Introduction
Gadolinium-contrast enhanced MR imaging is a gold standard in the diagnosis of brain tumors. In clinical practice, i.e. working with field strengths of up to 1.5T, 0.1mmol/kg body weight of Gadolinium-contrast agent is commonly considered the standard dose.

As T1-relaxation times and signal-to-noise ratio (SNR) increase with field strength, there is evidence to suggest that T1-shortening contrast agents may be more effective at higher magnetic fields [1].

To quantify these effects in-vivo, we performed a prospective intra-individual comparative trial on patients with contrast enhancing brain lesions. Aim was to find out whether the increased SNR and contrast-to-noise ratio (CNR) and the increased relaxation times at higher magnetic field allow one to reduce the dose of contrast agent at a given lesion contrast.

Materials and Methods
Patients
This is an intra-individual comparative study on 12 patients (6 female, 6 male, mean age 58 years, age range 29 to 76 years). Eleven patients had primary brain tumors and one had cerebral metastases.

Imaging
All patients underwent contrast-enhanced MR imaging on three consecutive days: once on a state-of-the-art 1.5T system (standard protocol, full dose with 0.1mmol/kg Gadolinium-DTPA), once on a 3T system with the full dose, and once at 3T with the half-standard dose (0.05mmol/kg). Images were acquired on clinical whole-body 3T and 1.5T MR-scanners (Intera, Philips Medical Systems, Best, The Netherlands) both equipped with strong gradient systems (amplitude 30 mT/m, slew rate 150 mT/m/ms). A transmit/receive and receive head coil was employed at 3T and 1.5T, respectively. On all occasions, the same T1-weighted SE images were obtained in transverse orientation (TR=500ms, slice thickness 5mm, field of view 230x230mm, matrix size 256x206). Delay after Gadolinium-DTPA injection was kept the same in all examinations.

Analysis
Quantitative image analysis was performed by ROI-measurements of enhancing lesions and contralateral white matter. CNR was calculated using the mean of three independent measurements each. Number and configuration of lesions were assessed visually.

Results
ROI-based image analysis demonstrated 2.5-fold higher CNR for the full dose at 3T compared to the full dose at 1.5T. Half-standard dose at 3T still yielded higher CNR (1.3-fold) as compared to full dose at 1.5T.

These quantitative results are in accordance with the qualitative impression of the images (figure 1). Visual analysis revealed the same number and configuration of enhancing lesions at all three protocols.

Discussion
Owing to the inherently higher SNR/CNR at 3T, these data suggest that it is possible to halve the standard contrast dose of 0.1mmol/kg and still achieve an at least equivalent CNR of enhancing brain lesions compared to standard 1.5T MR imaging using the full contrast dose.

When searching for small cerebral metastases, use of higher than standard doses of contrast agent has been shown to be more effective [2]. Therefore, we suppose that in selected cases (e.g. search for subtle blood-brain-barrier disruptions secondary to metastases or inflammation), the full dose of 0.1mmol/kg at 3T may be used to increase diagnostic sensitivity compared to full dose imaging at 1.5T.

References
1. Elster AD. How much contrast is enough? Dependence of enhancement on field strength and MR pulse sequence. Eur Radiol 1997; 7 Suppl 5: 276-80