The Role of Imaging in the Assessment of Cancer Treatment

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Synopsis
The tomographic imaging of anatomic structures, obtained with CT and MRI, has become an integral part of cancer treatment. While such anatomic images are clearly useful, they also have a number of limitations. Standard CT and MRI can measure the size of a tumor, but provide little information about its physiologic status. Newer imaging techniques such as DCE MRI, MR spectroscopy, and positron emission tomography produce images of physiology that provide an attractive means to measure response. These approaches are becoming more important in the development of targeted drugs and will become a standard part of routine therapeutic evaluation.

Imaging has played an important role in the diagnosis and staging of cancer since the introduction of radiography. Over the last twenty years, the measurement of treatment response has gained increasing importance and studies indicate that chemotherapy and radiation used alone or in combination have found increasing success. Prior to that time, surgical treatment constituted the primary effective therapy while chemo- and radiotherapy presented limited options and were generally used for short-term palliative effect. Today, there is an ever-widening choice of chemotherapeutic agents. For example, until about ten years ago it was debated if any chemotherapy was useful in improving symptoms or prolonging life in patients with metastatic lung cancer. Today, even if the first line of chemotherapy fails, second and third line regimens have been developed and approved. As more choices become available, the need for rapid assessment of response becomes more important. The agents are expensive and toxic, so an early determination of the efficacy of a particular regimen becomes more. Fortunately, these advances in treatment have been accompanied by improved imaging options. The tomographic imaging of anatomic structures, obtained with CT and MRI, has become an integral part of cancer treatment. While such anatomic images are clearly useful, they also have a number of limitations. Standard CT and MRI can measure the size of a tumor, but provide little information about its physiologic status. Some tumors may respond to treatment by becoming fibrotic, leaving a lesion that he changed little in size, despite the efficacy of therapy. On the other hand, a tumor may initially shrink significantly in size, but the remaining lesion may contain completely viable cancerous components that may rapidly grow back. These issues have recently gained even more importance with the testing of more targeted therapies. With some of these therapies the goal is to slow tumor growth, and shrinkage of the tumor is not always the expected outcome. In all these settings newer approaches to imaging tumor physiology provide attractive means to measure response. For example, MR imaging of tumor blood flow and spectroscopy are increasingly being examined for use in research and clinical studies. The role of newer imaging technologies is gaining particular importance in the development of new drugs. A large number of drugs (>300) are now in early stage clinical trials. The cost (estimated at about $US 800,000,000) and time involved in developing these agents is leading investigators to seek new ways to evaluate their efficacy. Rapidly determining that a new agent is ineffective is as important as demonstrating that an agent is useful. When one can identify and image the target of a particular agent, this also will assist in determining the best schedule for therapy. For example, treatment with some anti-vascular agents was initially begun every 21 days. Imaging with DCE MRI demonstrated, however, that changes in tumor blood flow lasted less than 24 hours, leading to testing of alternative drug delivery schedules. Some targeted therapies can actually lead to apparent increases in tumor size as the result of edematous changes within effectively treated lesions. Positron emission tomography (PET) with fluorodeoxyglucose (FDG) has found, for example, that gastrointestinal stromal tumors (GIST) can become physiologically inert within 24 hours of the start of therapy with imatinib (Glivec, Gleevec). As other new agents are developed it will be important to work collaboratively with imaging scientists to develop practical approaches to determining the efficacy of the therapy.