Combination of Image-Fusion and EM Tracking Provides High Degree of Accuracy in Deep Anatomical Structures

Evaluation of an Electromagnetic Image-Fusion Navigation System for Biopsy of Small Lesions: Assessment of Accuracy in an In Vivo Swine Model

L. Appelbaum, MD[1], L. Solbiati, MD[2], J. Sosna, MD[1], Y. Nissenbaum, BS[1], N. Greenbaum, BS[1], S. Goldberg, MD[1], [1]Department of Radiology, Hadassah Hebrew University Medical Center, Jerusalem, Israel and [2]Department of Interventional Oncologic Radiology, General Hospital of Busto Arsizio, Busto Arsizio, Italy

Academic Radiology, 2013; 20: 209-217

Summary and Methods

An in vivo swine study was performed to assess the overall targeting accuracy of an ultrasound system with navigation technology (Esaote SpA, MyLab Twice Virtual Navigator, Genoa, Italy), electromagnetic tracking (Ascension DriveBay, Vermont) and needle sensor technology embedded within the needle tip (CIVCO Medical Solutions, eTRAX™ Needle Tip Tracking System, Kalona, IA) and placed a the hub of the needle (CIVCO Medical Solutions, VirtuTRAX™ Virtual Tip Tracking System, Kalona, IA). The target accuracy of the two techniques was then compared to a free-hand technique. Metallic targets were embedded into the paraspinal muscle, kidneys and liver of the swine model. CT data sets were used in combination with real-time ultrasound imaging to evalaute the Virtual Navigator's response to respiratory motion and targeting accuracy in a live model.

Discussion and Results

Within the parspinal muscle, eTRAX and VirtuTRAX provided similar accuracy of needle placement (3.2mm +/- 1.6mm). When compared to free-hand, the statistical difference was signifcant. Free-hand accuracy was 5.7mm +/- 3.2mm while the guided technical accuracy was 3.2mm +/- 1.6mm.

The metallic targets placed in deeper organs including the liver and kidney were evaluated with Virtual Navigator and targeted using EM needle placement using a guided and unguided technique. Within the kidney, eTRAX demonstrated a better needle placement accuracy of 4.4mm +/- 3.2mm versus VirtuTRAX with a needle placement accuracy of 9.3mm +/- 4.6mm. There was no statistical difference between needle guide and free-hand technique when targeting the kidney. The fusion of the liver proved to be challenging due to respiratory changes and transducer pressure compressing the soft tissues of the swine subcostal abdomen. The targeting during respiration produced a 17mm variaction in accuracy. Utilized in combination with the needle guided approach can reduce the compression error.

Conclusions

In this study, the authors concluded image-fusion and electromagnetic tracking can provide targeting accuracy of less than 5mm.

Respiration and tissue compression from transducer pressure play a role in the accuracy of targeting the liver and in deeper organs. Within superficial structure, eTRAX and VirtuTRAX performed similarly, with eTRAX providing the best accuracy in needle placement to deeper structures due to the effect of needle bending at greater depths.

Author Commentary

"In conclusion, a combined image-fusion / EM tracking platform can provide a high degree of accuracy (<5mm) when targeting small lesions with standard biopsy needles. Results fall within the range of respiratory error; with best results obtained by incorporating an EM sensor into the tip of the biopsy system."

"EM tracking for biopsy of small metallic targets under the stated different parameters was successfully performed in every case."