INTRODUCTION AND OBJECTIVES

Ultrasound (US) based planning for HDR prostate brachytherapy is commonly used in clinic, mainly because it offers efficient real-time image-guided capability. The main difficulty with the US planning is the catheter reconstruction due to artefacts when multiple catheters are in place. Electromagnetic (EM) tracking devices offer a fast and accurate solution with automatic reconstruction of catheters. The aim of this work is to summarise the challenges posed by the use of the EM technology in a clinical environment and how to manage them.

METHOD

The investigational device from Philips Disease Management Solutions was commissioned and integrated in our clinical practice. The system is presented in Fig. 1. First there is the computer and its cart (Fig.1a). The EM field generator, as shown in Fig1d), is used to create an EM field of 50x50x50cm³. This field is required for spatial localisation of EM sensors. The EM generator is attached to a mobile arm which is fixed to the treatment couch. EM sensors (Fig.1c) are placed on the side of the template and on the side of the US (Fig.1b) to be able to locate these items in space. Another EM sensor is at the tip of the stylet (Fig.1e), which will be inserted in catheter for automatic catheter reconstruction. The US system is a BK with bi-plane 8848 probes. The probe holder (Fig.1b) is mounted on the stepper with a mobile arm, and the stepper is attached to the treatment couch (Fig.1f). Finally, the template is a fully EM compatible template from D&K technology.

The clinical use of such system comes with requirements starting with the calibration of the EMT to the US image which is a crucial step. To succeed with the calibration, a list of conditions should be respected. First, the calibration validation must be done at the OR with the same clinical set-up and in a US compatible prostate phantom. The calibration tool specifically design for that purpose is presented in Fig.2a. Also displayed in Fig.2b and c are the setup for calibration in a salted water tank and the calibration tool mounted on the US probe. There are also challenges working with an EM system in an OR environment regarding the patient set-up and the equipment used around the system. Finally, organ delineation and catheter’s tracking also come with challenges and various solutions were explored.

RESULTS

A critical step to ensure accurate results is the registration of the EMT reference frame to the US image. This needs to be done in accordance to TG-128 (salty water - 43g/L), so that water temperature doesn’t influence the calibration. No metal part should be within the EM field. A small metal rod hidden in our water container hinge introduced an error up to 1.8mm. This further includes any support with metallic parts used to hold the calibration phantom. During this process, the stylet needs to be moved slowly in order to allow the system to correctly track the path. The validation of the calibration must be done at the OR with the exact same set-up used for patients and in a US compatible prostate phantom. Another aspect is the clinical environment. Metallic parts on the OR table can create EM disturbances and introduce errors. In our set-up, the distance between the edge of the EM generator and the table stand needs to be more than 70cm to avoid disturbance, which translate in error of about 2mm on tip positions and height of reconstructed catheters. Cell phones, jewels, watches, metal clamps, metallic part on urinary bag, and so on shouldn’t be placed close to the EM field, as they introduce error relative to the calibration up to 2mm. However, stirrups as well as surgical or vasectomy clips did not show any effect. In our clinical trial, no patient with pacemaker, neurostimulator, implanted insulin pump, hip or knee prosthesis was allowed in order to avoid disturbance. Once the patient is set-up and the US image is acquired, the organ delineation can be done, before the catheter insertion, while the image is clear of artefact. But, since during the catheter insertion the prostate can be pushed or rotate, be sure to adjust contours on final US scan. Finally, the stylet used for EM tracking and automatic reconstruction can also create some issues. It is not rigid enough to allow for an easy tissue perforation during catheter insertion, but stiffer than the source cable, sometimes introducing catheter motion during retraction with an AP shift of the tip up to 3mm. Thus, it remains important to visualize the reconstruction with sagittal live imaging.

CONCLUSIONS

EM tracking offers the possibility of fast and accurate solution for catheter guidance and reconstruction in US-guided prostate HDR. Pointers were given beyond the vendor provided guidance to avoid potential pitfalls and ensure that the stated accuracy is indeed reached.

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