Compilation of a pathological validation database for ultrasound monitoring of tumour ablation

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Background

Percutaneous thermal ablation is a treatment technique that uses localized thermal energy in the management of soft tissue cancers. There is currently no practical way to track the ablation progress, and so it goes unmonitored, often leading excessive or insufficient ablation. This has stimulated investigation into the use of US as a potential ablation tracking technology. Objectives: It was thus the objective of this study to facilitate the development of US-based monitoring methods through the compilation of an ex-vivo, spatially correlated ground-truth database of US and histopathology imagery.

Methods

This was accomplished through development of a practical implementation of a previously generated proof-of-concept (PC) design. The PC design faced methodology problems including geometric distortions resulting from loss of marker system integrity and problematic pathology imaging technique. The marker material chosen was too hard and would shift upon slicing and the pathology images were taken using a standard digital camera on a stand, introducing errors from external lighting and shifts in stand position. This study introduced a marker material that sliced very easily yet was still strong enough to maintain system integrity. A CCD scanner was used for pathology imaging with the gel block containing the tissue sample and markers wet mounted on top of the scanner glass. This technique eliminated glare and provided very clear images. 3D reconstruction of tissue sections was accomplished using a MATLAB computer program. Percentage overlap values were compared to those of the PC.

Results

A practical implementation of the PC design was successfully generated. The average percentage overlapping volume achieved was 90.6%, an increase of 3.4% from the PC. It is important to note that the overlap results of the PC were acquired after additional registration calculations were done to compensate for marker shift. This study did not use these compensatory calculations, which speaks to the strength of this study's developments. Implications: Demonstration of the feasibility of US as a tracking technology will lead to increased availability of thermal ablation as a successful treatment option with lower risk of side effects due to insufficient tracking. Although thermal ablation is the primary context of this platform, this set-up could also be applicable to a wide range of treatments, especially when combined with other imaging modalities.