Gamma Knife Dosimetry and Treatment Planning

All the beam channels of the Gamma Knife are stationary and are manufactured to very narrow mechanical tolerances. If allowance is made for the decay of the ^{60}Cobalt, these beam channels may be considered identical and unchanging from a radiophysical point of view. The design of the Gamma Knife is such that all beam channels of the same size are identical, independent of the individual unit or its model. This means that the storage of beam data in the dose-planning system GammaPlan can be greatly simplified. This is a great advantage since it would be difficult, to measure individual beams to the required accuracy inside the unit on site.

Despite the simplicity of pre-storing the beam data, this approach has one disadvantage. It requires that the users, must trust in the reliability of this data at any specific installation.

The justification for pre-storing the beam data will be illustrated by discussing the nature of the Gamma Knife single beam data, how it is obtained and its reliability. In this context, the Out Put Factor (OPF) of the 4 mm helmet will receive extra attention. The dosimetry of the Gamma Knife is influenced by the unit's technical design. Thus, introductory remarks will outline those aspects of this design which affect dosimetry.

Today, a more selective delivery of the radiation dose to the target volume may be achieved as the result of better imaging techniques, faster computers, improved functionality of the treatment planning software and technical improvements in the irradiation procedure of the Gamma Knife. These developments enable improved radiosurgical procedures. However, an unavoidable consequence of the improvements is that the treatment plans become increasingly complex as more isocenters are used. This greater complexity does not affect the irradiation procedure itself, but it does make it more difficult to assess the appropriateness of a given dose-plan. It should be emphasised that the consequences of increasingly complex dose-plans do not apply to the dose calculation algorithms, since these can be tested under simpler situations. The concern is that with greater complexity there may be a greater risk that human errors or expression of hitherto hidden errors in the software may remain undetected.

An investigation over how different detectors respond to narrow photon beams is made at the Karolinska Institute and will briefly be reported.

Objectives

1. Introductory remarks outlining those aspects of the Gamma Knife design, which affect dosimetry.
2. Presentation of radiophysical data underlying the dose calculations in GammaPlan with repeat to:
    - type of data
    - how it is obtained
    - its reliability
3. Specific issues:
    - Correction of dose rate for its dependence on beam size. The out put factor of the 4 mm helmet will receive extra attention
    - dose normalization
    - are there simple and reliable means to validate the calculated treatment time
4. Response of detectors when used to measure properties of narrow photon beams.