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How to work together between nuclear medicine and radiotherapy departments?

Comment travailler en commun entre services de médecine nucléaire et de radiothérapie ?

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Abstract

Among the available imaging techniques, functional imaging provided by nuclear medicine departments represents a tool of choice for the oncoradiotherapist for targeting tumour activity, with positron emission tomography as the main modality. Before, during or after radiotherapy, functional imaging helps guide the oncoradiotherapist in making decisions and in the strategic choice of pathology management. Setting up a working group to ensure perfect coordination at all levels is the first step. Key points for a common and coordinated management between the two departments are the definition of an organizational logistic, training of personnel at every levels, standardization of nomenclatures, the choice of adapted and common equipment, implementation of regulatory controls, and research/clinical routine continuum. The availability of functional examinations dedicated to radiotherapy in clinical routine is possible and requires a convergence of teams and a pooling of tools and techniques.

Résumé

Avant, pendant ou après la radiothérapie, l'imagerie fonctionnelle permet de guider l'oncologue radiothérapeute dans ces décisions et dans son choix stratégique de prise en charge de la pathologie. Pour parvenir à une utilisation optimale de l'imagerie fonctionnelle en radiothérapie, il convient de

définir un cadre de travail et un certain nombre de règles de bonnes pratiques. La mise en place d'un groupe de travail pour assurer une parfaite coordination à tous les niveaux est la première étape. Les points clés pour une prise en charge commune et coordonnée entre les deux départements sont la définition d'une logistique organisationnelle, la formation du personnel à tous les niveaux, la standardisation des nomenclatures, le choix d'équipements adaptés et communs, la mise en place de contrôles réglementaires, le continuum recherche/routine clinique. La mise à disposition d'exams fonctionnels dédiés à la radiothérapie en routine clinique est possible et nécessite une convergence des équipes et une mise en commun des outils et des techniques.

Keywords

Radiotherapy

Nuclear medicine

Coordination

PET/CT

Treatment position

Common support

Mots clefs

Coordination

Radiothérapie

Médecine nucléaire

TEP/TDM

Position de traitement

Prise en charge commune

1. Introduction

With the deployment of high-tech radiation treatments, such as stereotaxis, static, rotational intensity modulation or proton treatments, the oncoradiotherapist is increasingly working on imaging examinations from multiple modalities in order to better define the target volume and its possible extensions. Among the available imaging techniques, functional imaging, and foremost positron emission tomography (PET), provided by nuclear medicine departments represents a tool of choice for

the oncoradiotherapist for targeting tumour activity. Before, during or after radiotherapy, functional imaging helps guide the oncoradiotherapist in making decisions and in the strategic choice of pathology management.

Numerous studies have shown that PET imaging allows, depending on the radiotracer uptake, to adapt prescribed radiation dose (this is called dose painting) (1). Thus, for example, an additional dose can be added to the hypoxic areas of the tumour, which are known to be radioresistant and visible on (¹⁸F)-labelled misonidazole or (¹⁸F)-fluoroazomycin arabinoside PET imaging (2). In this approach, the prescribed dose is directly correlated to the radioactive concentration of the radiopharmaceutical.

The performance of imaging examinations during treatment makes it possible to evaluate the tumour response to treatment. Depending on the response observed, it is possible to readjust the volumes of interest or the dose to be delivered (3). Reducing the target volume limits the exposure of healthy tissues and thus contributes to a better tolerance of the treatment. On the other hand, taking into account an increase in volume maintains optimal targeting in order to guarantee the effectiveness of the treatment. A dose escalation on radioresistant areas can also complement the treatment.

Finally, functional imaging performed after radiotherapy provides an indication of the effectiveness of the treatment performed and detects possible recurrences.

To achieve an optimal use of functional imaging in radiotherapy, a framework and a number of rules of good practice should be defined. Based on the experience gained over the last ten years in the field, we propose to define recommendations for the implementation of collaborative work between the nuclear medicine and radiotherapy departments.

2. Good practice recommendations

The organization should be primarily focused on the patient journey and can be divided into the following subobjectives:

- organize the deployment of the PET/CT in radiotherapy condition, or even the use of CT associated with PET for the calculation of radiotherapy dosimetry (fewer examinations, more precision);
- optimize radiotherapy and nuclear medicine coordination to reduce the time to care;
- fix technical and organizational obstacles resulting from these changes in practice.

To achieve these objectives, we propose various recommendations:

2.1. Set up a radiotherapy and nuclear medicine steering working group

The creation of a multidisciplinary steering group clearly demonstrates the willingness of the imaging (nuclear medicine/radiology) and radiotherapy departments to work together to improve patient

management. Human resources necessarily included in this steering group represent the professionals taking part in the patient's management in each of both departments involved (physicians, nuclear medicine and radiotherapy physicists, managers, technologists, dosimetrists, secretaries). The inclusion of people with dual skills (radiotherapist with nuclear medicine practice, radiotherapy physicist with good imaging practice, etc.) is an advantage when consensus/commitments need to be found and decision to be applied.

The objectives of such a steering group are:

- to choose imaging equipment compatible with the constraints of the radiotherapy set-up;
- to pool or to have common and homogeneous equipment allowing a patient management synergy;
- to choose the radiotherapy localizations (pathologies) concerned in order to limit the complexity of the implementation;
- to define and set up imaging acquisition protocols adapted to the needs of radiotherapy and tools dedicated (immobilization equipment, software) to the different common patient management;
- to solve the various problems, whether they are of a technical or logistical nature (to set up a feedback system);
- to disseminate unique and complete information to both services;
- to set up a dedicated quality assurance system (documentation, quality control, etc.);
- to ensure the follow-up and respect of the different instructions.

2.2. Define organizational logistics

Various steps are necessary for patient management.

2.2.1. Prescription of PET imaging examination by the oncoradiotherapist, and validation by the nuclear physician

The request for a PET imaging scan in radiotherapy position is the starting point of the patient's management. This request, approved by the nuclear medicine physician, must therefore contain all the information necessary to perform an examination for future radiotherapy treatment, in particular:

- the tumour location;
- the desired technique (type of acquisition, injection or not of contrast agent, four-dimensional modality, etc.);
- information given to the patient about future radiotherapy treatment;
- the choice of patient immobilization equipment.

2.2.2. Making appointments (jointly or sequentially)

Appointments must be made by the imaging secretary office in collaboration with the radiotherapy secretariat/planning. Specific planning slots should be available in order to guarantee a fast patient's management. At the same time the schedules in nuclear medicine department should be optimized to group several PET exams of this type in succession and thus avoid handling the radiotherapy equipment.

2.2.3. Information distribution to the teams

Nuclear medicine and radiotherapy teams must have the same level of information at the same time. Possible dissemination tools include: the hospital information system, nuclear medicine and radiotherapy information system or a mailing list.

2.3. Train staff

Multidisciplinary knowledge is necessary for the implementation of this type of patient management:

- radiotherapy and nuclear medicine secretary office are trained in specific logistics to understand the issues involved in programming the patient's management or carrying out the exams;
- nuclear medicine manipulators must be autonomous in placing the patient in radiotherapy condition;
- dosimetrists must know how to use PET imaging data for planning (dedicated radiotherapy reconstructions) as well as contour files (if performed in nuclear medicine department);
- nuclear physicians, if they segment tumour uptakes, must be trained to export contours in radiotherapy format (digital imaging and communications in medicine radiotherapy structure set [DICOM RTSS]);
- radiotherapists are aware of the specificities and limitations of PET imaging.

2.4. Standardize nomenclatures

Specific terminologies are needed during the journey of patients undergoing this type of examination (examination request, appointment, specific name of the examinations, name of the examination series, contour nomenclature, etc.).

2.5. Choose the right equipment

2.5.1. Computer tools (visualization/contouring/transfer)

If the contours are made in the nuclear medicine department, the software used to make the contours must allow to export in DICOM RTSS format.

If the contours are performed on the radiotherapy software, it must be able to perform a standardized display (standard uptake value) and allow a contour by thresholding with respect to the maximum standard uptake value of a three-dimensional (3D) region of interest.

2.5.2. Specificities of the PET examination room

In order to achieve the best integration of functional imaging in radiotherapy, the equipment present in the PET/CT room must be adapted to the set-up of patients in radiotherapy position.

2.5.2.1. Minimum settings

As a minimum, settings should be as follows:

- field of view size (ring diameter) compatible with radiotherapy set-up;
- rigid tabletop: helps to improve patient repositioning between sessions;
- centring lasers: necessary for patient positioning and alignment;
- tattoo system: identification of landmarks on the patient's skin to help with alignment.

2.5.2.2. Recommended settings

The use of the same contention systems as for radiotherapy allows the patient to be imaged under the exact conditions of the future radiotherapy treatment and thus helps to facilitate the registration between examinations.

2.5.3. Acquisition technique

If the PET/CT is used for dosimetry calculations, the acquisition and reconstruction parameters must be identical to those used in radiotherapy:

- slice thickness, spatial resolution and field of view (acquisition field of view);
- number of slices;
- acquisition parameters (kV, mAs);
- respiratory synchronization;
- injection of contrast agent.

2.6. Implement regulatory quality controls

Beyond the standard quality controls required for every PET system, working with the tools of radiotherapy requires compliance with the regulations in force regarding quality control dedicated to radiotherapy.

2.6.1. Lasers

The teams must check their adjustment daily. This control concerns their horizontality, verticality and orthogonality.

2.6.2. Flatness of the examination table

This must be checked externally at the start of the installation and on an annual basis.

2.6.3. Patient z-axis positioning accuracy

This is a monthly internal and annual external control.

2.6.4. Correspondence curve between Hounsfield units and electronic densities

If the CT of the PET/CT exam is used for dosimetry planning, a calibration curve linking the electronic densities to the Hounsfield units must be established and checked annually. This curve must be integrated into the planning software (TPS) for dosimetry calculation. This verification must be carried out internally on an annual basis. The use of the PET/CT for dosimetry planning requires a specific declaration of the PET scanner to the nuclear security agency.

2.6.5. Data transfer

Check that data transfer between the various software made available in the departments does not lead to loss of information. This concerns the format of the images (compression, interpolation during PET/CT fusion), their headers as well as the associated contours (smoothed or not). An annual internal verification must be carried out.

2.6.6. PET quality controls (not mandatory)

Quality controls are carried out on the PET imaging to ensure that the standard uptake value measurements are stable over time.

2.7. Interpretation, discussion, common contouring meeting between the radiotherapist and the nuclear medicine physician

PET/CT examination in treatment position does not theoretically require a report. However, it is of interest to the radiotherapist, especially if the regions of interest segmented are defined by the nuclear medicine physician (exported in DICOM RTSS).

Discussions/explanations between the nuclear physician and the radiation therapist in front of the same viewing and contouring screen prove to be the optimal communication solution. This multidisciplinary contouring meeting allows a quick consensus to be reached, but requires additional medical time.

2.8. Research and clinical routine continuum

The rigor necessary for the proper accomplishment of clinical research protocols is an important support to ensure that these protocol-specific operating modes are integrated into the clinical routine and thus contribute to a better care of the patient and his or her course between the nuclear medicine department and the radiotherapy department.

For several years, the Henri-Becquerel centre in Rouen (France) has acquired expertise in tumour characterization using metabolic imaging (PET) as well as in the mechanisms of tumour evaluation during radiotherapy. Several clinical trials have enabled the imaging and radiotherapy teams to collaborate together to achieve personalized patient care, particularly for localizations such as the lung, oesophagus, or the lymphatic system (4-10).

3. Conclusion

Working together between nuclear medicine and radiotherapy departments requires the setting up of a working group to ensure perfect coordination at all levels. The key points for a common and coordinated management between the two departments are the definition of an organizational logistic, training of the personnel at every level, standardization of nomenclatures, choice of adapted and common equipment, implementation of regulatory controls, the research and clinical routine continuum.

The availability of functional examinations dedicated to radiotherapy in clinical routine is possible and requires a convergence of teams and a pooling of tools and techniques. Working together between two different disciplines allows constructive exchanges but also often leads to constraints and can generate conflicts. This is generally linked to misunderstandings that can be overcome through common information and training. The human factor is, as always, a central point of a project like this one, and dialogue is the solution.

This mode of operation is the precursor of a future mode of work in radiotherapy that will rely more and more on imaging. The evolution of equipment (digital PET, PET linear accelerator) and improved precision (detectability) will enable the radiotherapist to make full use of multimodal imaging in all phases of the treatment.

Author statement

All persons who meet authorship criteria are listed as authors, and all authors certify that they have participated sufficiently in the work to take public responsibility for the content, including participation in the concept, design, analysis, writing, or revision of the manuscript.

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