QUALITY ASSURANCE IN TOTAL BODY IRRADIATION

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The central aspect of all quality assurance programs in radiotherapy is to guarantee the prescribed dose and dose distribution in every treated patient. This should assure as much as possible benefit from the intended treatment and should also facilitate the comparison of treatment results of multicentrical studies. In general radiotherapy is an interdisciplinary task and especially this is true for total body irradiation (TBI) prior to bone marrow transplantation (BMT). Many factors influence the clinical outcome of this combined treatment modality and their interaction is by far not well understood, although till now several thousands TBI/BMT have been performed world-wide. The International Bone Marrow Transplant Registries (IBMTR) and the European group for Blood and Marrow Transplantation (EBMT) collected the parameters and the results of treatments for evaluation. However there are serious difficulties concerning the evaluation of gathered clinical data so far because of differences in procedures used for both medical and physical approach [Sánchez-Doblado et al. 1995]. It is nearly self-evident, that a quality management [e.g. ISO 9004-2:1991] covering the whole complex treatment would be useful.

Quality assurance in TBI starts with the clinical diagnosis and with the formulation of the therapeutical concept. The requirements on diagnostic imaging modalities, surgical and pathological procedures etc. will be omitted in this context. A clear dose prescription is a prerequisite for all following steps in TBI [e.g. AAPM 1986, QUAST 1988, Sánchez-Doblado et al. 1995]. This is not self-evident and contrasts with more conventional radiation therapy treatment situations, where often a single number for prescription and description of dose is sufficient [ICRU 1993]. The reason lies in the complex target volume in TBI and additionally in the variety of treatment techniques applied. As an absolute minimum we need at least one point to which the prescribed dose can be referred. Now most centres use the midpoint of abdomen at the level of the umbilicus for prescription. It is clearly evident that this alone is unsufficient for a halfway informative description of dose and dose distribution in the patient.

Therapeutic TBI doses, alone or in combination with chemotherapy, may exceed the tolerance of certain organs, for instance lungs, eye lens, etc. In particular, the lungs are the most critical organ at risk, because interstitial pneumonitis is one of the main causes for fatal treatment complications in TBI [e.g. Barrett et al. 1983, Keane et al. 1981, Morgan et al. 1996, Trott 1992, Weiner et al. 1986]. The radiotherapist should therefore specify the dose the lung should receive and often this makes additional lung shielding necessary. The fractionation scheme and the dose rate because of its special importance for the development of pneumonitis in single-dose TBI should clearly be stated.

Clinical treatment planning for TBI differs in some distinctive points from conventional radiotherapy procedures. The localization/simulation consists mainly in taking radiographs of the thorax in order to delineate the lung areas to be shielded. Ideally this should be done under treatment conditions. Normal therapy simulators do not suit well for this task because of their restricted geometry. Some centres use therefore diagnostic x-ray units or even the treatment machine. Radiotherapists should take care to delineate the area to be shielded not too large. This could result in underdosage of not assigned parts of the target volume, for instance the lymph nodes below the clavicles. For the evaluation of clinical data the shielded volume of the lungs should be estimated.

Physical treatment planning mostly rests on calculation schemes that have been developed and adjusted to the special treatment situations in the departments. Often it is supported by self-made computer programs. Even modern commercially available therapy planning systems do not enable the medical physicist to calculate dose distributions in TBI for daily routine and further development seems urgently necessary.

Basic phantom dosimetry and patient dosimetry for compensation of contour variation and for inhomogeneity correction especially for lung dose determination should be performed under TBI conditions [e.g. AAPM 1986, Quast et al. 1990, Sánchez-Doblado et al.1995]. A careful dosimetry under TBI conditions

simulating closely the patient's treatment situation is also strongly recommended because of the before mentioned limitations of the calculation methods.

Treatment verification in TBI is similiar to that in conventional radiotherapy. It consists in controlling the different treatment parameters like patient position, alignment of shielding blocks and compensators or boli and correct machine settings. The recommended or prescribed protocols for quality assurance of radiotherapy machines apply also to this distinctive treatment modality. Port filming is the method of choice to control especially the correct position of shielding blocks of the lungs.

In vivo dosimetry has a distinctive importance for quality assurance in TBI, despite all the technical and systematical limitations associated with this method [Rittmann 1996]. This contrasts clearly with conventional radiotherapy, where it plays only a minor role. An important reason for the use of in vivo dosimetry is, that in TBI a high dose is delivered in a relative short time. Therefore it is usually not possible to correct faulty procedures [Christ et al. 1991]. Additionally in vivo dosimetry yields valuable information about dose and dose distribution in this complex target volume considering in particular the inherent problems with the calculation schemes. Subsequently it is possible to minimize the dose deviations from the prescribed values, what hopefully helps each individual patient.

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