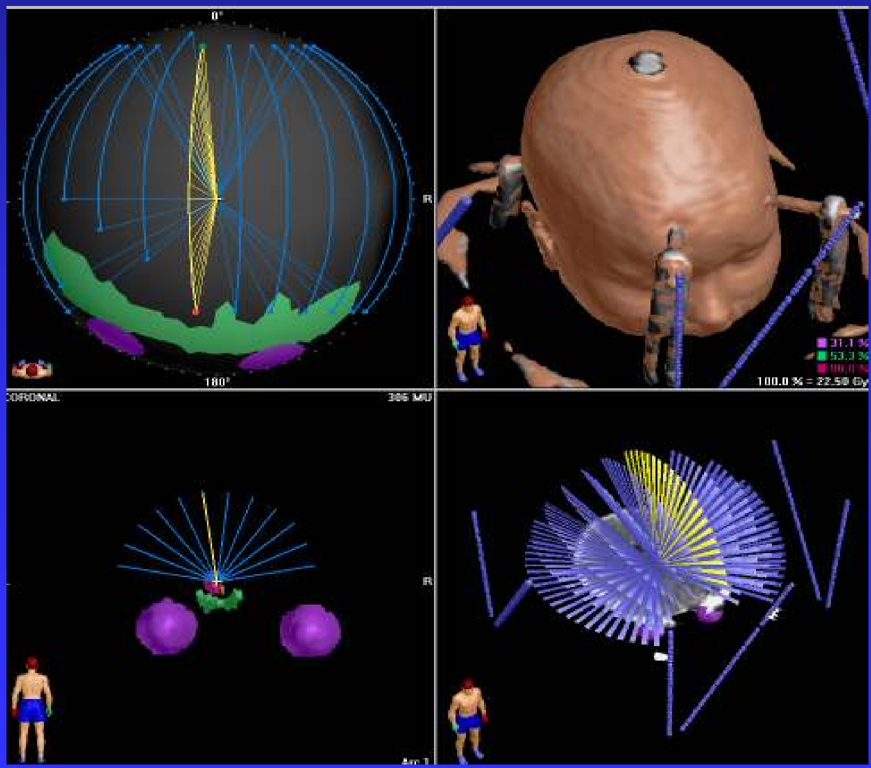
Individual functional imaging and measurements on normal tissue response in radiotherapy



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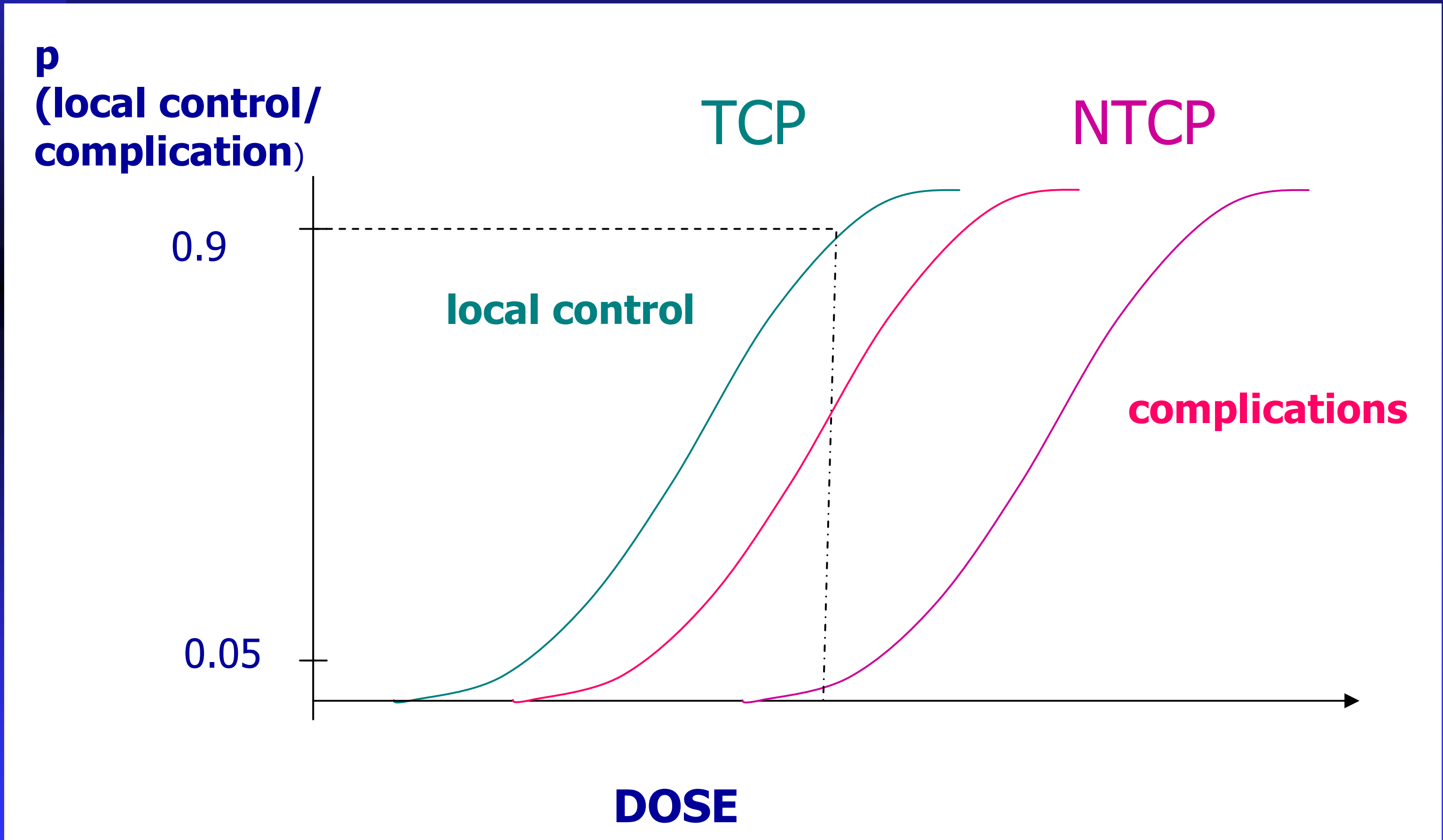
To achive successful radiotherapy

(= right amount of radiation to right volume

in right time)

- to precisely define the target to be treated
- proper and repeatable fixation
- to apply the right technique
- to apply the right dose fractionation
- to deal with the normal tissue complications
- to quantify and predict the response of a single patient

The problem of optimization



Fractionation in RT:

- Radiobiological studies on cell lines and animal studies
- Clinical data obtained from patients
- Clinical tolerance dose levels obtained after having exceeded doses which cause damage
- Various scoring systems for complications
- Questionnairies

Examples

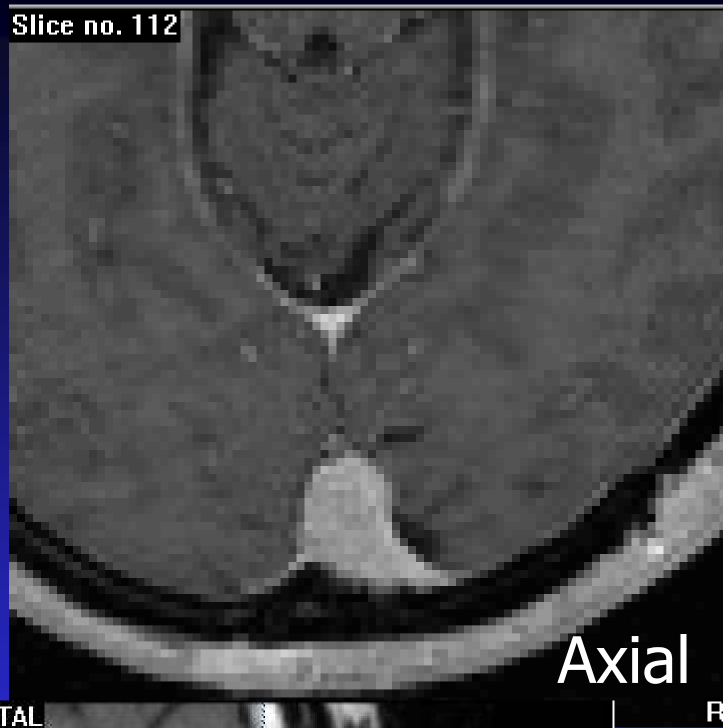
1. the critical structure cannot be seen on images used for RT planning
2. the function and tolerance dose of a critical organ of an individual patient is not known
3. to study the vascular response of a individual patient and its correlation to treatment response

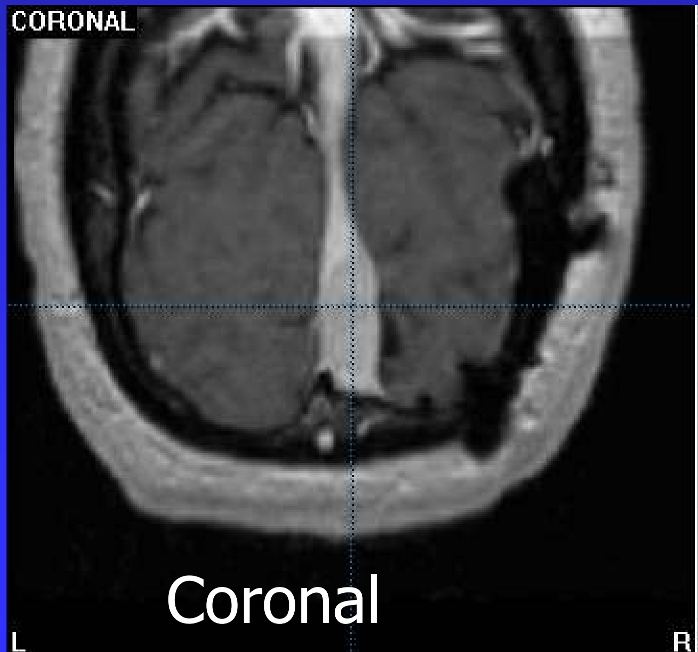
1. Magnetoencephalography (MEG) with anatomical magnetic resonance imaging (MRI)

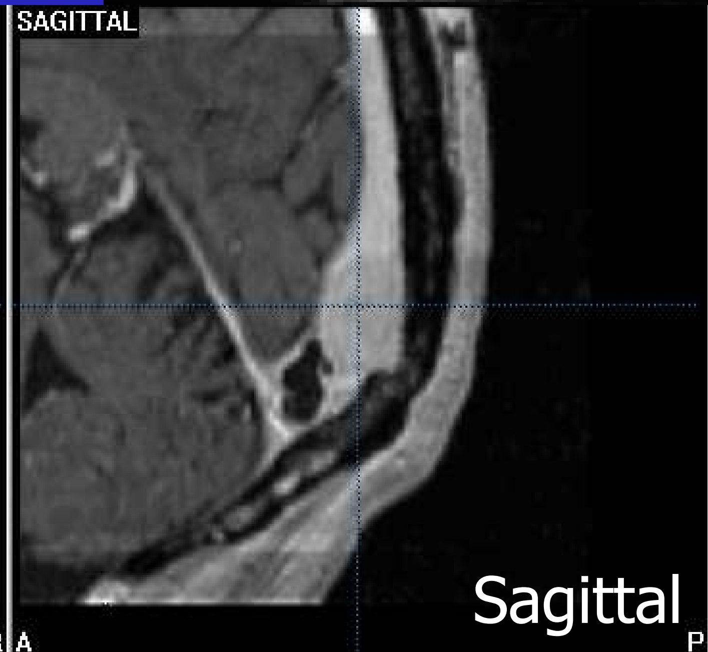
- Tumor situated close to cortex
- Localization of functional areas on the cortex using registration of magnetic field
- Excellent time resolution: 1-2 ms
- Spatial resolution: few mm
- Stimulus/task => response on the cortex
- Fusion with MRI

MEG: Occipital meningioma

T1-weighted contrast MRI





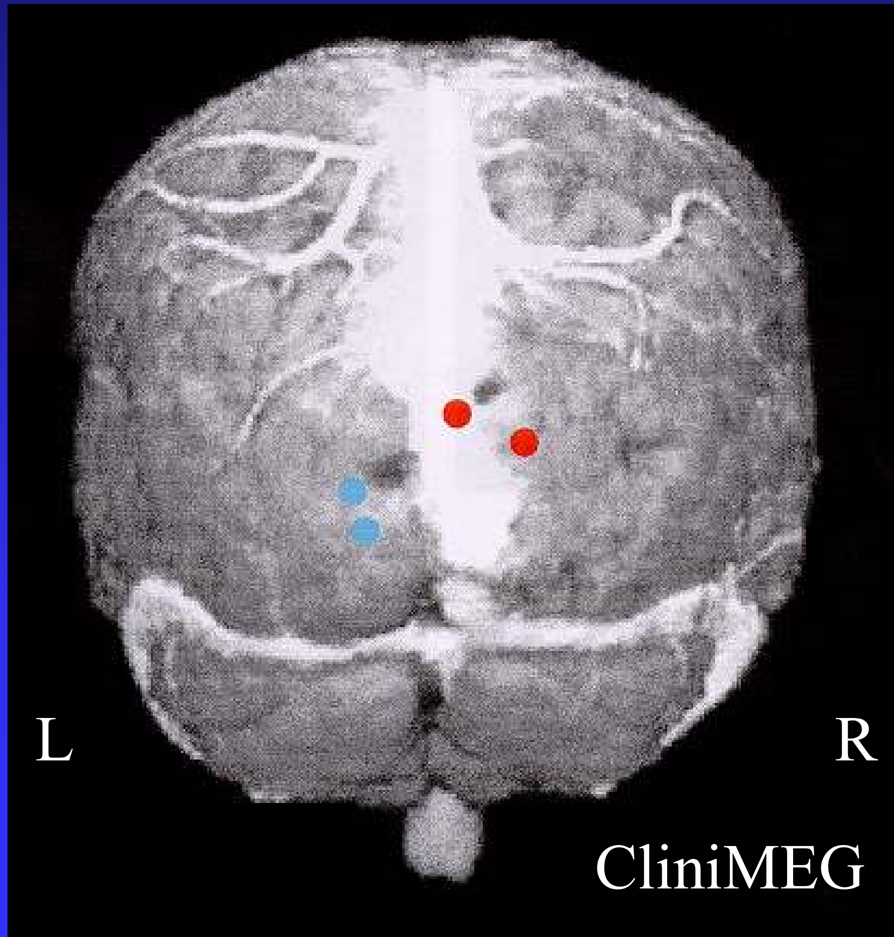


Case/MEG: Occipital meningioma

- Activated regions from visual stimuli from the left side (red marker)

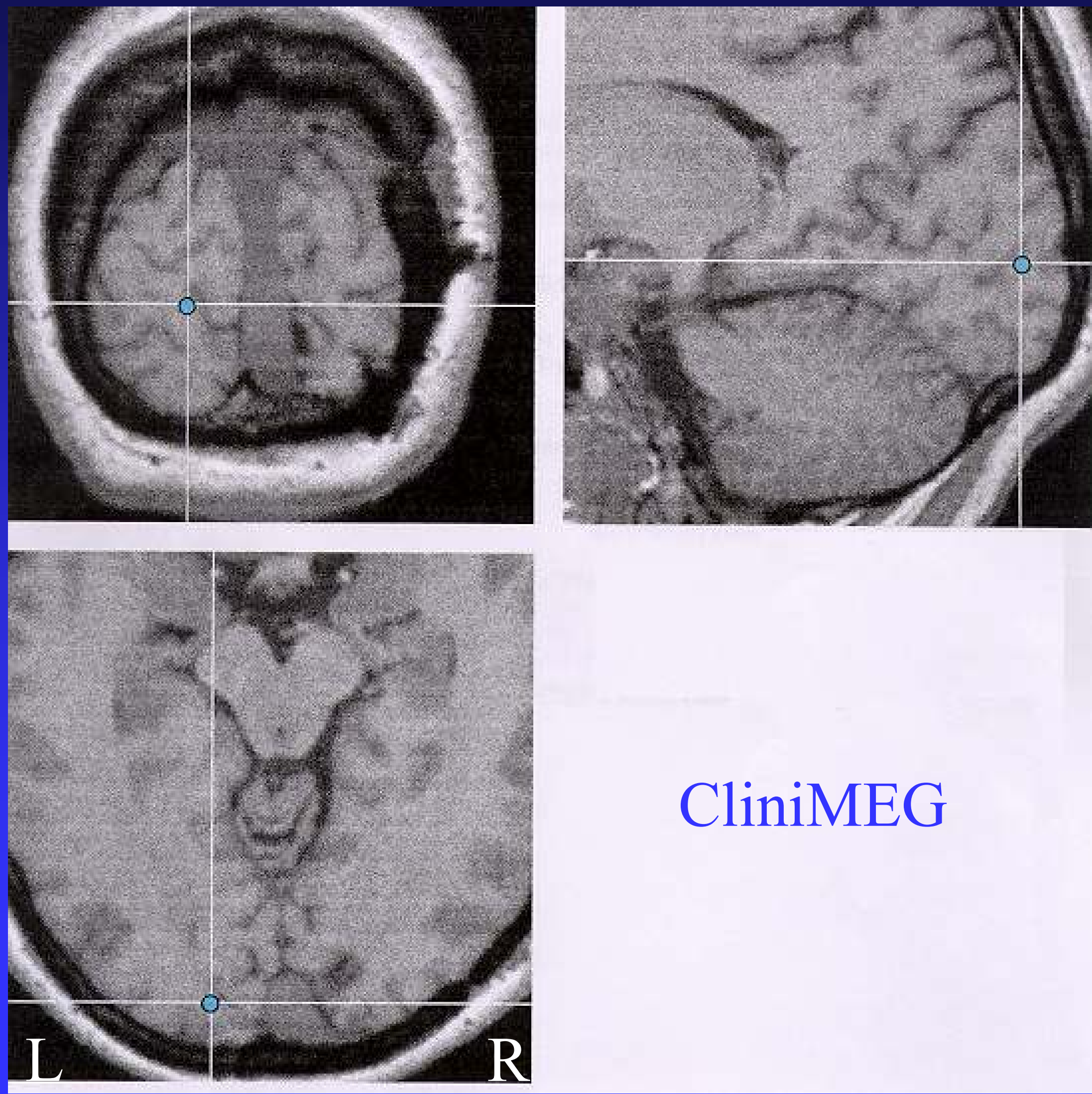
- Activated regions from visual stimuli from the right side (cyan marker)

Reconstructed model of the brain surface with veins



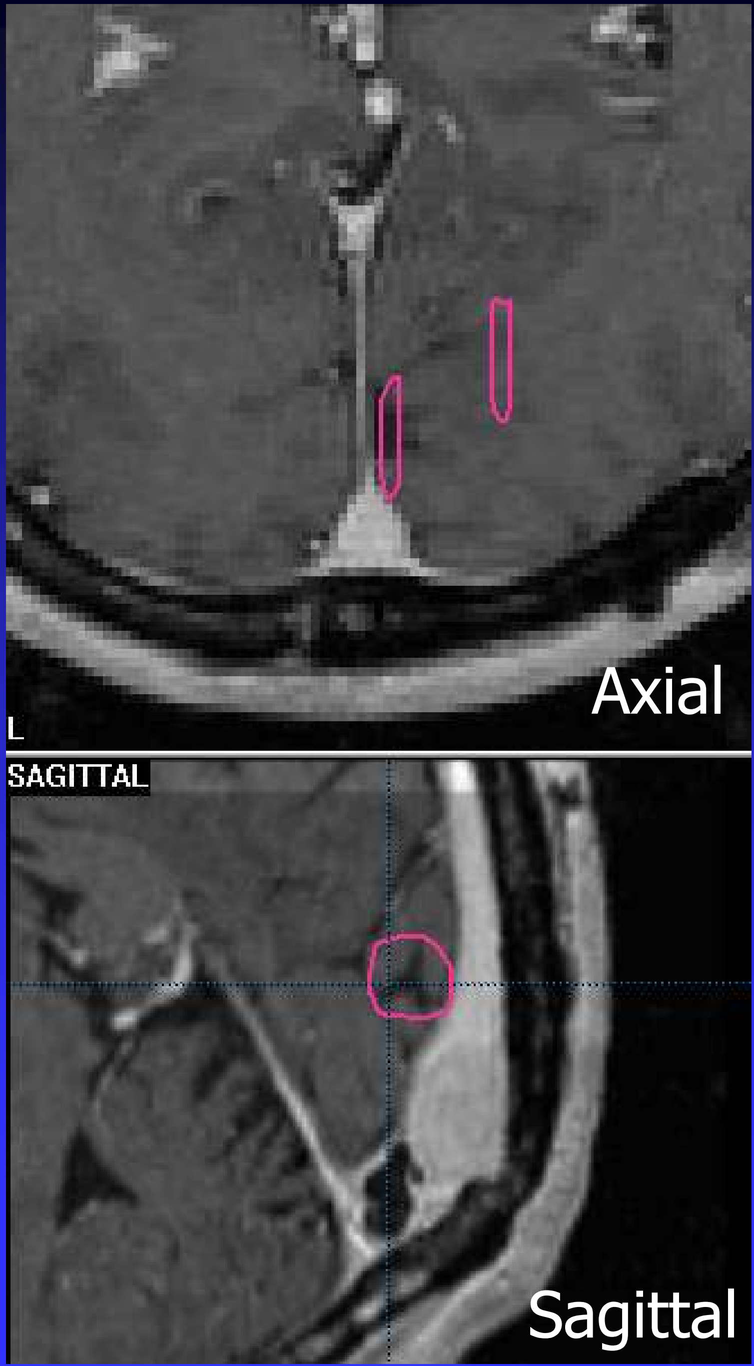
Case/MEG: Occipital meningioma

maximum of MEG signal localized in MRI images

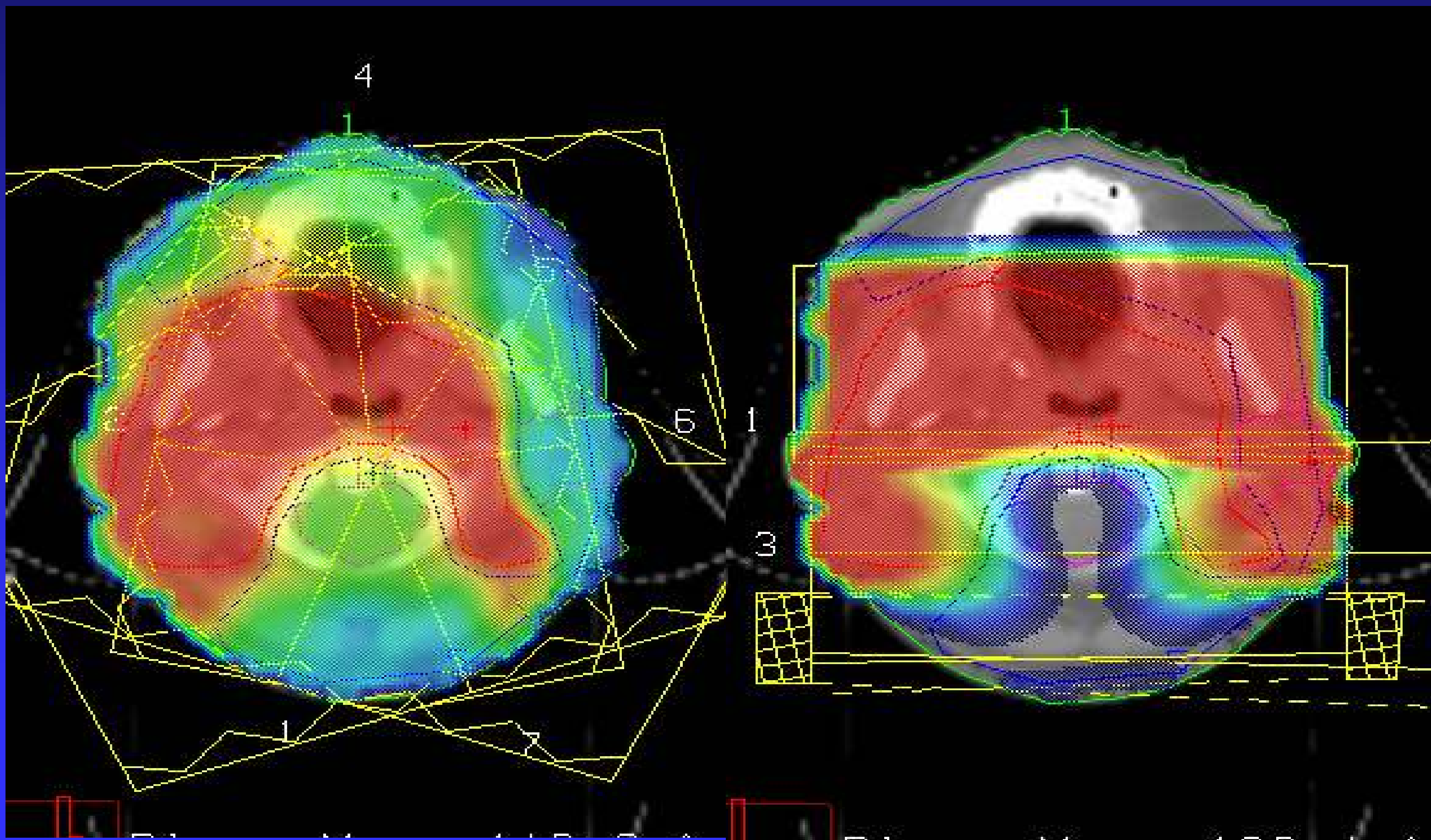


Case/MEG: Occipital meningioma

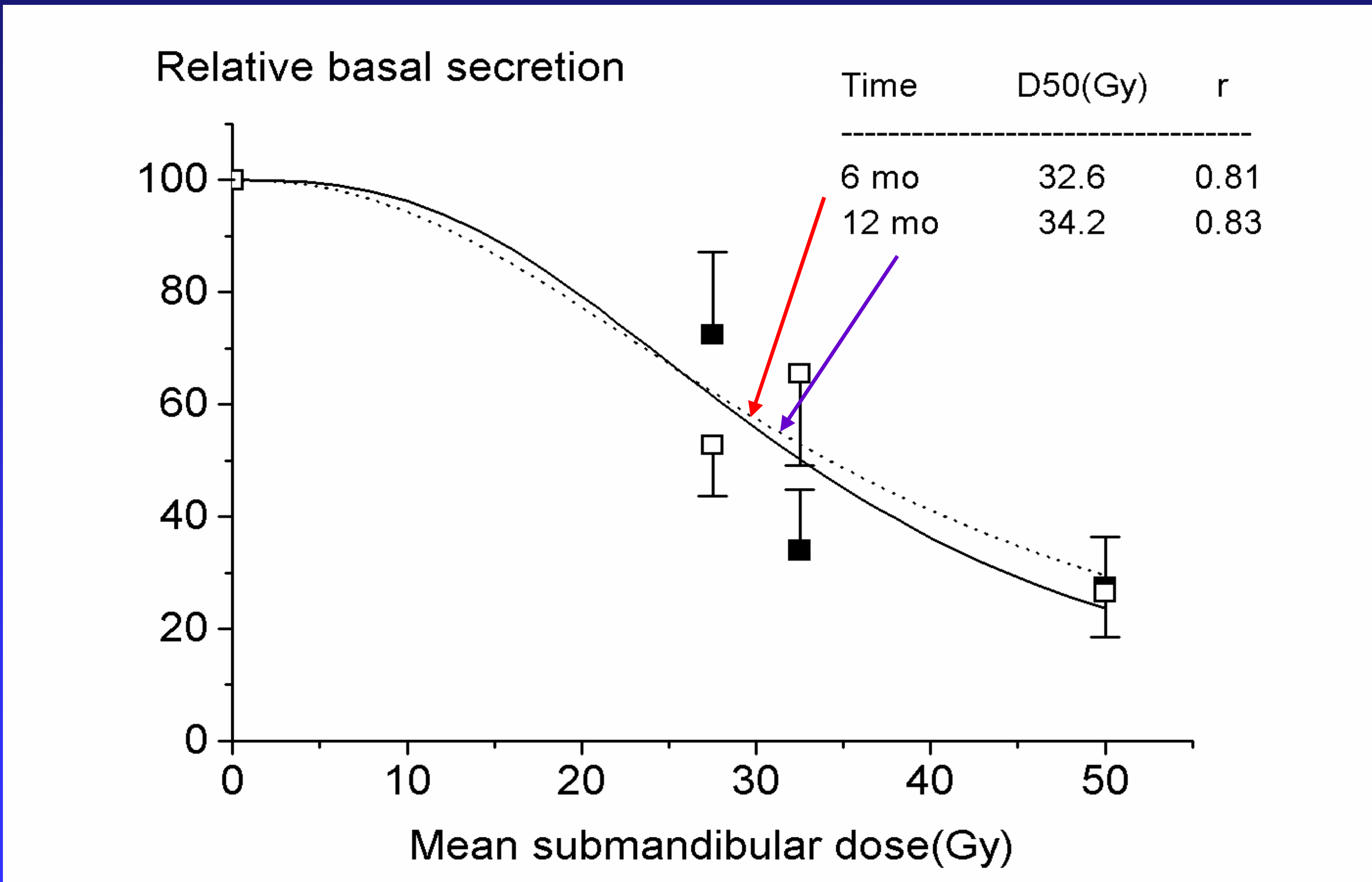
Primary visual cortex localized by MEG for stereotactic radiotherapy planning



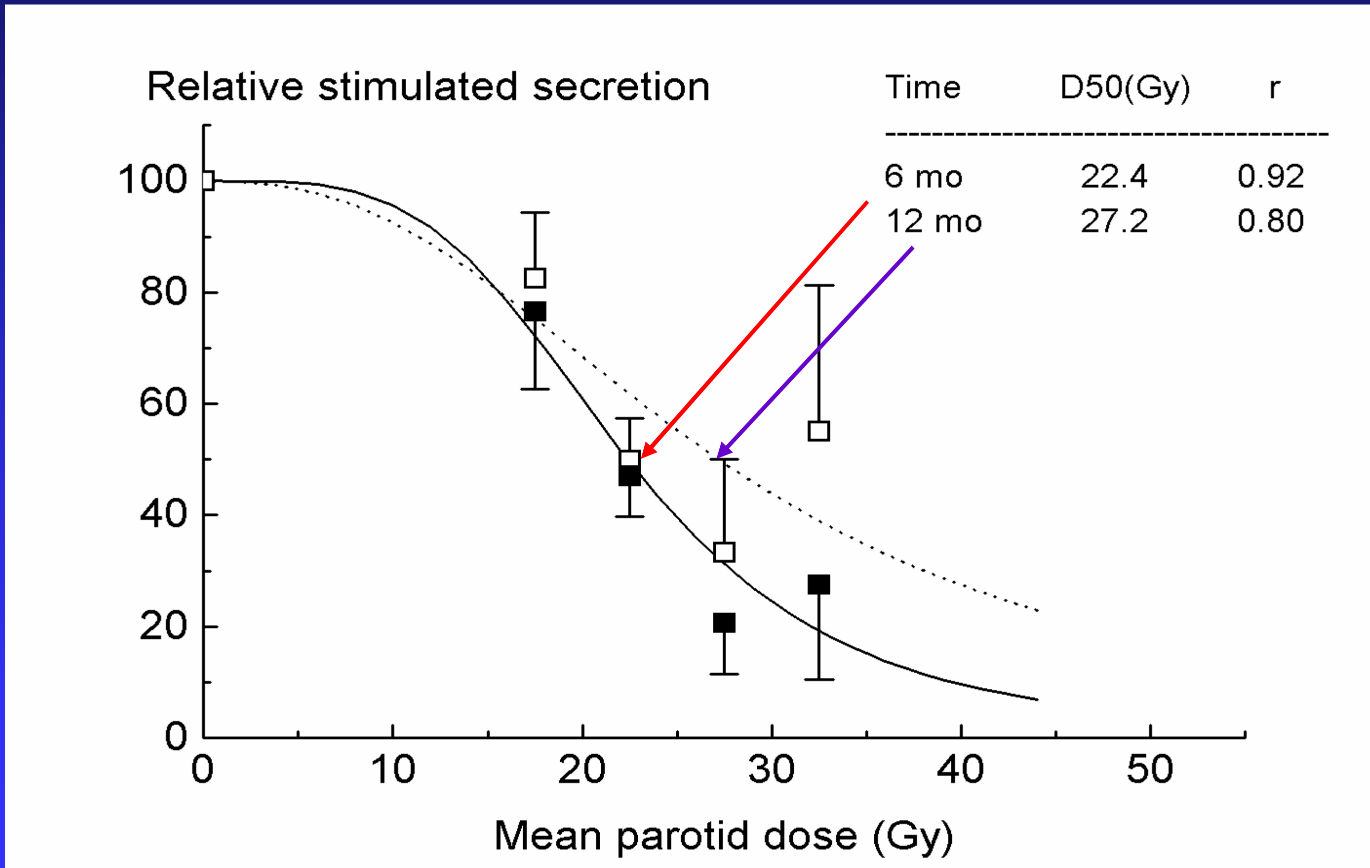
2. Salivary glands in Intensity Modulated (IMRT) vs. conventional RT



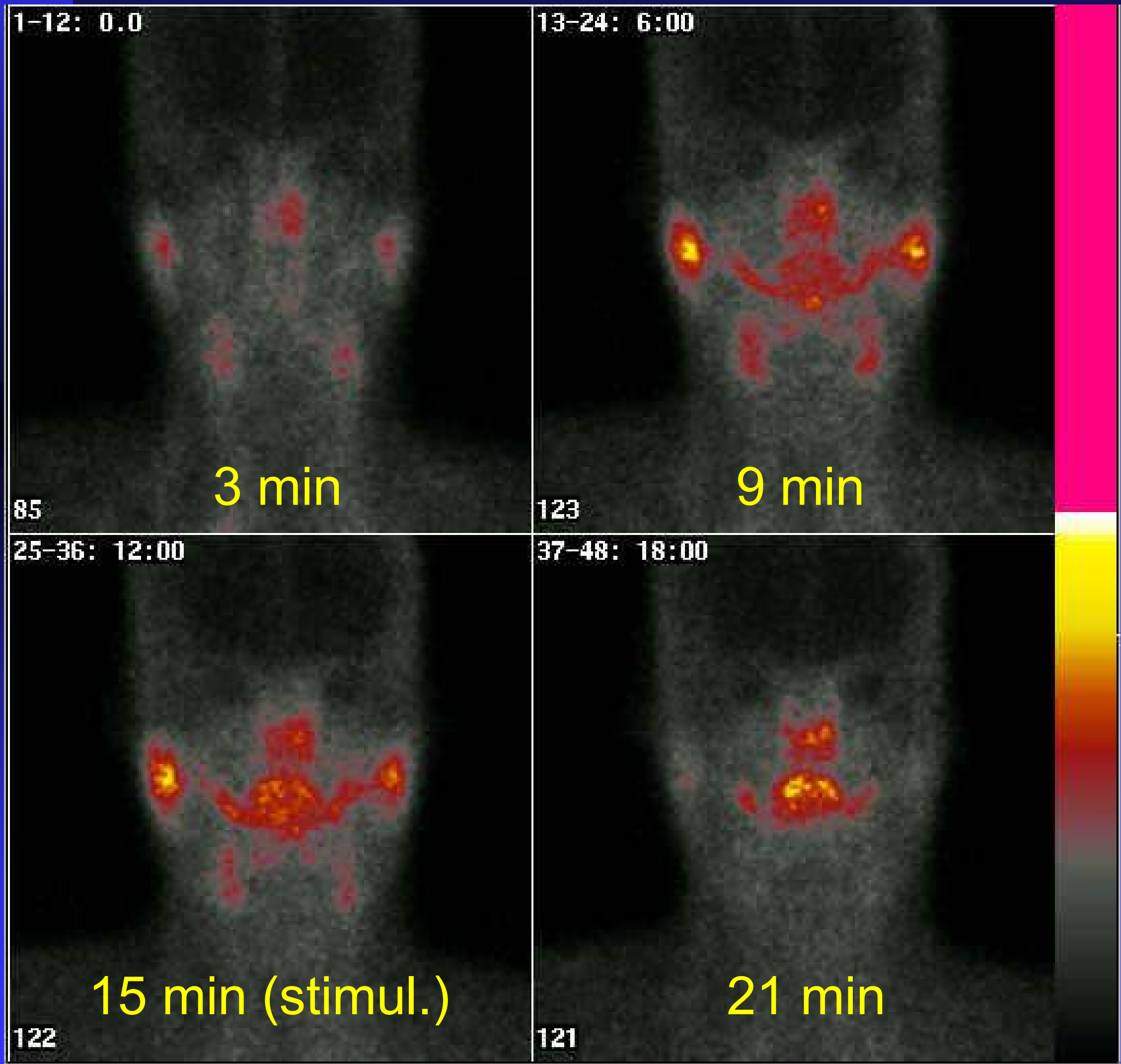
Relative basal saliva secretion vs. submandibular dose



Stimulated saliva secretion vs. parotid dose



Salivary scintigraphy



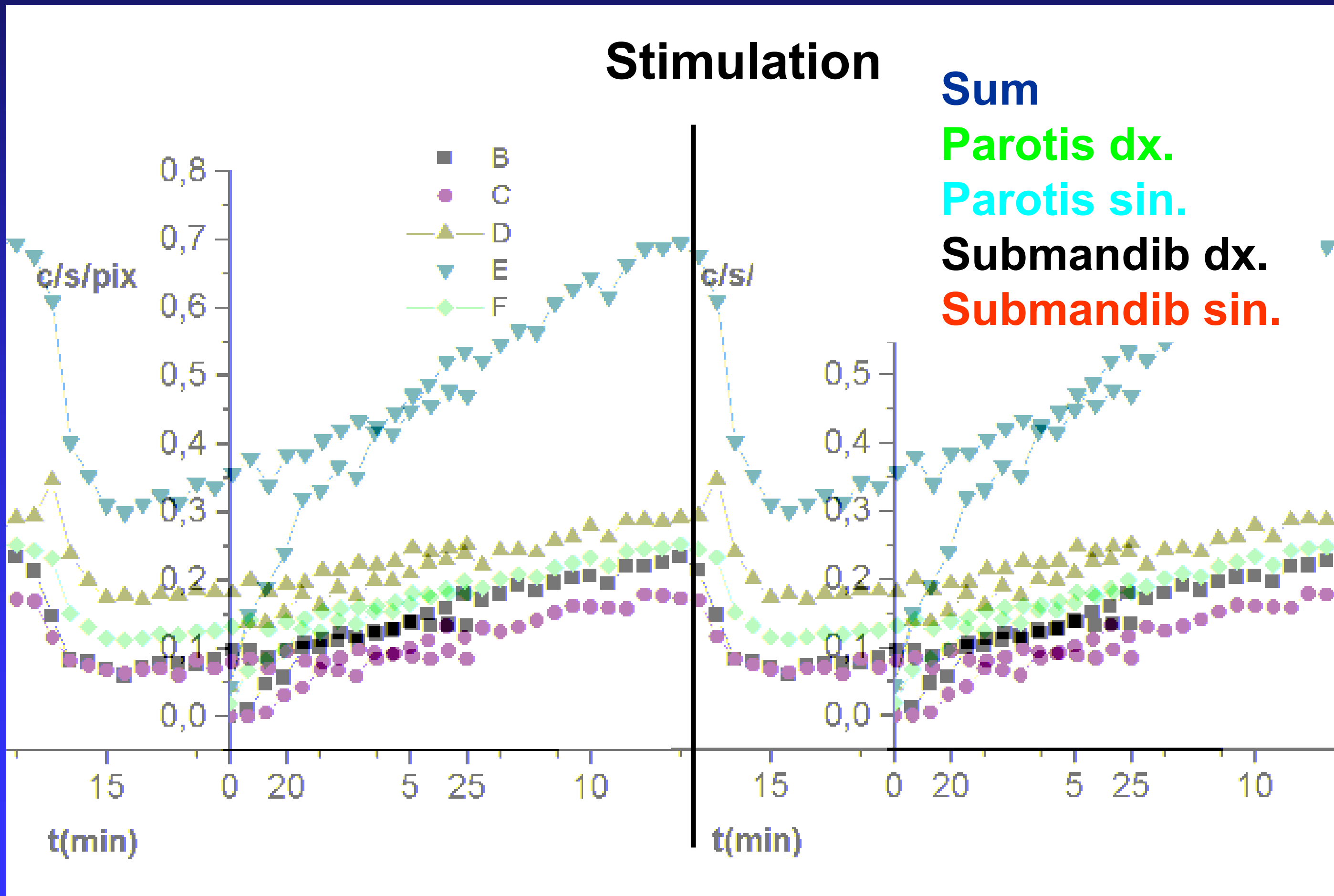
185 MBq TcO_4^-

Dynamic imaging:

- **30 sec / image (AP)**
- **total time 30 minutes**
- **At 15 minutes a stimulation with lemon juice**

- **Whereafter static lateral images on both sides**

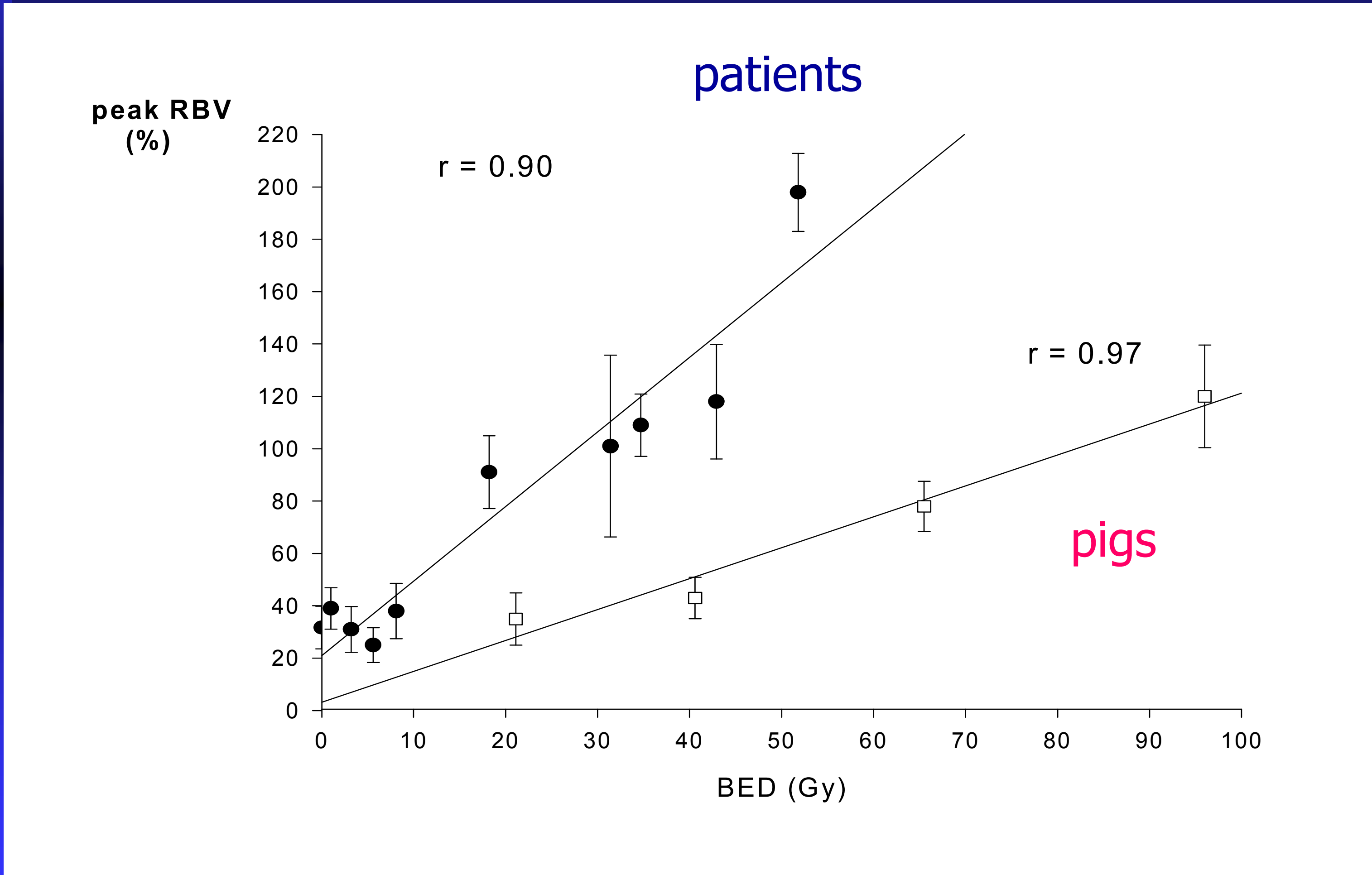
Salivary scintigraphy



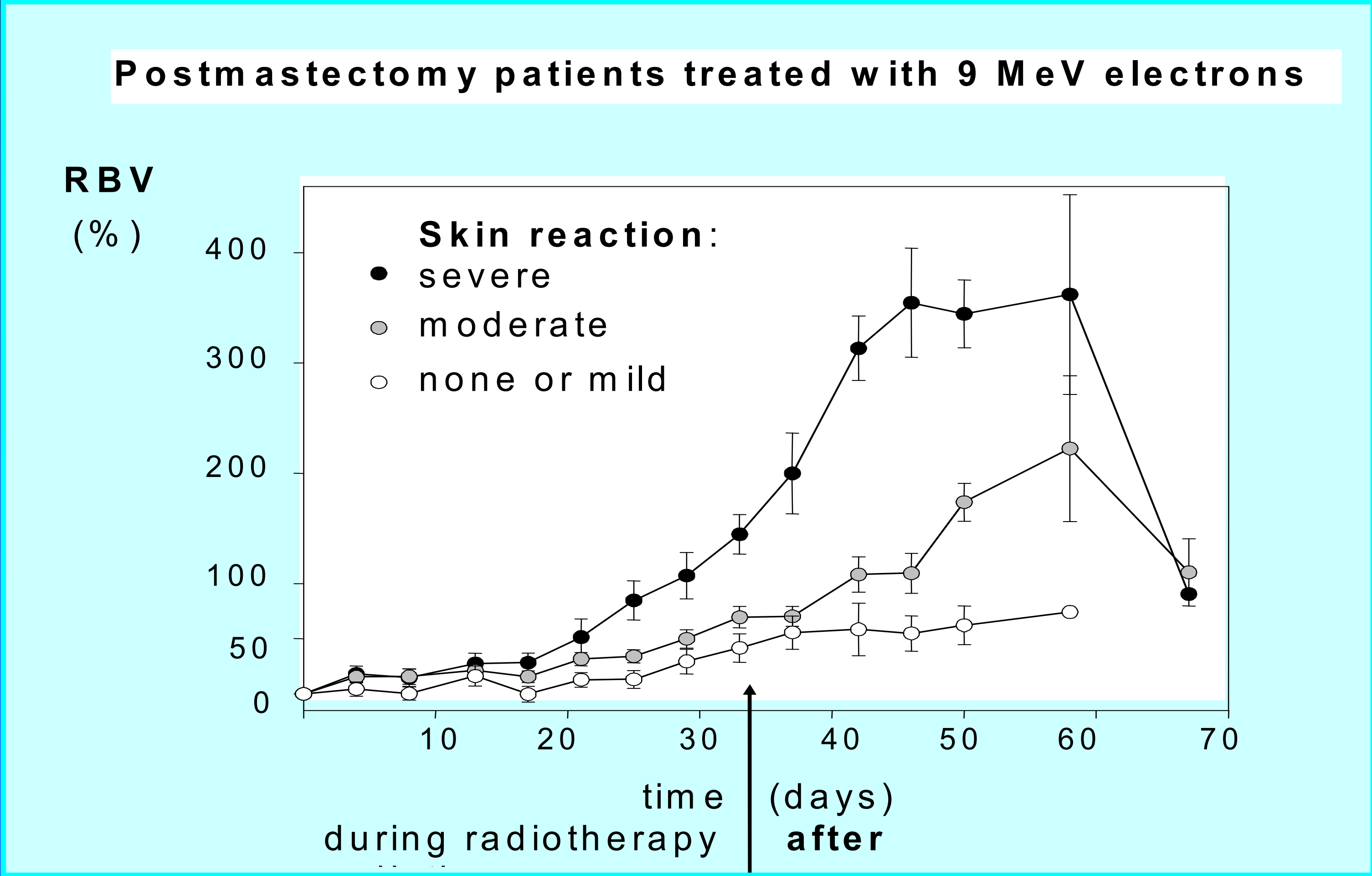
3. Quantifying cutaneous haemodynamics

- self constructed laser Doppler device (λ=632nm)
- the amount and the velocity of red blood cells (RBA, RBV) and the redness of the skin measured on 194 patients receiving radiotherapy with various fractionations
- measurements performed prior,during and after RT

Changes in RBV vs. biologically effective dose (BED)

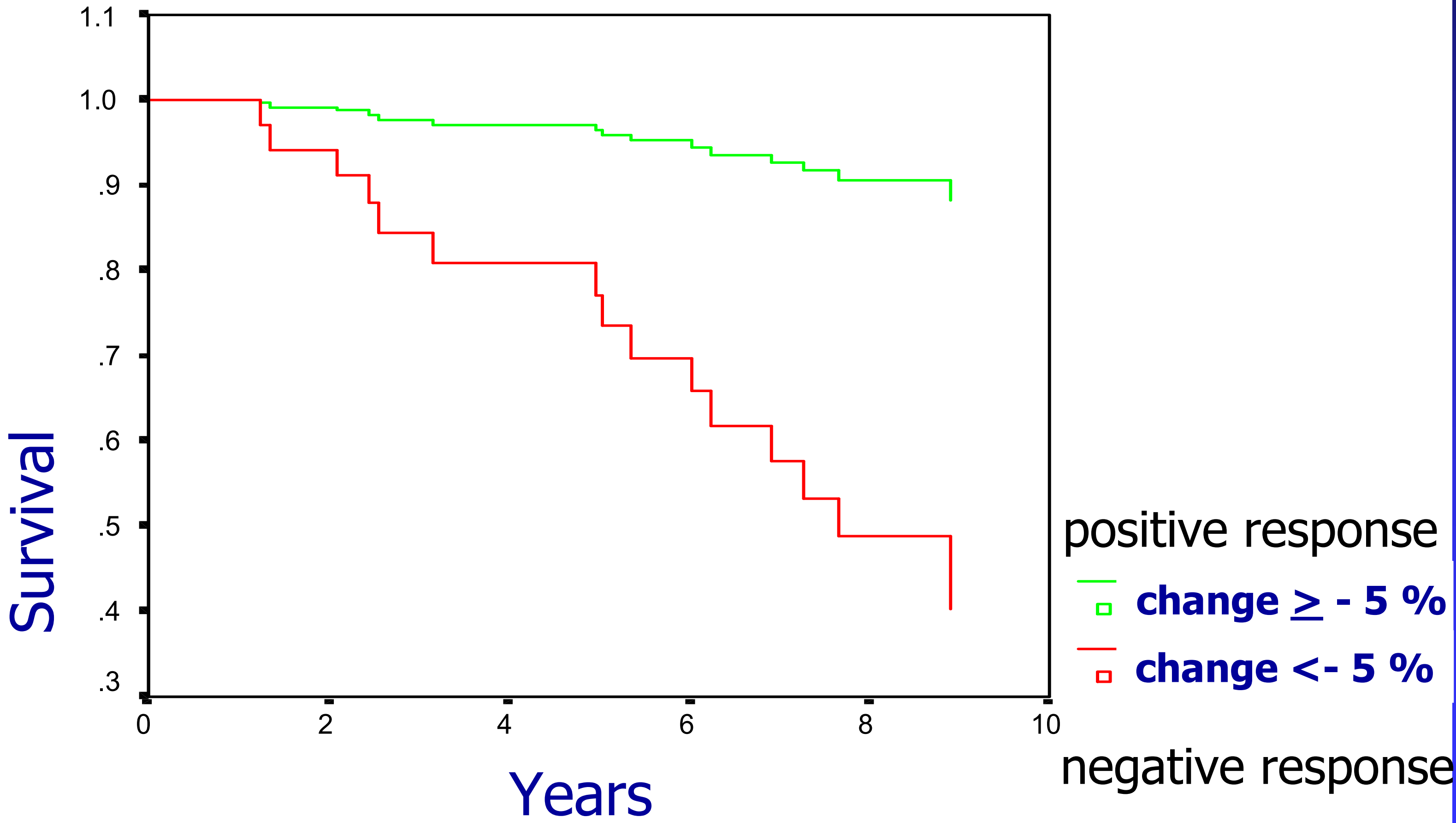


Changes in Red blood velocity



Change in reflectance at 1 week during RT vs. survival

(is an independent prospective factor, p<0.001)



Conclusions

- The mentioned functional data of normal tissues provide valuable and applicapple information for individualized radiotherapy treatment planning
  - in localizing critical areas to be avoided
  - in specifying tolerance doses not to be exceeded
  - in determining the haemodynamic responses eventually predicting the clinical outcome