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Single-marker based navigation system for image-guided percutaneous intervention

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Topic: Interventional Oncology / Experimental work in IR

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Purpose

To successfully place a coaxial puncture needle for biopsy or tumor ablation within a preselected target lesionusing stereotactic image guidance.

Material and Methods

A novel single marker-based surgical navigation system was evaluated in a series of ten needle insertions on a liver phantom. Five copper wires of 1.6mm diameter served as internal targets in a gelatin liver phantom, which was placed within a 1:1 scale human torso. After placing optical tracking markers around the planned insertion area, a diagnostic CT scan was performed and the data was transferred to the system. An automatic image-to-patient registration based on the markers visible in the image data and by the tracking camera was then performed.

After planning of a suitable needle trajectory (five in-plane, five double oblique, path length 74±20mm), needle insertion was performed and a control scan was acquired after each needle placement.

Results

A planning time of 54±21s was required for defining a needle trajectory. Needle insertion time was 11±44s for the 10 punctures. For nine out of ten targets, needle placement accuracy below 10mm was achieved. The needle positioning accuracy measured in the control CT scan was 3.8±1.8mm in-plane and 3.4±2.0mm ofplane leading to an Euclidian placement error of 5.5±1.7mm. The fiducial registration error achieved with the automatic single-marker based registration approach was 1.0±0.2mm.

Conclusion

Feasibility and efficacy of the proposed navigation approach under clinical time and workflow constrains has been shown. The achieved average needle placement accuracy fulfills the current clinical requirements and might be improved by using a needle guidance device.