



SESSION 3

IMAGING IN ONCOLOGY





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The role of different radiologic methods in early detection of breast carcinoma

Key words: Early breast cancer; Imaging; Algorithm

Breast cancer is the most frequent female neoplasm and has become the most important cause of death in women, affecting one in nine of them. To reduce the death rate from breast cancers, these malignancies must be detected and treated at a small size and early stage. Therefore the major goals of breast diagnostics are early detection of malignancy and its differentiation from other breast diseases. Basic imaging methods for early breast cancer diagnosis are: mammography, US as an additional method to mammography, and contrast-enhanced MRI of the breast. Each of those methods has its advantages and limitations, but combining proper diagnostic modalities increases sensitivity for malignancy. It is important to be aware of the strength and weak points of each modality to make the most effective choice for each patient.

MAMMOGRAPHY

Mammography is a basic imaging method for prevention, detection and early diagnosis of breast cancer.

Advantages of mammography are:

1. Only imaging modality suitable for screening.
2. Only methods for reliable visualization of microcalcifications which are present in about 30%-50% of early malignancies and often are the only sign of malignant tumor.
3. Sensitivity of almost 100% in the fatty breast.
4. Possibility of visualizing the small nonpalpable tumors.
5. Enable stereotaxic fine needle biopsy

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The manuscript was received: 12. 11. 2000.

Accepted for publication: 28. 11. 2000.

Limitations of mammography are:

1. In dense "fibroglandular" breast the sensitivity of mammography decreases - there is no difference between the tumor and surrounding tissue.
2. Sensitivity is limited because early malignancy frequently exhibits an uncharacteristic appearance (increasing opacity).

ULTRASOUND

The examination is completely non-invasive and can be used without restriction.

Advantages of US are:

1. US is extremely reliable in differentiating cystic from solid lesions.
2. US images are tomograms of the breast-gives precise anatomical information.
3. In dense breast the sensitivity of US is high - malignant tumor is hypoechoic, clearly visualizing in fibroglandular breasts- surrounding tissue is more echogenic.
4. It can evaluate integrity of pectoralis muscle and fascia.

Limitations of US are:

1. Decreased sensitivity in the absence of a palpable abnormality.
2. Small spatial resolution which limits the possibility of detection of small lesions.
3. Reduced sensitivity in the fatty and large breast.

MRI

Contrast enhanced MRI of the breast offers new possibilities in early diagnoses of breast cancer. It is also used to help diagnose breast cancer in cases in which mammography and US yield inconclusive or discrepant results.

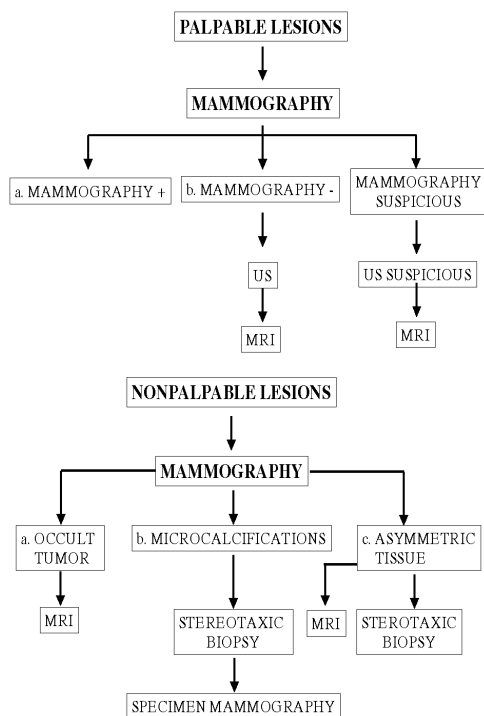
Advantages of MRI are:

1. Sensitivity-94%-100%, which is considerably higher when compared with conventional breast imaging (irrespective of breast type).
2. Relatively high specificity- 60%-89%. It enables differentiation not only cystic from solid, but also benign from malignant lesions. Two different approaches have been pursued to improve the technique's specificity: a) imaging protocols with high spatial resolution which aim at a precise analysis of the lesion's structure and internal architecture to distinguish benign from malignant lesions; b) dynamic protocols with high temporal resolution for analysis of the lesion's enhancement behavior where benign and malignant lesions are distinguishable owing to their different enhancement kinetics.
3. Detection of very small lesions (spatial resolution can be as high as 1 mm).
4. Early detection of malignancy around/behind silicone implants.
5. Detection of occult primary breast carcinoma.
6. Reliable detection of recurrent cancer. For example, MRI is the only method that enables examination of recurrent tumor in irradiated breasts.

Limitations of MRI are:

1. Low sensitivity for ductal carcinoma in situ.
2. High costs and long examination time.

Having in mind all the above mentioned imaging methods, it is advantageous to have a defined examination protocol. Based on our experience we suggest the following protocol:



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Radiotherapy treatment planning and recommendations: needs for preliminary diagnostic information

Key words: Radiotherapy; Treatment planning; Imaging

OBJECTIVE

Since radiotherapy has been introduced as an anticancer drug, its goal has always been oriented towards local or loco-regional tumor sterilization without excessive radiation toxicity. The term "high dose-high precision" has become an imperative for current radiotherapy. The effectiveness of the radiotherapy (external beam and brachytherapy) is preserved by accuracy of dose delivered at the reference point or reference volume (1). Current radiotherapy techniques applied (conformal irradiation, stereotactic radiosurgery, brachytherapy boosting and consequent therapy dose elevation up to 70-80 Gy) are based on computer 2D and 3D isodose planning. The basic input data for radiotherapy planning is relevant diagnostic information obtained by various diagnostic procedures such as radiodiagnostic (CT, MRI, angiography, ultrasound, scintigraphy, SPECT, PET, etc.) or other much invasive procedures such as explorative surgery with radio-opaque marking, endoscopy procedures, etc. Nowadays, sophisticated equipment such as CT-based radiotherapy simulator (2) or technique of the virtual simulation enter radiotherapy, enabling radiotherapy treatment planning without impact of "classical" radiodiagnostic. However, clinical benefit of these the most expensive techniques have to be revealed in the future.

To be relevant for radiotherapy treatment planning, beside the tumor extent and shape (tumor delineation), these procedures have to provide other information such as geometric relations between tumor and surrounding healthy tissue, the basic patient anatomical data, etc. However, the patient's position during data acquisition has to be the same as the

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The manuscript was received: 07. 11. 2000.

Accepted for publication: 28. 11. 2000.

radiotherapy set-up position. It seems that only radiodiagnostic procedures such as CT and MRI for external beam radiotherapy, as well as, endoluminal procedures for brachytherapy only, can give relevant information for radiotherapy planning.

THE BASIC PRINCIPLES

Excluding diagnostic aspect, with relatively high quality standard (modern diagnostic methods and equipment), as well as, aspect connected to the therapy strategy (prescribing) that is defined throughout contemporary radiotherapy protocols, quality of a treatment can be presented throughout dose specification and therapy execution (especially patient set-up) (3). Worldwide-adopted recommendations oriented to radiotherapy practice (both external beam radiotherapy (4,5) and brachytherapy (6)) are based on the recommendations given by International Commission on Radiation Units and Measurements (ICRU).

DEFINITIONS OF TERMS AND CONCEPTS (ICRU 50) FOR EBRT WITH PHOTONS

When treating a patient with radiotherapy, the radiation oncologist prescribes volumes, doses and dose fractionation, to both tumor and to normal tissues in its vicinity. Radiotherapy prescription includes a statement of the aim of therapy (radical treatment of malignant disease; palliative treatment of malignant disease; treatment of non-malignant disease), the volume definition and the specification of doses, fractionation and treatment parameters. Different volumes may be defined with varying concentrations of demonstrated or suspected malignant cells, or to probable changes in the spatial relationship between volume(s) and therapy beam(s) during treatment (patient/tissue movements; possible inaccuracies in the treatment set-up, etc.).

Prior to the treatment planning two volumes should be defined: Gross Tumor Volume (GTV) and Clinical Target Volume (CTV). During the treatment planning Planning Target Volume (PTV) and Organs at Risk have to be defined. As a result of the treatment planning Treated Volume and Irradiated Volume have to be defined, too.

Gross Tumor Volume (GTV). The GTV may consist of primary tumor, metastatic lymphadenopathy, or other metastases i.e. those parts of the malignant growth where the tumor cell density is largest. The shape, size and location of the GTV may be determined by means of different diagnostic methods (clinical examinations, and various imaging techniques). No GTV can be defined if the tumor has been removed (e.g. previous surgery). There are two main reasons for GTV identifying: i) an adequate dose must be delivered to the GTV in order to obtain local control; ii) recording of tumor response in relation to the radiotherapy applied.

Clinical Target Volume (CTV). The CTV is a tissue volume that contains a demonstrable GTV and/or subclinical microscopic malignant disease. The CTV has to be treated adequately in order to achieve the aim of radiotherapy. In practice, the delineation of a CTV will require consideration of the bio-oncological factors (invasive capacity, potential to spread, etc.). Additional volumes with presumed subclinical spread (e.g. regional lymph nodes) may also be considered for therapy, and defined as other CTV(s). The first one can be designated as CTV I and latter as CTV II, CTV III, etc.

Planning Target Volume (PTV). In practice, to ensure that all tissues included in CTV(s) receive the prescribed dose, one has to plan to irradiate

a geometrically larger volume than CTV(s), due to a number of factors, such as: i) movements of the tissues which contain the CTV and/or movements of the patient; ii) variation in size and shape of the tissue that contain CTV(s); iii) variation in beam geometry characteristics, but field penumbra is not included in PTV. PTV is defined for selection of appropriate beam sizes and arrangements. It is related to the beam(s) through a fixed coordinate system (laser-pointer planes, the patient skin tattoo or a bony landmark).

Organs at Risk. Normal tissues in the vicinity of the PTV, whose radiation sensitivity may significantly influence treatment planning and/or prescribed dose can be divided into three different classes: i) lesions can be fatal or result in severe morbidity; ii) lesions result in moderate to mild morbidity; iii) lesions are mild and reversible, or result in no significant morbidity.

Treated Volume. Limitations of radiotherapy treatment technique for dose delivering solely to PTV, leads to the definition of the Treated Volume. Treated Volume is the volume enclosed by an isodose surface, selected and specified by the radiation oncologist as being appropriate to achieve the purpose of treatment. There are several reasons for identifying Treated Volume, such as: i) relation between Treated Volume and PTV is an important optimization parameter; ii) recurrence within Treated Volume, but outside PTV may be considered to be "in-field" recurrence due to inadequate dose and not a "marginal" recurrence due to inadequate volume definitions.

Irradiated Volume. A part of tissue volume may receive significant dose due to normal tissue tolerance. Irradiated Volume can be considered as an important optimization parameter when different radiotherapy irradiation techniques are used i.e. the Irradiated Volume depends on the treatment technique used.

Doses Reporting. The dose at or near the center of PTV as well as the maximum and the minimum dose to the PTV shall be reported. This point is referred as ICRU Reference Point. The ICRU Reference Point shall be selected according to the general criteria: i) it should be clinically relevant and representative of the dose throughout the whole PTV; ii) it should be easy to define in clear and unambiguous way; iii) it should be selected where the dose can be accurately determined; iv) it should be selected in region without steep dose gradient.

There are three levels of dose evaluation for reporting in radiotherapy considering completeness and accuracy of report. Level 1 (Basic Techniques) requires the dose at the ICRU Reference Point, the maximum and minimum doses to the PTV estimated, at least, using central axes depth dose tables. Level 2 (Advanced Techniques) requires that the GTV, CTV and PTV can be defined in one or more planes (CT or MRI scans) with complete dose distribution in the central and other planes i.e. it requires at least 2D isodose planning. Tissue inhomogeneity corrections should be considered when appropriate. Level 3 (Developmental Techniques) requires 3D dose computation with available dose-volume histograms. This classification seems to be in accordance with ESTRO radiotherapy technique complexity (7).

Documentation. The recording of certain parameters at each step constitutes the necessary documentation of the treatment. It has to consist of at least treatment chart (prescription sheet, treatment plan and parameters, patient set-up explanation; notes for every given fraction, notes on the patient supervision and all dose measurements, notes on the reactions of the patient during the entire course of treatment, etc.).



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Radiotherapy treatment planning and recommendations: impact of diagnostic radiology

Key words: Radiotherapy planning; Imaging; Positioning

Imaging in oncology is mainly concerned with the demonstration of tumor mass in the first instance and a diagnosis of cancer is often suggested by the imaging appearance alone. Also, during the diagnostic process imaging has an important role in the cancer staging. It should provide a detailed information of the local extend of the disease and the relationship of the primary tumor mass to local organs. The radiologist should be familiar with the optimum techniques available to provide the best possible definition of gross tumor volume (GTV) for any particular tumor. Staging also requires assessment of lymph node and distant metastases. Therefore, an accurate staging is vital for the optimal patient treatment.

Advances in diagnostic radiology have led to the development of more sophisticated radiotherapy treatment and increased precision of delivered radiation to the patient. For the purposes of radiotherapy treatment planning, several imaging methods can be used such as plain radiography, ultrasound (US), computed tomography (CT), magnetic resonance imaging (MRI). However, all of those procedures have limitations and these need to be understood.

Conventional plain and contrast radiography are mainly used in planning of anteroposterior fields and in cases of palliative treatment. Nowadays, digital imaging has been a widely used replacement for plain radiography since it provides better contrast resolution giving us consistently better diagnostic image.

Despite the great value of diagnostic ultrasound in clinical practice it is seldom used in a radiotherapy planning. Ultrasound has been used for determination of the depth of lymph node metastases, chest wall thickness in breast treatment planning, position of the uterus in the malignancies of this localization. It is expected that the development of 3D ultrasound scan-

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The manuscript was received: 14. 11. 2000.

Accepted for publication: 28. 11. 2000.

ners will increase the role of ultrasound in radiotherapy planning.

Computed tomography, especially helical CT, is currently a method of choice in 2D or semi 3D radiotherapy planning. The main reasons are possibilities of direct measurements of the tissue electron densities (defined in Hounsfield Units) and tumor diameters. The main requests needed from radiation oncologist and radiation physicist for accurate planning of radiotherapy can be solved with CT images. Those requirements are:

1. Position of the patient during the CT scanning should be identical to the treatment position on the flat couch (Figure 1), according to the different radio-opaque markers.
2. The region of interest should be precisely selected (localization, diameters, relationship of the tumor to local organs) and complete axial scan should be shown
3. A "scout view" (or topogram) should be recorded as well as referent values of the scale to determine the necessary range of travel of the couch.
4. Contrast agents are used in selected examinations, hence intrinsic electron density of tissues is generally preserved on CT images.

Computed tomography scans have been gradually integrated into radiation therapy planning over the past two decades. This integration has



Figure 1. CT scanning of a patient positioned for a radiotherapy planning of the right breast

evolved into the practical development of the CT virtual simulator. The aim here is to provide the radiation oncologist with a full set of volumetric 3D data that can be used to generate an accurate treatment plan based on an accurate delineation of the GTV.

Magnetic resonance imaging (MRI) is nowadays established as a method of choice in the evaluation of central nervous system and musculoskeletal pathology. Also MRI is of great value in the exploration of abdominal and pelvic diseases. The main advantages of MRI comparing to other radiological procedures are possibilities of multiplanar imaging and excellent soft tissue contrast. However, its value in the radiotherapy planning has not been established yet. The main reason is inability of MRI to directly provide the values of electron density of tissues on images. Also, the positioning of the patient in MRI can be a great problem especially when specialized coils are used. Additional difficulties in planning the therapy on the basis of MRI image can arise because delineation of the GTV on images is somewhat dependent on the particular pulse sequence used to obtain images of tumor. These drawbacks, along with a relatively high cost of MRI examination resulted in widely accepted clinical practice that CT and not MRI is preferred for routine radiotherapy planning.

There is a little doubt that a variety of novel diagnostic tools can have a profound impact on radiotherapy treatment planning and recommendations. The challenge that presents itself to us today is to integrate these techniques into the radiation management of the patient. The good practice needs close collaboration between the radiologist and radiation oncologist in order to properly integrate various diagnostic and treatment modalities into the successful and cost effective management of the cancer patients.

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Role of neuroimaging in treatment planning of brain tumours in children

Key words: Neuroimaging; Brain tumors; Children

Nearly 20% of all neoplasms in children arise within the central nervous system (CNS). Treatment of childhood brain tumors is multidisciplinary and involves surgery, radiotherapy and in selected case chemotherapy. Adequate treatment planning based on proper diagnosis, staging and radiotherapeutic management should decrease the risk of failure and improve the disease-free survival rate.

SUPRATENTORIAL BRAIN TUMOURS

Advances in neuroimaging have greatly improved the accuracy of diagnosis and staging of CNS tumors. Magnetic resonance imaging (MRI) is a highly sensitive modality usually providing precise definition of tumor location and extent. In cerebral hemispheric gliomas, MRI may be the only imaging tool sensitive enough to identify small often presenting solely due to seizures. Although sagittal imaging by MRI provides unique and often diagnostic information in suprasellar and pineal region lesions, calcification (typically seen in craniopharyngiomas and malignant germ cell tumors) may be better appreciated by computerized tomography (CT). Positron emission tomography (PET), single photon emission tomography (SPECT) and magnetic resonance spectroscopy (MRS, an investigation procedure providing focal biochemical analysis) appear to be of potential value in assessing tumor viability or differentiating post-therapy changes from tumor progression (1,2).

As radiotherapy remains the treatment of choice for the majority of brain tumors in childhood if complete excision is not possible, the use of proper radiotherapeutic management is very important. The use of CT and/or MRI in treatment planning has significantly improved precision of radiotherapy.

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The manuscript was received: 06. 11. 2000.

Accepted for publication: 28. 11. 2000.

The target volume for low-grade astrocytomas should be narrowly defined. Juvenile pilocytic astrocytomas (JPA) are usually well-circumscribed lesions; 95% isodose coverage with 1 to 1.5 cm margin, including the tumor and cyst wall (if present), is best defined by T1 MRI with gadolinium contrast. Similar guidelines are appropriate for the well-delimited ordinary astrocytomas, using 1 to 2 cm margins. For the occasional JPA or more common ordinary astrocytomas without uniform enhancement, the T1 image is usually adequate; it is unusual to see more extensive changes on T2 sequence for low-grade lesions. Multiple wedged fields or areas are preferable whenever feasible to narrowly limit the high-dose volume for central and most peripheral hemispheric tumors (3).

Tumor characteristics, in supratentorial malignant gliomas, are similar to those in adults, with often poorly marginated, generally enhancing lesions on MRI or CT associated with surrounding white matter changes ("edema") and often central necrosis. Adult studies have shown infiltration of the small, round anaplastic cells well into the perilesional low-density areas on CT or areas of abnormal signal on T2 MRI.

Surgical resection is often limited in malignant gliomas, and postoperative radiotherapy is usually obtained. The target volume is best defined by the enhancing lesion and surrounding low-density change (on CT) or signal abnormality (on T2 MRI). A detailed review of imaging and histologic extent in untreated patients with malignant glioma suggests that a 3 cm margin around the target volume as defined provides adequate coverage, avoiding full brain irradiation (4).

In craniopharyngiomas the volume of irradiation is limited to the well-marginated tumor, including its cystic components, just like in low-grade astrocytomas (5).

With detailed MRI, gliomas occurring in the pineal region are often identified as neoplasms of the adjacent tectal plate or midbrain. Both low-grade and malignant astrocytomas have been reported as pineal region tumors (6).

POSTERIOR FOSSA TUMORS

Brain computerized tomography (CT) scan with and without contrast and magnetic resonance imaging (MRI), are the definitive diagnostic tests for posterior fossa tumors. Medulloblastomas have the appearance of a large, round or ovoid, moderately well-defined homogenous, hyperdense lesion which enhances with contrast. As the tumor grows, it often displaces the fourth ventricle anteriorly. Medulloblastoma spreads within the ventricular system and within the cerebro-spinal fluid (CSF) and subarchnoid dissemination is reported at diagnosis in 10-30% of children (7, 8). That is why postoperative staging requires imaging of the brain (to assess a degree of resection and potential subarchnoid metastasis) and spine (by gadolinium enhanced MRI or by CT-based myelogram) plus lumbar CSF cytology. These imaging are required in all patients with tumors that have tendency to spread within the ventricular system and CSF-supratentorial primitive neuroectodermal tumour (PNET), ependymomas, germ cell tumors, pineoblastoma, choroid plexus carcinoma. In some cases of low-grade ependymomas, in properly staged patients - that is, those with negative CSF cytology and modern imaging with spinal MRI when it is negative, cranio-spinal irradiation (CSI) can be avoided. That is very important, especially in children, because CSI has a well-known morbidity (9).

When planning the CSI the lower border of the spinal field is set up at the bottom of S2 or the lowest level of the thecal sac as determined by

MRI, whichever is lower (10).

In patients with medulloblastoma, after CSI, posterior fossa boost is delivered, by parallel opposed lateral fields. The anterior border of the posterior fossa is, on a lateral radiograph, at the posterior clinoid. The superior border of the tentorium is one-half and two-thirds of the distance from the base of the skull to the top of the skull. A sagittal or coronal CT or MRI scan will show the location well.

MRI is essential in delineating the extent of brainstem tumors. The MRI scan will often show a larger area of abnormality than CT scan. Stroink et al. has proposed a grouping system based on pretreatment CT scan which could also be utilized with MRI (11). In this system Group I tumors are isodense contrast-enhancing lesions dorsally exophytic into the fourth ventricle, Group IIa tumors are hypodense nonenhancing intrinsic lesions of the brainstem, Group IIb tumors are hyperdense exophytic lesions extending ventrally and laterally into the cerebellopontine and prepontine cisterns, Group III tumors are intrinsic cystic lesions with contrast-enhancing capsules and Group IV tumors are focally intrinsic lesions that are isodense and brightly enhancing.

Positron emission tomography using fluorodeoxyglucose (FDG-PET) is now being employed, on a research basis, in the unital evaluation of brainstem tumors and the monitoring of treatment. It is thought that more malignant tumors have a greater degree of FDG uptake at presentation. Serial PET scans showing conversion of a "hot" lesion to a "cold" one following radiotherapy is taken as a helpful sign. The PET scan may be particularly helpful, along with careful serial physical examinations, in making the distinction between the progressive disease and the post-treatment toxicity (12, 13).

Modern neuroimaging methods should provide better diagnosis and staging of CNS tumors in children and consequently use of proper and optimal treatment planning. Based on this imaging, designed radiotherapy techniques should decrease the volume of normal tissue irradiated and, perhaps, reduce the neuropsychological sequelae of irradiation, which is especially important in children (14).

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New statements in monitoring response of treatment and follow-up with diagnostic imaging methods in oncology

Key words: Oncology; Imaging; Follow-up

Technological developments in tumor imaging have been spectacular, but the true extent to which these advances may have contributed to improve the outcome for patients is often uncertain. There are many aspects in attempts to define the objective response of a tumor to anticancer agents.

Many issues published on these subjects and new World Health Organization (WHO) criteria have led to a number of different modifications of clarifications, resulting in a situation where response criteria are no longer comparable among research organizations - the very circumstance that the WHO publication had set out to avoid.

The new approach to response evaluation criteria in Solid Tumor is based on the model proposed by James et al. (1). The four categories of: 1. complete response; partial response; 3. stable disease, and 4. progressive disease as originally categorized in the WHO Handbook (2) should be retained in any new revision.

At baseline, tumor lesions will be categorized as follows: measurable (lesions that can be accurately measured in at least one dimension as 20 mm with conventional techniques or as 10 mm with spiral CT scan or unmeasurable (all other lesions, including small lesions and truly non measurable lesions).

Lesions on chest X-ray are acceptable as measurable lesions when they are clearly delineated and surrounded by aerated lung. However CT and MR are the best currently available and most reproducible methods for measuring target lesion selected for response assessment.

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The manuscript was received: 12. 11. 2000.

Accepted for publication: 28. 11. 2000.

Use of MR is a complex issue. MR is entirely acceptable and capable of providing images at different anatomic planes. It is, therefore, important that, when MR is used, lesions must be measured at the same anatomic plane by the use of the same imaging sequences on subsequent examinations. MR scanners vary in the images produced. Some of the factors involved include the magnet strength (high-field magnets require shorter scan times, typically 2-5 minutes), the coil design and patient cooperation. Wherever possible, the same scanner should be used. For instance, the images provided by a 1.5-Tesla scanner will differ from those provided by a 0.5-Tesla scanner. Although comparisons can be made between images from different scanners, such comparisons are not ideal. Moreover, many patients with advanced malignancy are in pain, so their ability to remain still for the duration of a scan sequence - on the order of 2-5 minutes - is limited. Any movement during the scan time leads to motion artifacts and degradation of image quality, so that the examination will probably be useless. For these reasons, CT is, at this point in time, the imaging modality of choice.

Ultrasound examinations should not be used in clinical trials to measure tumor regression or progression of lesions that are not superficial because the examination is necessarily subjective. Entire examinations cannot be reproduced for independent review at a later date, and it must be assumed, whether or not it is the case, that the hard-copy films available represent a true and accurate reflection of events. Furthermore, if, for example, the only measurable lesion is in the para-aortic region of the abdomen and if gas in the bowel overlies the lesion, the lesion will not be detected because the ultrasound beam cannot penetrate the gas. Accordingly, the disease staging (or restaging for treatment evaluation) for this patient will not be accurate.

The use of positron emission tomography (PET) and proton magnetic resonance spectroscopy in oncology has increased dramatically in recent years, but these techniques have not been widely available yet, and many have not been validated.

Frequency of tumor re-evaluation while on treatment should be protocol specific and adapted to the type and schedule of treatment. Follow-up of every cycle (6-8 weeks) seems a reasonable norm. Smaller or greater time intervals than these could be justified in specific regimens or circumstances.

The evaluation of tumor response in the daily clinical practice of oncology may not be performed according to these criteria of clinical trials.

It is unusual for routine practice, unless there is extensive supporting evidence of its efficacy from clinical trials, for diagnostic techniques to be subjected to such rigorous scientific evaluation.

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Computed tomography in assessing rectal cancer downstaging with preoperative radiotherapy

Key words: Preoperative radiotherapy; Rectal cancer; Spiral computed tomography

Accurate disease staging in patients with rectal cancer is very important, because the optimal therapy depends on it. Spiral computed tomography (CT) plays significant role in staging rectal cancer and it is widely used. Numerous studies have been published on the preciseness of CT in estimation depth of invasion of the rectal wall (muscularis propria penetration - stage T2, T3, Dukes B), the extent of infiltration of perirectal fat tissue (stage T3, Dukes B), in detecting positive lymph nodes (N1), distant metastasis (M1), as well as in evaluation of tumor down staging after preoperative radiotherapy.

The first results reported high accuracy of CT in preoperative staging of colorectal cancer (1) but further studies showed that many tumors were not precisely staged because of the present macroinvasion of the surrounding perirectal fat tissue as well as metastases in lymph nodes which were of normal size. This discrepancy was the result of the fact that many advanced cases were included in the first studies. The accuracy of CT in assessment of intestine wall invasion depth is about 70% (2,3). Zerhouni et al. (4) achieved the accuracy of 74% in a group of 365 patients. Thomson et al. (2) have shown in their group of rectal cancer patients - Dukes B and C - that only 15 out of 25 patients were correctly staged.

Two primary limitations of CT in preoperative rectal cancer staging are the difficulties in detecting minimal invasions of perirectal fat tissue and great prevalence of metastases in lymph nodes which are of normal size. The accuracy of CT in estimating microinvasion of pericolic and perirectal fat tissue in the studies varies between 53-77% (5).

In detecting metastatic lymph nodes CT revealed 62% accuracy and 48% sensitivity (4). Gomille et al. has reported results of preoperative scan-

ners of 153 rectal cancer patients in whom they analyzed different criteria for positive lymph nodes (N1). The results were compared to postoperative histological findings. In detecting regional lymph nodes, smaller than 1 cm, the sensitivity of CT was 47%. In detecting metastatically changed regional lymph nodes larger than 1 cm or more metastatic nodes smaller than 1 cm, the sensitivity of CT was 71%.

In a well-known study Kim NK et al. (7) it is pointed out that the accuracy of CT in identifying the depth of rectal wall invasion is 65.2%. The accuracy in identifying metastatic lymph nodes was 56.5%, sensitivity 56%, specificity 56.8% while the accuracy in detecting infiltration of posterior vaginal wall was 28.5%.

Spiral CT has several advantages in comparison to the standard one:

a) speed-taking into consideration that a patient is continually moved through gentry the duration of examination is significantly shorter;

b) improved detection of small lesion spiral scanner examination is performed during just one breathold period and the cuts obtained are really continual. Also, the data obtained are voluminous and as such can be identified even after the scanning;

c) better contrast image-spiral CT can record the region of interest in a short interval and with time synchronization with bolus of intravenously administered contrast to make sure that the optimal contrast opacity is obtained;

d) reconstruction of the image and a possibility of later improvement.

CT has an important role in choosing the patients that will benefit from radiotherapy and in radiotherapy planning as well as in evaluation of responses to performed preoperative radiotherapy.

Preoperative radiotherapy is indicated in treating rectal cancer T3 and T4 stage of the disease (Dukes B and C). It is used for the purpose of decreasing the malignant potential of dissemination of tumor cells during the operation, sterilization of peripheral clinically undetectable malignant foci and deposits in lymph nodes, increase in resectability by moving the cancer from nonoperative to operative one (downstaging), which increases the percentage of complete resections as well as sphincter saving operations. Numerous studies have shown that preoperative radiotherapy decreases the percentage of local recurrence from 20-50% to 12-15% (8) but the improvement in overall survival was not proved.

Hypofractionated regimes (with dosage of 45-50Gy and an operation after 6 weeks after completed radiotherapy) and conventionally fractionated regimes (with dosage of 45-50Gy and operation 4-6 weeks after completed radiotherapy) are used in preoperative radiotherapy.

At the Institute for Oncology and Radiology of Serbia during a period from March 4th 1996 to April 10th 1999 clinical prospective non-randomized study was performed in a total of 48 patients with a locally advanced rectal cancer. All patients were treated by preoperative radiotherapy with a therapy dose of 45 Gy applied during 5 weeks on a Linear electronic accelerator.

Examinations of all patients were performed on CT (HeliCAT II, ELSCINT Israel) with the aim to stage initially and plan adequately preoperative radiotherapy. The CT scanning was performed on a flat surface in prone position and the previous preparation of patients (30 ml 76% urographine contrast diluted in 1 liter of water which the patient drank 1.5 hours before the examination, with intravenous application of 60-120 ml of Telebrix 380 contrast during the examination). For abdomen examination the volume of cross-section was 10 mm and for small pelvis examination 5 mm.

CT scanning was performed four to six weeks after preoperative radio-

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The manuscript was received: 05. 11. 2000.

Accepted for publication: 28. 11. 2000.

therapy (before the operation) in order to assess tumor down-staging.

The condition without any signs of tumor was denoted as complete regression (CR).

The decrease of tumor for more than 50% in comparison to pretherapy size was denoted as partial regression (PR). Complete and partial regression makes the response rate (RR). In case without any changes before and after therapy was registered as no change (NC) and locoregional and distant dissemination as disease progression (PD).

In our group (total of 48 patients), complete regression (CR) was detected in 5 patients or 10.42%, partial regression (PR) in 23 patients or 47.92% and no-change (NC) in 19 patients of 39.5%. Disease progression did not appear in any of the patients and in one patient or 2.08% the response was not assessed. The response rate (RR) in the studied group was 58.4% i.e. it was detected in 28 patients (9). In order to identify the real contribution of preoperative radiotherapy in percentual down-staging of tumor, initial and postradiotherapy tumor volume was calculated (scanner measuring by longitudinal, transversal and anteroposterior diameter of tumor) and the data obtained were compared. The average decrease of tumor volume after preoperative radiotherapy for the whole group of patients was 70.25% (9).

Many authors have shown that preoperative radiotherapy significantly contributes to primary tumor regression.

Horn et al. (10) have conducted a study in which 159 patients were preoperatively treated by radiotherapy, with dose of 31.5 Gy applied in 18 fractions while 150 patients were operated only. Mean tumor diameters of patients who were treated with radiotherapy were statistically significantly smaller in comparison to tumor diameters of patients who were only operated.

Reis Neto et al. (11) have reported the results of preoperative radiotherapy conducted in 34 patients with therapy dose of 40Gy applied in 20 fractions. Tumor regression of more than 70% was diagnosed in 26 patients or 76.4%, and the regression of more than 90% in 6 patients or 17.6%.

Gurner et al. (12) in their group of 65 patients proved the decrease in tumor size of more than 55% in 33 patients, more than 30% in 16 patients, while 16 patients did not show significant decrease in tumor size.

Based on the data from previous studies and the results obtained in our study, we can conclude that computerized tomography has a significant role in initial diagnosis and rectal cancer staging, planning preoperative radiotherapy as well as assessment of tumor response (downstaging).

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Contraversies in breast imaging - detection of recurrent carcinoma after conservative surgery and radiation therapy

Key words: Breast cancer conserving therapy; Recurrence; Imaging

The imaging investigation is of the essential importance for breast cancer follow-up after the conserving therapy, because the rate of tumor recurrence is reported to be 5%-10%, at 5 years, and 10% -16%, at 10 years.

The ideal imaging investigation must be non-invasive and have sensitivity and specificity of 100%.

Although recent advances in conventional imaging of the breast (mammography and ultrasound) have greatly improved image quality, the techniques are not without limits. Its limited efficiency is especially manifested for breast cancer follow-up, after the breast conserving therapy.

1. Is mammography really that bad?
2. Do we need another breast imaging examination?

With meticulous mammographic technique, early detection of recurrent cancer is possible, especially in the development of new fine microcalcifications. It remains the best modality for detection and evaluation of microcalcifications.

- What is wrong with mammography?

The shortcoming of mammography after the conserving therapy (i.e. exclusive radiation therapy) is a low sensitivity to evidence the new tumor mass or increasing density (without calcifications) at the dense mammograms.

Approximately 5%-15% of recurrence are not detected on mammography. Occasionally, in difficult cases, US is helpful.

At last, its specificity is not successful for differentiation recurrence from benign, post treatment, fibrosis.

Lack of evidence for definitive diagnosis, increases the number of unnecessary biopsies.

- To improve the specificity of diagnosis (indeterminate mammographic findings) do we need a new imaging technique?

- Yes, that is post-contrast MRI, in addition to (or instead) of mammography.

Recurrent tumor demonstrates early enhancement, while benign fibrosis shows no substantial enhancement.

Various investigators have shown that the MR imaging can be used to detect or exclude recurrent tumor 12 months after the radiation therapy. The accuracy of dynamic MR imaging is limited before 12 months because of the non-specific enhancement of tissue after recent surgery and radiation therapy.

This manner for following-up, is a recommendation for women who are at greater risk for recurrence. This group includes women younger than 35 years, women with an extensive intraductal component of disease, and women with comedo type intraductal cancers.

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The manuscript was received: 13. 11. 2000.

Accepted for publication: 28. 11. 2000.