2007: Improvements with PET/CT for invasive bladder cancer Brazilian exports report dramatic improvements using simple innovations, detection of locally recurrent or residual bladder tumors using 18F-FDG PET/CT with delayed images after a diuretic (furosemide) and oral hydration: 18F-FDG PET/CT Delayed Images After Diuretic for Restaging Invasive Bladder Cancer

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To see some abstracts discussing MRI, PET and CT and the latest in imaging, the PET/CT scans, see below.

This is a link to some institutes and centers using PET in the US as well as internationally; http://www.aapm.org/pet/

Tri-X PET designs the equipment, and has a website detailing the PET scan's uses, as well as a few locations of PET centers; http://www.tri-x.com/

For an in depth online article about PET, look here (pdf file): http://www.nuc.ucla.edu/html_docs/PET/petbrochure.pdf


PET/CT

Combined PET/CT scanners represent an important evolution in technology that is helping to bring molecular imaging to the forefront in cancer diagnosis, staging, and therapy monitoring.

A combination of two body-imaging techniques can more accurately tell doctors how far a patient's cancer has spread than full-body MRI scans, German researchers say. Their (2004) study compared full-body PET/CT scan technology with full-body magnetic resonance imaging in 98 cancer patients with tumors in such places as the lungs, head, neck, thyroid, gastrointestinal tract, liver and bones.
In the study, combined PET/CT scans correctly identified tumors, any cancerous lymph nodes and any further cancer spread in 75 of the 98 patients, or 77 percent. That compares with 53 out of 98, or 54 percent, with MRIs.

Whole-body dual-modality PET/CT and whole-body MRI for tumor staging in oncology. Antoch G, Vogt FM, Freudenberg LS, Nazaradeh F, Goehde SC, Barkhausen J, Dahmen G, Bockisch A, Debatin JF, Ruehm SG. Department of Diagnostic, University Hospital Essen, Essen, Germany study abstract

Why nearly all PET of abdominal and pelvic cancers will be performed as PET/CT. Wahl RL. Division of Nuclear Medicine, Russell H. Morgan Department of Radiology and Radiological Sciences, Johns Hopkins University School of Medicine, Baltimore, Maryland, USA J Nucl Med. 2004 Jan;45 Suppl 1:82S-95S below

The following article on the study and applications of PET scans for detecting metastases was taken from the Norris Cancer Report http://www.usc.edu/ (used with permission):  

A Clearer View

Physicians are improving technology to better visualize and diagnose a variety of cancers.

by Phil Davis and Eva Emerson

Cancer can still run, but it has a tough time hiding these days. Technological advances now offer intriguing looks at the inner workings of the human body.

At the USC PET Imaging Science Center, director Peter Conti, M.D., uses a positron emission tomography (PET) scan to expose colonies of colorectal cancer cells that have migrated to a patient's lung and liver. Surgeons were considering removal of a cancerous mass in the patient's abdomen, but Conti's detailed metabolic scan revealed other masses in the lung and liver-a surprise not shown in the other imaging studies performed.

While the news was grim, Conti says the patient will be spared a painful and costly operation that would not have eliminated the cancer. Instead, the patient's physicians can now draw up a chemical attack guided by Conti's images that clearly pinpoint where the cancer is hiding.

Unlike X-rays that take pictures of anatomy, PET scans allow physicians to visualize the body's metabolism. A patient is
injected with a close cousin of the sugar glucose—the body’s fuel-marked with a radioactive tracer that allows radiologists to map the body’s use of the fuel. Because cancer cells break down glucose at a higher rate than normal cells, they stand out on a PET scan.

"We are moving the threshold out a little farther, in terms of seeing cancer," Conti says. "The more you can see, the more intelligent the decisions you can make regarding treatment."

Following that philosophy, Conti uses anatomical imaging such as a computed tomography (CT) scan and a PET scan when making a diagnosis. CT scans provide cross-sectional images of the body’s bones and organs. The CT scanner beams X-rays through the body. Data on how much of the X-rays penetrate the body are transmitted to a computer, which creates an internal image with remarkable detail.

At the USC/Norris Comprehensive Cancer Center and Hospital, radiation oncologist Oscar Streeter Jr., M.D., and his colleagues are using conformal radiotherapy, which converts CT images in a computer program-developed at USC-into a detailed 3D internal image of a patient's body. This image helps target radiation therapy more directly at cancer cells, sparing healthy tissue. Streeter says enhanced targeting enables radiation oncologists or radiation therapists to direct higher total doses of radiation at cancer cells while minimizing side effects experienced by the patient.

Magnetic resonance imaging (MRI) is another useful tool in seeing cancer. MRIs generate a magnetic field 8,000 times greater than the Earth's magnetic field, causing the body's hydrogen atoms to line up uniformly. A scanner scatters the atoms, then a computer tracks their radio frequency when they realign. This translates into a sharp, colorful image useful in detecting ailments such as brain tumors.

Yuri Parisky, M.D., a specialist in breast and oncology imaging, is testing a thermal breast imaging system in conjunction with mammography. The system uses an infrared camera to record the natural heat radiation emitted from the breast. The images are used to create a computer model of the breast, theoretically allowing doctors to better spot cancer cells. The system has the potential to drastically reduce the number of breast biopsies, now the only sure way to differentiate between malignant and benign lumps in the breast.

One thing imaging systems cannot yet detect are tiny clusters of individual cancer cells. Pathologist Richard Cote, M.D., is studying techniques to use color computer images to detect micrometastases—cancers so small they cannot be seen. Cote and others believe that these undetected cancers may lodge in new sites and develop into more serious secondary tumors. Because of the chance of micrometastasis, patients must undergo chemotherapy after surgery. By detecting the tiny cancer clusters in advance, many patients may be spared the need for painful postsurgical chemotherapy.

But, Cote says, detecting the tiny cancer clusters is like "searching for a needle in a haystack."

To help with this search, Cote and his colleagues are working with Chroma Vision, a software program that scans tissue samples for micrometastasis based on color. Currently, they are searching for lung cancer and have begun pilot programs for similar research in prostate, breast and bladder cancers.
With continued advances in technology, there may soon be no place left for cancers to hide, making them easier targets for destruction.

Below you'll find a few studies on Medline discussing PET/CT, PET and MRI for use in bladder cancer imaging, and a rather disturbing one about CT scans.

Medline Abstract: PET/CT

Why nearly all PET of abdominal and pelvic cancers will be performed as PET/CT. Wahl RL. Division of Nuclear Medicine, Russell H. Morgan Department of Radiology and Radiological Sciences, Johns Hopkins University School of Medicine, Baltimore, Maryland, USA J Nucl Med. 2004 Jan;45 Suppl 1:82S-95S

Clinical experience at Johns Hopkins and published literature regarding PET/CT applications in the abdomen and pelvis are reviewed, and the strengths and limitations of this evolving technology are summarized. More than 2,700 whole-body PET/CT scans including the abdomen and pelvis were performed for clinical indications by our nuclear medicine service from June 2001 through September 2003. Indications for these studies are reviewed, and our clinical impressions of diagnostic advantages and limitations of PET/CT are reported. Of the >2,700 whole-body PET/CT scans performed at our institution, >90% were for known or suspected cancers. Primary abdominopelvic indications were second in frequency to thoracic indications. In addition, a comprehensive literature search was performed, and key articles related to PET/CT in the abdomen and pelvis were identified, reviewed, and summarized. Under the search term "PET/CT," 142 articles were identified under the National Library of Medicine Pub Med database, and a number of general findings are summarized. CONCLUSION: PET/CT allows for the accurate localization of foci of radiotracer uptake and their separation from normal structures. In our experience, the method is quantitatively accurate, rapid, and easily implemented, including contrast studies, in clinical practice in a wide range of abdominopelvic indications. Although artifacts can occur from a variety of causes, close attention to protocol details and patient immobilization reduces their frequency. Where systematically studied, PET/CT improves diagnostic accuracy compared with PET alone. It is anticipated that PET/CT will increasingly become the routine and preferred procedure for abdominopelvic evaluations with PET imaging. It has already become the preferred method at our center. PMID: 14736839 [PubMed - indexed for MEDLINE]

Medline Abstracts: PET

PET is a new method in nuclear medicine which examines the metabolism and not the morphology. Tumors show a higher rate of glycolysis than benign tissue and hence can be detected by radioactive glucose. This method has proved good for various tumors. In this study the lymph node staging of bladder cancer by PET was investigated. In 64 patients a PET of the pelvis after injection of fluorodeoxyglucose (FDG) was carried out preoperatively; the PET-results were compared with the histology of the OR specimen after classical pelvic lymphadenectomy. For lymph node staging positive nodes were found in 14 patients which was correct; a false-negative result was obtained in 7 patients. In 37 patients the PET-result was true-negative and in 6 patients false-positive resulting in a sensitivity of 67%, a specificity of 86% and an accuracy of 80%. Therefore, our PET results are encouraging and seem to be better than those obtained by classical staging procedures such as CT or MRI. Lymph node staging of bladder neck carcinoma with positron emission tomography Bachor R; Kotzerke J; Reske SN; Hautmann R Urologe A 1999 Jan;38(1):46-50 Urologische Universitätsklinik Ulm. UI - 99180942
The introduction of Positron Emission Tomography (PET) and the use of the glucose analog F-18-Deoxyglucose (FDG) can help to improve the sensitivity of the diagnosis of lymph node metastases. Sensitivity exceeding 90% can be achieved when advanced imaging protocols and image reconstruction methods are used for PET. Superior staging information is obtained with PET as compared to morphological imaging methods for the most frequent tumor types. The accuracy of N-staging can be significantly improved by adding PET to the pretherapeutic diagnostic procedures. Limitations exist with regard to false positive results. Acute or chronic inflammation as well as unspecific reactions following radiotherapy may mimic tumor tissue. Sensitivity and specificity of positron emission tomography (PET) for the diagnosis of lymph node metastases. Strauss LG Medical PET Group-Biological Imaging (E0105), German Cancer Research Center, Heidelberg, Germany. Cancer Res 2000;157:12-9 PMID: 10857158, UI: 20315147

OBJECTIVES: The aim of this study was to evaluate whether pelvic lymph node metastases in patients with neoplasms of the bladder or prostate can be detected applying positron emission tomography with 2-[(18)F]-2-deoxy-D-glucose (FDG-PET). METHODS: Eight patients with bladder cancer and 17 patients with prostate cancer were examined with FDG-PET before pelvic lymph node dissection. Results of PET were then compared to histology of pelvic lymph nodes obtained at surgery. RESULTS: Lymph node metastases were detected by histopathological examination in 3 patients with bladder cancer and in 6 patients with prostate cancer. At the sites with histologically proven metastases, increased FDG uptake suspicious of metastatic disease was found in 2/3 and 4/6 patients, respectively. The smallest detected metastasis was a micrometastasis with a diameter of 0.9 cm. In 3 additional patients who all had histopathologically proven micrometastases (Staging of pelvic lymph nodes in neoplasms of the bladder and prostate by positron emission tomography with 2-[(18)F]-2-deoxy-D-glucose. Heicappell R, Muller-Mattheis V, Reinhardt M, Vosberg H, Gerharz CD, Muller-Gartner H, Ackermann R Department of Urology, Heinrich-Heine-Universitat, Dusseldorf, Germany.fu-berlin.de 1999 PMID: 10559612, UI: 20026056

Researchers at the University of Michigan assessed fluorine-18 fluorodeoxyglucose positron emission tomography (FDG-PET) scanning on 12 patients with histologically proven bladder cancer who had undergone surgical procedures and/or radiotherapy. Of 20 organs with tumor mass lesions confirmed pathologically or clinically, 16 (80%) were detected by FDG-PET scanning. FDG-PET scanning detected all of 17 distant metastatic lesions and two of three proven regional lymph node metastases. FDG-PET was also capable of differentiating viable recurrent bladder cancer from radiation-induced alterations in two patients. Although they found a major problem in use of FDG-PET imaging due to FDG accumulation in the urine, the authors felt that the preliminary data indicates the feasibility of FDG-PET imaging in patients with bladder cancer. Preliminary assessment of fluorine-18 fluorodeoxyglucose positron emission tomography in patients with bladder cancer. Kosuda S; Kison PV; Greenough R; Grossman HB; Wahl RL Department of Internal Medicine, Division of Nuclear Medicine, The University of Michigan Medical Center, Ann Arbor, Michigan, USA.Eur J Nucl Med 1997 Jun;24(6):615-20 IDS: PMID: 9169567 UI: 97313396

Irrespective of the staging level being addressed, the available techniques commonly used in the staging of bladder cancer include...
cancer uniformly have limitations, as well as advantages and disadvantages with respect to each other. A common shortcoming of both plain and cross-sectional techniques employing conventional X-rays is their lack of specificity. Solitary abnormalities on bone scan or chest film serve as an excellent examples of this dilemma. The specificity of conventional imaging techniques is further compromised by attempts to increase sensitivity. As long as nonspecific anatomic changes are used as discriminating criteria, increases in test sensitivity will always occur at the price of specificity. It is hoped that advances in PET scanning and the use of isotope-labeled, tumor-selective monoclonal antibodies will overcome the limitations of currently available techniques. Which staging studies are indicated and their optimal sequence for performance are influenced by pre-existing clinical information. While MRI appears to have slightly better sensitivity and specificity for both local and regional tumor stage relative to CT, its benefits are to some degree offset by its greater cost and the need to image the patient in multiple planes for lengthy intervals. Staging of advanced bladder cancer. Current concepts and pitfalls. See WA; Fuller JR Department of Urology, University of Iowa, Iowa City. Urol Clin North Am 1992 Nov;19(4):663-83 PMID: 1441024 UI: 93069723

MRI

For an excellent and detailed article about MRI imaging, see Scientific American's expert answer to reader questions: How do MRI's detect medical problems? online.

Improved MRI techniques;

Researchers evaluated a fast dynamic first-pass magnetic resonance (MR) imaging technique, for use in contrast enhancement patterns of the urinary bladder cancer and surrounding structures, to assess its usefulness in evaluating tumor and node staging, as well as differentiation of urinary bladder cancer from postbiopsy effects. Sixty-one consecutive patients with histologically proved urinary bladder cancer were referred to undergo unenhanced and dynamic MR imaging 1-4 weeks after transurethral resection or biopsy. Results with unenhanced T1- and T2-weighted images were compared with those obtained with the unenhanced images plus dynamic contrast material-enhanced single-section turbo fast low-angle shot (FLASH) images...Overall, tumor staging accuracy improved significantly from 67% to 84% (P < .01) by adding the turbo FLASH images. It was concluded that Fast dynamic first-pass MR imaging, with at least one image acquired every 2 seconds, improved delineation of urinary bladder cancer, tumor staging, and detection of metastases.

Staging urinary bladder cancer after transurethral biopsy: value of fast dynamic contrast-enhanced MR imaging. Barentsz JO; Jager GJ; van Vierzen PB; Witjes JA; Strijk SP; Peters H; Karssemeijer N; Ruijs SH Department of Radiology, University Hospital Nijmegen, The Netherlands. Radiology 1996 Oct;201(1):185-93 PMID: 8816542 UI: 96413381

The staging of both bladder and prostate carcinoma is important to determine appropriate therapy. Routine clinical staging of these tumors, however, has only limited accuracy. This article reviews the literature on contrast-enhanced MR of both bladder and prostate cancer, including technique optimization and potential benefits of contrast-enhanced studies. Contrast-enhanced MR imaging of the bladder and prostate Siegelman ES; Schnall MD Department of Radiology, Hospital of the University of Pennsylvania, Philadelphia, USA. Magn Reson Imaging Clin N Am 1996 Feb;4(1):153-69 PMID: 8673712 UI: 96231338

Since the introduction, pelvic MRI has been considered the best non-invasive technique for primary staging of urinary bladder cancer. Before using MRI an understanding of normal and pathological MR images of the urinary bladder is essential. This review therefore describes the MR anatomy of the urinary bladder as well as the appearances of carcinoma. MRI plays an important clinical role in staging the primary tumour. In superficial tumours, clinical staging, which includes transurethral biopsy, is the best technique. For invasive tumours, MRI is superior to other techniques such as CT scanning, transvesical ultrasonography and clinical staging. A limitation of both MRI and CT scanning is their inability to recognize minimal tumour growth in the muscle layer of the bladder wall, or to differentiate between post-
transurethral resection oedema and tumour. Therefore, in all patients with urinary bladder cancer staging should preferably start with MRI followed by clinical staging. Unfortunately, however, because of the high cost of this strategy, MRI has to be reserved for staging deeply invasive and superficial poorly differentiated tumours. Primary staging of urinary bladder carcinoma: the role of MRI and a comparison with CT.

Barentsz JO; Jager GJ; Witjes JA; Ruijs JH Department of Radiology, University Hospital Nijmegen, The Netherlands Eur Radiol 1996;6(2):129-33

PMID: 8797968 UI: 96390995

In this study, the authors stated that MRI's unparalleled ability to depict soft tissue structures and highlight pathology have made it the best method for determining the extent of many disease processes. This article reviews the use of MR to evaluate diseases of the prostate gland and bladder. In both, the major indication for imaging is the local staging of cancer, and MR is currently the best imaging modality.


In this study from the Netherlands, the authors state that MR imaging and clinical staging complement each other; MR imaging is the most accurate technique for differentiating the various stages of deep tumor infiltration and detection of metastases, whereas clinical staging is the best technique for differentiating between postbiopsy effects and the various stages of superficial tumors. The role of MR imaging in staging of this disease and monitoring of therapy is reviewed and illustrated. Finally, the authors present an overview of current and future applications of this technique. What is new in bladder cancer imaging. Barentsz JO; Witjes JA; Ruijs JH Department of Radiology, University Hospital Nijmegen, The Netherlands.Urol Clin North Am 1997 Aug;24(3):583-602 PMID: 9275980 UI: 97421863

Limitations of CT in staging invasive bladder tumors:

Computerized tomography (CT) of the abdomen and pelvis is often routine in the preoperative staging assessment of invasive transitional cell carcinoma of the bladder. We determine the accuracy of staging CT findings, usefulness before planned extirpative surgery and impact on surgical management of this disease. Materials and Methods: We retrospectively reviewed the medical records, including radiographic, operative and pathological reports, of 82 consecutive cases. All patients presented with muscle invasive bladder tumors, were considered candidates for radical cystectomy and underwent preoperative staging CT of the abdomen and pelvis between July 1994 and June 1998. The ability of CT to provide additional staging information in terms of depth of tumor invasion, local extent of tumor, pelvic lymph node involvement and distant metastases was examined. We determined whether CT findings altered surgical management for individual patients. Results: CT was able to discriminate depth of invasion in only 1 patient (1.2%) and correctly identified extravesical tumor spread in 4 (4.9%). Lymph node and distant metastases were accurately determined in 4 (4.9%) and 2 (2.4%) cases, respectively. The overall accuracy of CT was 54.9%, with an under staging and over staging rate of 39.0% and 6.1%, respectively. CT provided accurate, additional staging information in only 8 cases (9.8%). Surgical management was altered in 3 cases (3.7%) and only 1 (1.2%) avoided an unnecessary operation as a result of CT findings. Conclusions: Staging CT of the abdomen and pelvis in patients with invasive bladder carcinoma has limited accuracy, mainly because of its inability to detect microscopic or small volume extravesical tumor extension and lymph node metastases. CT tends to under stage advanced disease and failed to alter surgical management in nearly all of our cases. Limitations of Computerized Tomography in Staging Invasive Bladder Cancer Before Radical Cystectomy Michael L. Paik; Michael J. Scolieri; Scott L. Brown; J. Patrick Spirnak; Martin I. Resnick; Dept of Urology, Case Western Reserve Univ, Sch. of Medicine, Cleveland, Ohio; J Urol 2000 June;163(6):1693-1696 American Urological Association, Inc.

back to diagnostic procedures