) as recently published by Kooshkabadi et al. Overall, the preoperative mean tremor score was  $3.3 \pm 0.8$  and  $1.8 \pm 1.2$  ( $p < 0.00001$ ) after radiosurgery. The mean handwriting score was  $2.8 \pm 0.8$  before GKT and  $1.6 \pm 1.0$  ( $p < 0.00001$ ) afterward. The mean preoperative drinking score was  $3.1 \pm 0.8$  and  $1.8 \pm 1.1$  ( $p < 0.00001$ ) afterward. The clinical benefit of radiosurgery for any indication occurred at an average of two months (range, one week to 8 months).

### Conclusion

There are increasing numbers of patients with medically refractory and disabling tremor who are poor candidates for open surgery and require some form of treatment. Gamma Knife® radiosurgical thalamotomy has provided benefit to the majority of patients who underwent the procedure. It has been found to be both safe and effective. The outcomes data has been consistent across centers, both in the United States and Japan. The technique appears to be underutilized given the large number of patients with disabling tremor, especially in an aging population.

## References

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