AbstractID: 2681 Title: In Vivo Force-Torque Measurement during Prostate Brachytherapy

Purpose: The main goal of this study is to measure the needle insertion force/torque (F/T), velocity/ acceleration (V/A), and tissue/organ deformation during actual brachytherapy procedures in the operating room (OR). These *in vivo* data will guide the design of a Robot-Assisted Platform for Intratumoral Delivery (RAPID) system.

Method and Materials: We have acquired F/T and V/A data from actual patients and a single surgeon placing brachytherapy needles in the OR using a hand-held adapter equipped with a 6 degree-of-freedom (DOF) F/T sensor (Nano25^{TM}). During this *in vivo* measurement, the needle progression into the soft tissue was registered using ultrasound (US) imaging technique. A 6 DOF electromagnetic (EM)-based position sensor (miniBIRD$^{®}$) was attached to the hand-held adapter to measure 3D position and orientation of the hand-held adapter.

Results: The *in vivo* data reveals that maximum needle insertion force is about 18N, velocity is about 72cm/s, and acceleration is about 3000cm/s^2. This relatively high acceleration may have some implications on the inertia force, which may help the surgeon in needle insertion. We observed significant transverse force (about 1.7N). From *in vitro* data it was observed that the force and torque during robotic needle insertion in animal soft tissues were significantly smaller as compared to that for humans.

Discussion: Additional *in vivo* data are being collected from different patients to study the effects of patient specific criteria such as age, height, ethnicity, body mass index (BMI), prostate specific agent (PSA) value, special anatomy, previous treatment, etc. on needle insertion force/torque and tissue deformation. Since frequent *in vivo* data collection and experimentation are impractical, we will use these data to determine the soft animal tissues and soft materials which have close resemblance to human tissues.

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