Further accrual and follow-up is required to confirm these findings of toxicity reduction and biochemical control rates, however this is the first report to our knowledge to demonstrate a clinical benefit to daily target localization in prostate cancer.

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PO-Topic IV-05

PROSTATE BIOPSY AND LOCAL THERAPY INSIDE CONVENTIONAL CLOSED MRI WITH ROBOTIC ASSISTANCE – ANIMAL STUDIES

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Purpose: Perform biopsy and local therapy of the prostate, inside a conventional closed 1.5 T MRI scanner under real-time image guidance.

Background: In the US, nearly one million prostate biopsies are performed every year, and for 2002 the projected number of new prostate cancers was 189,000 (1). The gold standard for the guidance of prostate biopsy and local cancer therapy has been transrectal ultrasound (TRUS) imaging (2). TRUS-guided biopsy, however, fails to correctly detect the presence of prostate cancer in approximately 20% of cases (3). For similar reasons, TRUS does not allow for precisely targeted local therapy. The TRUS probe implies variable normal force on the rectum wall, causing dynamic deformation and dislocation of the prostatic anatomy during imaging and needle insertion. On the other hand, MRI can provide everything that TRUS does not: superior tissue imaging, real-time monitoring of the delivery, and build-up of therapeutic substances, as well as monitoring of physiologic changes induced by the intervention. Several researchers have demonstrated the clinical utility of MRI imaging in prostate care (4,5), yet no viable engineering solution exists for the actual delivery of biopsy and local therapy inside a conventional closed MRI scanner.

Methods: In our solution, the patient is situated inside the magnet in prone position with elevated pelvis. A cylindrical robotic device translates and rotates inside the rectum and inserts a needle into the prostate in an oblique angle across the rectum wall. The robot is guided by real-time tracking signal from the MRI scanner in 50-ms cycles. Networked computers process the high-resolution MRI images and enable the clinician to select the target and control the motion parameters of the device that is operated remotely from outside the scanner. The insertion of the needle and deposition substances is monitored in real-time MRI images at 1 Hz frequency.

Results: We performed targeted needle placement experiments on seven dogs, in vivo, under full anesthesia, on a 1.5 T closed MRI scanner. The accuracy of needle placement was consistently under or around 2 mm. Only negligible organ motion was detected during targeting, as well as during needle insertion. No excessive damage or bleeding was seen in the rectum and prostate gland. Deposition of injected liquid agents was successfully monitored in real-time MRI images and the buildup of dose was also monitored over series of targeted injections. Placement of capsulated agents (such as brachytherapy seeds) was also successfully accomplished and the ability to deliver predefined patterns was also demonstrated.

Conclusion: The viability of the system was demonstrated for biopsy, prostatic injection, and brachytherapy seed placement in vivo on nine canines. Development of an advanced system suitable for human trials is a work in progress.

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PO-Topic IV-06

RADIOIMMUNOTHERAPY AS A MODEL OF IMAGE-GUIDED THERAPY

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Recent advances in antibody engineering and tumor antigen identification have led to common application of radiolabeled antibodies for imaging, staging, and follow-up of patients with specific cancers. If the uptake of a radiolabeled antibody in tumors and/or the radiosensitivity of the tumors is high enough, such as in non-Hodgkin's lymphoma, treatment of the tumors with the antibody labeled with usually a beta-emitting nuclide could be contemplated. A treatment planning and dosimetry program for radioimmunotherapy (RIT) has been developed at our Center. The program imports CT or MR images of the patient for anatomy contouring and tumor volume marking. The drawn regions of interest are then mapped onto nuclear medicine images in 2D or 3D. After incorporating temporal variations of the concentrations of the radiolabeled antibody in blood and urine samples of the patient, the program will generate time activity curves and cumulative activities for tumors and various organs. Radiation dose estimates to these organs and tumors will then be computed based on the nuclide to be used for tagging the antibody in therapy. The program can provide 3D molecular information that could be useful in external beam or brachytherapy treatment. The program therefore forms a part of a comprehensive image-guided therapy planning system in which external beam irradiation, brachytherapy, and other experimental therapies could be combined. To illustrate the usefulness of our planning program, the RIT plans with ^{90}Y-labeled antibodies for a non-Hodgkin's lymphoma patient and a patient with breast CA metastases will be presented and discussed.

PO-Topic IV-07

IMAGE-GUIDED CORONARY INTRAVASCULAR BRACHYTHERAPY TREATMENT PLANNING

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The location of the lesion requiring coronary intravascular brachytherapy IVBT is well defined, which is rarely the case when using radiation to treat malignant diseases. The anatomy of the irradiated vascular structure may be obtained with intravascular ultrasound (IVUS) imaging. IVUS provides details for evaluating pathology and geometry of the treated artery. However, IVUS images are rarely obtained for routine clinical coronary IVBT procedures. On the other hand, Fluoro and Cine images are always obtained for percutaneous transluminal coronary angioplasty (PTCA) performed at the time of coronary brachytherapy. These images may be used for image-guided radiotherapy planning. The Fluoro images provide details on the position, length and diameter of the stent in the artery, length of the in-stent restenoses, and the geometry of the normal surrounding vascular system. In addition, the position of the radioactive sources in the treated artery can be identified on the Fluoro images. Knowing the location of the radioactive sources permits evaluating the dose distribution to the lesion and normal surrounding tissues. The implanted artery and the location of the gold markers on the catheter containing the radioactive source train were identified on radiographic images taken during the PTCA procedure. Dosimetry was performed for an implant consisting of either 12 or 16 Sr-90 seeds each 2.5 mm in length. The image magnification was obtained by dividing the measured distance between the two gold markers in the catheter by the length of the source train, taking into account the curvature of the artery. An algorithm was developed that determined the location and