

Intra-operative dosimetry in prostate brachytherapy

Gabor Fichtinger (Associate Research Professor, CISST ERC), Danny Song (Assistant Professor, Radiation Oncology) and Dr. E. Clif Burdette (Principal Scientist, Acoustic Medsystems, Inc.) have jointly developed a novel method for intra-operative dosimetry and implant optimization in prostate brachytherapy.

With an approximate annual incidence of 220,000 new cases and 33,000 deaths in the United States, prostate cancer continues to be the most common cancer in men. Ultrasound guided brachytherapy (insertion of radioactive seeds into the prostate) has emerged as a definitive treatment modality of early stage, low risk prostate cancer with an expected 50,000 surgeries every year. The main limitation in contemporary brachytherapy is faulty seed placement, which may cause insufficient dose to the cancer and/or excessive radiation to the rectum, urethra, or bladder. The former might permit the cancer to relapse, while the latter causes adverse side effects like rectal ulceration. Current practice has limitations that may be overcome by intra-operative dosimetry and implant optimization, which has not had a clinically feasible solution for a plethora of technological barriers.

During the past several years, the CISST ERC team has overcome these and delivered a functioning clinical prototype. In essence, this new method registers ultrasound imaging (for soft tissue visualization) and C-arm fluoroscopy (for implant visualization) in a common frame of reference (Figure 17, left) and blends this multimodal information in an interactive display (Figure 17, right). The salient feature of the method is that it provides the revolutionary functions without altering standard clinical hardware and workflow and it is deployed as a pure software addition to the commercially available Interplant® brachytherapy implant guidance system developed earlier by Dr. Burdette's company.

Phase-1 clinical trials have been recently concluded. Implant reconstruction and dose analysis was performed after each third of the implant and also in the end of the revealed underdosed (cold) spots, thereby preventing more serious accumulation of errors. The cold spots were fixed by implanting extra seeds, ascertained in final reconstruction and dosimetry. The new system also made it possible, for the first time ever, to quantify the extent of intra-operative edema (a significant cause of dosimetric failures) and compensate for its effect instantaneously, right in the operating room. A full dosimetry and optimization session takes about 15 minutes, a most affordable tradeoff for the long coveted functionality of intra-operative dosimetry and implant optimization.

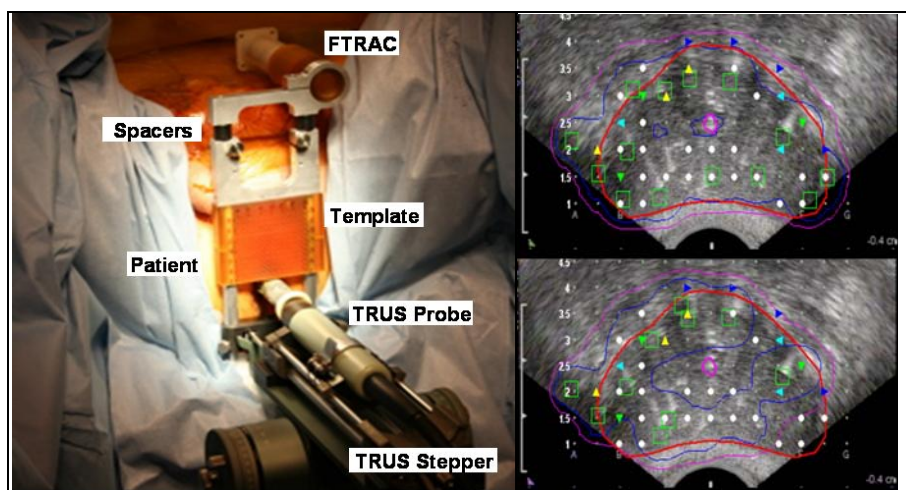


Figure 17: Registration of ultrasound to fluoroscopy with a radiographic fiducial in transperineal brachytherapy (left) and interactive dose display to detect cold spots (right).