

Comparing Varian EDGE and Gamma Knife Perfexion for brain metastases radiosurgery. Preliminary results

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Introduction: Brain metastases occur in 20–40 % of patients affected by primary solid tumors. Radiosurgery (SRS) was demonstrated to be safe and efficient for the brain metastases control. SRS can be delivered with dedicated equipment, like Gamma Knife (GK), or linacs. Few comparative studies have been conducted. In our institution we designed a phase III randomized trial to evaluate cerebral side effects following SRS delivered by Gamma Knife Perfexion (Elekta Instrument AB, Stockholm, Sweden) and linac EDGE (Varian Medical Systems, Palo Alto, CA).

Methods and materials: Patients with 1 to 4 brain metastases, from any primary except for small cell lung cancer (SCLC) or Lymphoproliferative disease, suitable for SRS were randomized to receive the treatment with GK or Linac EDGE. Primary end point was toxicity (symptomatic radionecrosis). Other survival endpoints were considered as secondary. Planning parameters, including target volumes, dose prescription and coverage, Paddick conformity index (PCI), gradient index (GI) and homogeneity index (HI) were determined as commonly defined. PTV was derived from GTV according to standard guidelines. Beam on time (BOT) was also recorded. Each index was calculated according to the corresponding target volume and treatment isodose. In our center, Linac

based immobilization was made by an open mask setup (Qfix Systems LLC, Avondale, PA). CBCT-based IGRT was applied and patients monitored by Optical Surface Monitoring tracking and gating System (OSMS) during the delivery. GK immobilization was performed by the traditional stereotactic head frame by Elekta. For this reason, no specific online imaging or tracking device was required. Due to the early stage of the study we only present preliminary dosimetric results. In this report, variables distributions are represented as box plots, including median (central line), quartiles (box) and adjacent values (whiskers) according to Tuckey. Dots are outliers.

Results: Until now, 50 patients with 74 metastases (range 1-4) were enrolled in this phase III trial (24 GK, 26 EDGE) with prescriptions as represented in table 1. GTV volume did not show any significant difference in the two arms, PTV was contoured for EDGE only (figure 1). Tumor coverage in GK was 100% for all cases except 5, reaching 99%. Median coverage for EDGE was evaluated as 99.2%. PCI evaluation was better for linac-based plans (figure2), whereas a better (lower) GI with a worse (higher) HI for GK was observed (figure3). For GK, we found an increase in GI (median = 3.05, $p=0.043$) and a decrease of HI (median = 0.20, $p<0.01$) for the 5 cases with prescription at a reference isodose higher than 50% (table 1). As expected, lesion specific BOT was greatly lower ($p<0.01$) for Linac (median = 1.91 min) respect to GK (median = 30.3 min).

Conclusions: Dosimetric characteristics were shown to be significantly different in the two study arms. For Linacs, a more conformed and homogeneous dose distribution was obtained in the target. In contrast, a better and significantly higher dose gradient was found in GK treatments. These data can be explained considering the differences both in the physical properties of the involved beams and the prescription modalities adopted for the two techniques. Data suggest that GTV in GK is largely covered as if a virtual margin was applied for covering a larger area, although a PTV is not explicitly contoured. Taking this “virtual” PTV into account would lead to a decrease in the observed differences in PCI and coverage between the two study arms. Although a possible deterioration in the GI for GK may occur at increasing reference isodose prescriptions, this should be better investigated in a larger series. Due to the shorter treatment time and the use of non-invasive immobilization system a better comfort for the patient may be associated to Linac-based therapy.

Table1: lesion prescription according to technique

Technique (ref volume)	Prescription dose (Gy)	Reference Isodose (%)	Mets (n)
EDGE (PTV)	24	95	32
	15	50	1
GK (GTV)	20	50	7
		65	1
	21	50	1
	22	50	2
		55	1
	23	50	5
	24	50	21
	60	3	
Lesion total			74

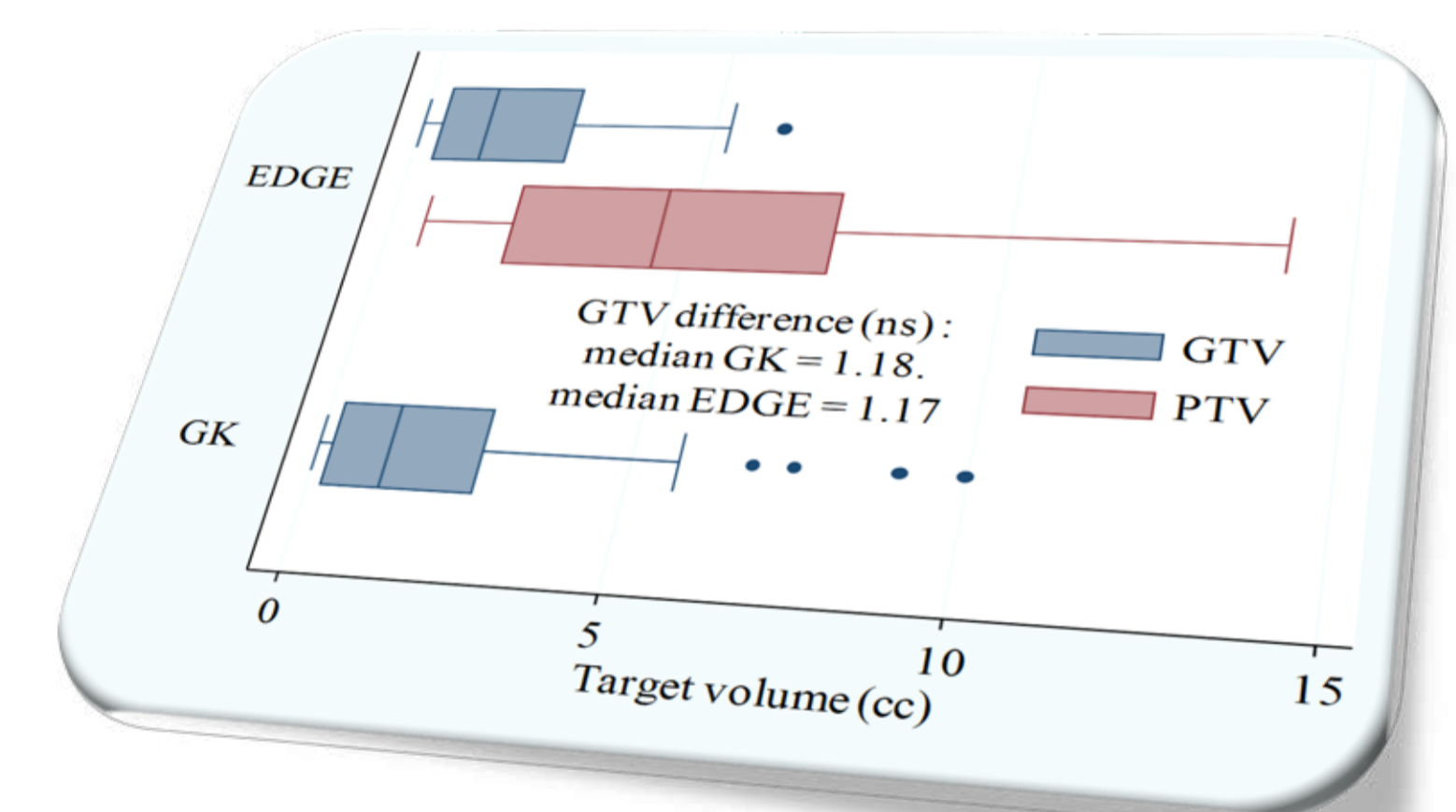


Figure1: target dimension in the two study arms. PTV for EDGE only

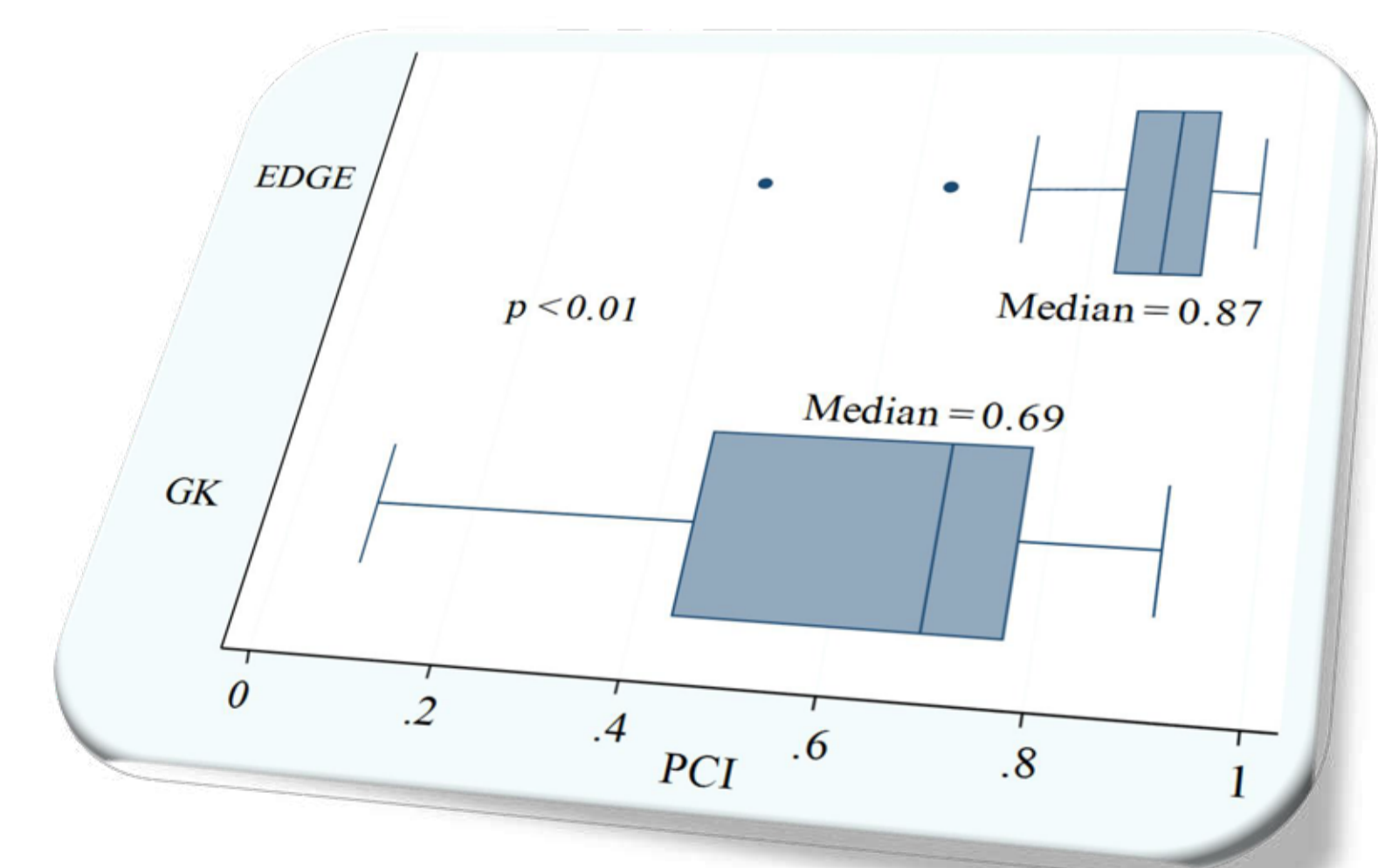


Figure2: PCI in the different techniques

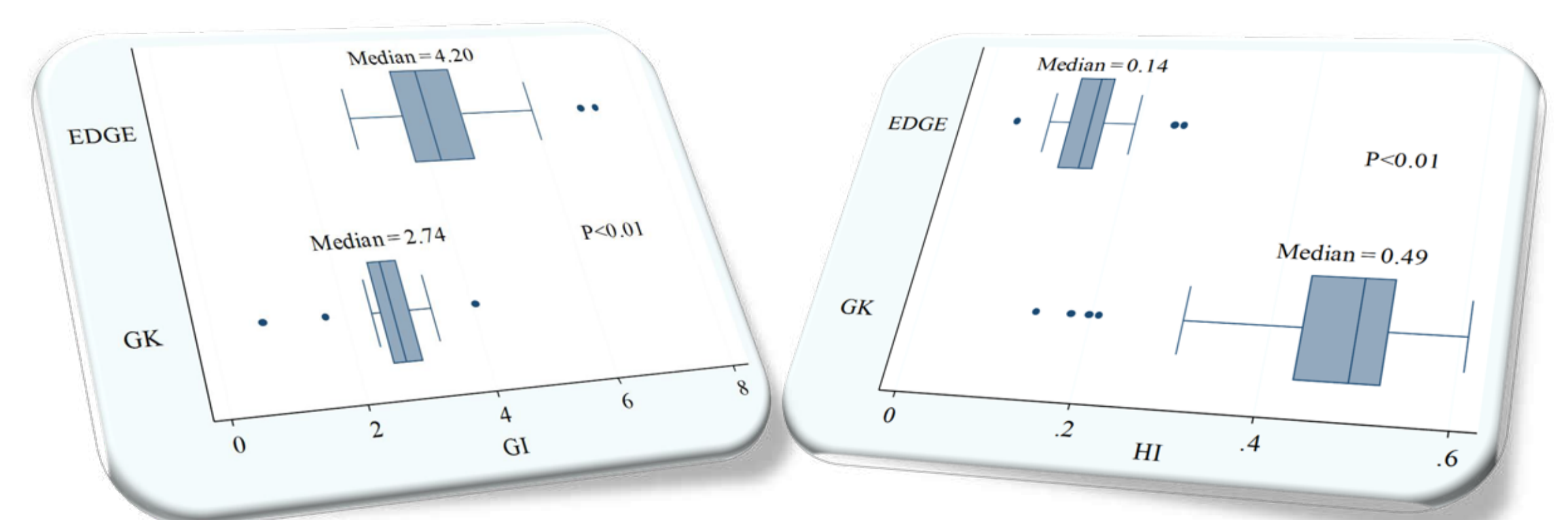


Figure3: GI and HI in the two different populations