THERMOPLASTIC MATERIALS APPLICATIONS IN RADIATION THERAPY
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THERMOPLASTIC MATERIALS APPLICATIONS IN RADIATION THERAPY (Abstract)
This is an example of the use of thermoplastic materials in a high-tech medicine field, oncol-
ogy radiation therapy, in order to produce the rigid masks for positioning and immobilization of
the patient during simulation of the treatment procedure, the imaging verification of position
and administration of  the indicated radiation dose. Implementation of modern techniques of
radiation therapy is possible only if provided with performant equipment (CT simulators, linear
accelerators of high energy particles provided with multilamellar collimators and imaging veri-
fication systems) and accessories that increase the precision of the treatment (special supports
for head-neck, thorax, pelvis, head-neck and thorax immobilization masks, compensating mate-
rials like bolus type material). The paper illustrates the main steps in modern radiation therapy
service and argues the role of thermoplastics in reducing daily patient positioning errors during
treatment. As part of quality assurance of irradiation procedure, using a rigid mask is mandat-
ory when applying 3D conformal radiation therapy techniques, radiation therapy with intensity
modulated radiation or rotational techniques.Key words: IMMOBILIZATION, THERMO-
PLASTIC MASKS, RADIOTHERAPY.

This article presents one of the uses of thermoplastic materials in high-energy radiation treatment of malignant neo-
plasms, produced by linear particles accelerators (radiation).

Modern techniques of external radiation therapy allow high doses of X-rays or elec-
trons in target tumor volumes defined after adapted localization and tumor extension
criteria, reducing radiation doses to organs at risk in the immediate vicinity of the
tumor.

These complex treatments involve accessories to immobilize the patient, high performance imaging methods: computer
tomography (CT), magnetic resonance imaging (MRI), positron emission tomog-
raphy (PET) for the precise localization of the tumor volume, algorithms that also
include tissue inhomogeneities, high performance accelerators with multilamellar collimators, 3D conformal treatment,
treatment with intensity modulated radiation therapy (IMRT), rotational therapy and imaging system for checking the treatment
position of the patient [1].

MATERIAL AND METHOD:
Steps to follow in radiation therapy
1. CT Simulation. Carrying out an ac-
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Accurate CT simulation by proper preparing and positioning the patient and through use of means of immobilization that allow further daily reproducibility of the position during the 5-7 weeks of treatment, is one of the most important steps for a proper treatment [2].

Depending on the anatomical region where the tumor that will be subjected to radiation is, the patient is comfortably positioned on a special support placed on the table of the simulator, afterwards the patient is immobilized in this position with the use of masks obtained by soaking for a few minutes (the time depends on the composition and thickness of the material) at 75°C thermoplastic plates, of adequate size for the immobilized area. On the external surface of the formed mask are placed radiopaque markers corresponding to the cutaneous projection of the origin point for the CT scanning. After completion of the simulation, on the mask are noted patient identification and accelerator data that will be used for treatment and the mask will be handed to the assistent from the accelerator (fig. 1).

In case that during treatment the patient undergoes significant changes regarding the immobilized area (weight loss, reduction of initially voluminous adenopathy or local edema), leading to a looser mask or, conversely, to a tighter mask, the patient undergoes a process of resimulation and immobilized with a mask molded according the new aspect of the area of interest [3].

For preventing local changes in the pretreatment phase it is recommended that the time from the CT simulation to onset of treatment does not exceed two weeks.

![Fig. 1. Examples of the thermoplastic material prior to molding (1a, 1b, 1c), modeling in tank at 75°C (1d) and after molding (1e, 1f).](image)

2. The treatment plan. The development of the treatment plan is based on shaping the target volumes and organs at risk on CT images obtained from simulation, followed by the prescription of the dose to the target volume and dose constraints for organs at risk.

The following volumes are identified: tumor macroscopic volume - GTV (gross tumor volume), the volume that estimates the microscopic extensions, the area of tumoral risk - CTV (clinical target volume) and target volume planned, which takes into account movement and positioning errors - PTV (planning target volume). The edges that are added to PTV depend on the irradiated zone, availability and quality of immobilizers used, the frequency of imaging verifications of the treatment position (daily, weekly), the average errors recorded in each radiation laboratory.

Completion of the treatment plan (fig.
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2) involves the use of algorithms that simulate the effect of passing through of the beams of radiation through the target volume and generates the characteristic isodoses as well as dose-volume histograms [4].

Fig. 2. The treatment plan for a patient with primitive brain lymphoma

3. Controls and implementation of treatment. The administration of high total radiation doses (50-70Gy) in tumor volume is done fractionated, with daily doses of 1.8-2Gy during 5-7 weeks, which involves repeating the verification procedures daily. Positioning errors are verified through imaging by overlapping anatomic landmarks contoured in the images from the simulation with landmarks from the control images on the accelerator table (fig. 3) and are corrected before each treatment session [5].

Fig. 3. Imaging treatment position control, achieved at the accelerator
DISCUSSIONS
The use of thermoplastic masks for patients treated in the Radiation Laboratory of Regional Oncology Institute, Iasi has become a common practice, especially for irradiation of primitive or secondary brain tumors and also head and neck tumors. Availability of immobilization systems has reduced positioning errors (average errors 1-2mm corrected prior to administration of radiation dose) and enables advanced radiation techniques (IMRT, RapidArc).

CONCLUSIONS
This is a model of practice for accurate irradiation of tumor target volume, while protecting adjacent critical structures, which demonstrates the importance of patient immobilization for treatment reproducibility and safety, widely recognized and which continuously raises concerns to optimize immobilizers [6].

REFERENCES