A malignant tumor is per se potential systemic disease. Early tumor detection, precise staging and accurate therapy monitoring in individual patients are essential for achieving best patient outcome in terms of survival and quality of life. Treatment decisions with either curative or palliative intention consider individual disease characteristics and identify patients who are candidates for aggressive medical or surgical interventions particularly. Repeated assessment of the disease progress is of fundamental importance for controlling the individual treatment success. The individual proceeding is predominantly based recommendations of multidisciplinary conferences where diagnostic and therapeutic strategies are carefully balanced taking all medical and radiological information into account. In this concept, initial and repeated tumor staging are preconditions for assessing prognosis, planning and monitoring individually optimized treatment strategies as well as keeping an eye on the therapy outcome.

Tumor serum markers are important tools for estimating the total tumor load and its changes during therapy, but they cannot provide information about the localization of the primary tumor, its extension into surrounding anatomical structures as well as its lymphatic and hematogeneous spreading. Whole-body imaging is consequently of fundamental importance for staging. It provides important components of the decision-making process by identifying both, tumor specific as well as disease or treatment related abnormalities, e.g. metastatic spreading and chemotherapy induced pneumonia. Up until a few years ago, only functional nuclear medicine examination methods enabled whole-body image information, for example, conventional bone scan with technetium-marked phosphate complexes and, more recently, positron emission tomography with the radioactive nuclide \(^{18}\text{F}\)-2-Fluoro-2desoxy-D-glucose (\(^{18}\text{F}\)-PDG-PET). But over the last 10 years spiral CT has gone through enormous technical advantages and whole-body imaging became feasible within one single examination. Whole-body spiral CT evolved rapidly to an indispensable tool in oncologic radiology enabling high-resolution imaging of the whole-body within only a couple of seconds. Nevertheless, the limited specificity of conventional CT morphological criteria for discriminating benign and malignant tissue remained, e.g. for detecting small lymph node metastases or for discriminating recurrent tumor from treatment related scar tissue. To solve this fundamental problem in oncologic radiology the combination of whole-body morphologic and functional information was urgently required. It was enabled by further advances in the scanner and computer technology leading to the recent development of PET-CT hybrid systems. This technology uses full capacity of both imaging methods offering to acquire metabolic and morphologic data within one single examination and to superimpose information on color-coded images. Clinical and research applications are at present tremendously evolving [1-3]. MRI has the distinct advantage to provide anatomical details with superior soft tissue contrast compared to CT and to yield additional functional information about e.g. perfusion and metabolism. But the method was for a long time understood as a dedicated only for evaluating local disease. Meanwhile, technological progress enabled also high-resolution MRI of the whole body within one single examination [4].
It is important to note, that the diagnostic accuracy of whole-body MRI strongly depends on the applied MRI technique. An impairment of spatial and/or contrast resolution compared to a series of sequentially acquired, conventional partial-body MRI examinations must be avoided for maintaining the diagnostic accuracy of MRI, particularly regarding the detection of small metastases, e.g. in the brain or moving organs like the liver. The use of surface coils and integrated parallel imaging acquisition technique (iPAT) enables to apply various spin-echo and gradients echo sequences for achieving equivalent high spatial and contrast resolution of each body part as compared to conventional MRI examinations of a single body part [4].

Exceptions are small anatomical regions where dedicated coils have necessarily to be used for high-resolution imaging, e.g. breast, prostate and small joints of hand and foot. By applying breath-hold or navigator techniques with iPAT, even small metastases can be detected within a whole-body examination, also in moving organs like the liver. Tumor lesions can furthermore be characterized by assessing their characteristic signal behavior on different MR sequences, e.g. diffusion-weighted (DWI) and spectroscopic MR sequences. The lack of x-ray exposure is favourable for performing various MR sequences including contrast-enhanced dynamic imaging studies as well closed follow-up examinations even in young and anticipated healthy individuals.

Clinical studies comparing whole-body MRI with PET/CT have proven that MRI is most sensitive for early tumor detection in different organs, like the brain, liver, or bone marrow [5-8]. Whole-body MRI can accordingly play an important role for evaluating metastatic disease and for estimating the individual total tumor burden. Regarding bone metastases, whole-body MRI has been proven to be more sensitive than conventional bone scintigraphy, X-ray, CT and PET/CT for different tumor types. Clinical studies with advanced melanoma patients comparing whole-body CT, MRI and PET/CT have proven the feasibility and clinical potential of high-resolution whole-body MRI [6, 7]. It has been found that whole-body MRI altered the therapeutic concept in ca. 25-60% of the examined patients, which was basically related to the high sensitivity to detect cerebral, hepatic and skeletal metastasis. Metastases to the lung are frequent sequelae of different tumors and CT is so far the method of choice for detecting small lung nodules. However, HASTE or 3D GRE sequences, which can easily be integrated in an wb-MRI protocol, yielded sensitivities about 90% for 4 to 10 mm nodules and approximately 100% for nodules larger than 10 mm [9]. Initial results also demonstrate the potential of wb-MRI to detect lung metastases. One major drawback of MRI remains the limited accuracy for early detection of lymph node metastases. Novel contrast media containing lymphotropic paramagnetic nanoparticles (USPIO) may help to increase the specificity [10].

To screen for multifocal tumor growth or distant tumor spreading whole-body can on principle be applied for all kind of malignant tumors. In order to minimize the total examination time, however, a whole-body MRI examination protocol should focus on the specific pathophysiology of the tumor as different tumors types are characterized by different patterns of local growth and systemic spreading. Regarding haematogenous spreading, for example, prostate cancer preferentially develops osteoblastic bone metastases, whereas colorectal carcinomas tend to initially spread into the liver or bronchial carcinoma into the brain. Accordingly, disease specific examination protocols have been implemented in our institution, which are based on a modular concept combing different organ specific examination protocols according
to the specific tumor entity and individual risk factors [11]. The examination protocols are leaned against oncologic guidelines and extended according to the individual clinical situation.

Whole-body imaging significantly increases the number of acquired images per patient. One examination comprises up to 1000 images, which all have carefully to be reviewed for the presence or absence of suspicious mass lesions consuming a notable amount of time and concentration. The time required for reading, documentation and discussion of the high number of images vary substantially, and 15-60 minutes are needed, particularly if additional images, e.g. from follow-up and/or multimodal diagnostic approaches with CT, PET or PET/CT have to be evaluated. Furthermore, the imaging findings have comprehensively to be presented in multidisciplinary conferences. The involved Radiologists are accordingly faced with heavier workload, in particular when referring clinicians are getting more and more aware of a comprehensive whole-body approach cutting down the total time demand for imaging. Workflow optimization has to be considered as a prerequisite for utilizing the potential of the whole-body imaging technology. Logistical considerations should be aimed at minimizing the time demand for both, the patient examination as well as the reading and reporting process. Challenging concepts for redesigning the workflow of oncologic imaging are currently on the right track.

References:


