Methods and Advanced Equipment for Simulation and Treatment in Radiation Oncology. Programa MAESTRO

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During external beam radiotherapy normal tissues are irradiated along with the tumour. Radiation therapists try to minimize the dose to normal tissues while delivering a high dose to the target volume. Often this is difficult and complications arise due to irradiation of normal tissues. These complication depend not only on the dose but also on volume of the organ irradited[1]. Experimental and clinical data have indicated that the probability of tumour control and normal tissue complications after radiation therapy are dose dependent, and that the corresponding dose-response relationships produce sigmoid-shaped curves[2]. However, for many human cancers the observed tumor control curve represents a population average for clones of different sensitivities. This problem is further complicated by uncertaines in tumor deliveration, organ motion, and in patients positioning from day by to day[3]. To compense for these uncertaines, large safety margins have usually been added to the planning target volume (PTV), extending into surrounding normal tissue, to decrease the risk of marginal tumor miss.

In delivering high dose, the radiation oncologyst pay attection every day not only to the target volume but, expecially, to critical surrounding tissues. At high dose very small variations of percentage of volume of normal tissue included in the target can determinate cronic and no-reversable dammage[4]. Up to now standard radiotherapy treatments are delivered using three dimensional conformal methods. 3D treatment planning uses advanced imaging thecniques for tumor and normal organ segmentation, new algorithms for precise dose calculation and computer aided optimization to generate treatment plans that confine the prescribed dose to the tumor, while maximally excluding the adjacent normal organs. Patients immobilization and computer-driven beam shaping devices as well as on line portal imaging are used to decrease treatment uncertainties and assure the quality of treatment delivery, but tolerance problems of normal tissue are present.

Moreover radiotherapy plans based on physical dose do not necessarity enterely reflect the biological effects under various fractionation schemes[5].

New techniques have been implemented to overcome this problem. Intensity-modulated radiation therapy (I.M.R.T.) extends the capability of 3D conformal methods. Studies show[6] that these methods can clinically reduce complications and can allow a larger safety margin for dose escalation. The ultimate goal is proved survival and improved quality of life.

In the sixth framework programme the European commission has founded the Integrated Project "Methods and Advanced Equipment for Simulation and Treatment in Radiation Oncology" (MAESTRO). The duration of the project is five years starting from the first of May.

The consortium comprises some of the major partners involved in radiation therapy and high energy physics in Europe: manufacturers and technology providers (IBA, SCANDITRONIX, DOSISOFT, NRG, ELDIM), research institutes (CEA, INFN, IGR, CNRS/IN2P3), universities (DELFT, COVENTRY, FIRENZE), and well-known Oncology centres: Institut Curie (France), REM Radioterapia (Italy), CCO (United Kingdom), UDE (Essen in Germany), COOK (Poland) and National Institutes (NPL, ISS-Italy).

In MAESTRO project, novel technologies in patient alignment, organ tracking, dose calculation and dose measurement will be developed, together with advanced software for radiotherapy image processing and merging for therapy planning using new conformal therapy modalities are investigated. Clinical environments will be provided for pre-clinical validation.

New tools will be available as prototypes before the end of this study, such as real-time imaging devices used with high energy photon beams and protons, and software using fast Monte Carlo codes, well-known for their high accuracy in any material and beam situation, and novel 2D surface and 3D volume dosimeters allowing better patient positioning and better beam and dose monitoring.

The aim of Maestro is to develop and validate in clinical conditions the advanced equipment need in using new techniques. The development of a clinical protocol is very important to evaluate the emerging results and to ensure that the new technologies will be clinically relevant and industrially viable.

The project is organised in 3 specific work packages on research and development activities and two blocks of training and management activities. The main field of interest of the MAESTRO project are sketched in Fig. 1, here below a brief description of the R&D work packages is reported.

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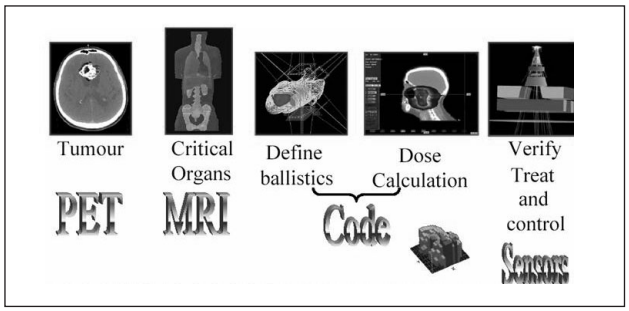

Fig. 1. Maestro's fields of interest.

The first one concerns the "Adaptive Radiation delivery, tracking and control for radiotherapy " (WP1). This package is important to evaluate the target and normal tissue motions to permit a safety dose escalation. During irradiation must be considered not only the normal tissue motions but also patient's comodities and different motion in different segments due to physiological settings or for example due to previous surgical approach (bowel motion-synechia).

The second one is about the "Radiotherapy Software development" (WP2). An accurate dose evaluation using a Monte Carlo based TPS is very important to understand the effective dose distribution to the target and critical organs. High dose in very small volume in normal tissue can determinate severe late complication.

"Sensors for dose evaluation in radiotherapy" is treated in the third work package (WP3). The special techniques are characterized by high dose delivered. Consequently clinicians pay attention also to small variation of dose on very small volume of critical organs to avoid cronic and no-reversible damage for these reasons strong requirements in the current dosimeters and techniques arise.

The three work programmes (WP1, WP2, WP3) have been constructed around research activities including recent advances in high technology development done in public research institutes and manufacturer's laboratories.

Within work package WP4 the clinical requirements will be defined, the QA procedures and protocol studies developed, comprising risk assessment studies, and the new devices proposed in the consortium evaluated.

The work package WP5 will deal with training and dissemination activities for researchers and medical physicists applying new instruments developed in this project. Particular attention will be devoted to obtaining guidance and critical evaluation concerning newly developed products, by practicing clinicians and medical physicists, in their clinical environment.

References

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