Image-guided procedures with the Xperguide system in interventional Neuroradiology

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Keywords Image-guided · Intervention · CT

Purpose

Description of the Xperguide technique for image-guided procedures in interventional Neuroradiology. Introduction: Static CT data for percutaneous image guided procedures lack real-time information. Fluoroscopic guidance does not provide information on the soft tissue. We present a technique that combines CT information and fluoroscopic controls for image-guided, percutaneous interventions.

Methods

The procedures were performed with the Allura Xper FD20/20 (Philips, Best, the Netherlands). An initial XperCT data set was acquired with the C-arm flat panel system. Based on the XperCT data entry and target points were defined using dedicated software (Xperguide). The needle path could be visualised in various reconstructed trajectories, and be corrected if necessary. For percutaneous interventions, the entry view (overlay of entry and target point), the progression view (perpendicular to the entry view), as well as two additional views can automatically be piloted to with the C-arm system. Needle navigation was supported with the SeeStar (Radi, Uppsala, Sweden). In the progression view the needle can be navigated along the planned trajectory displayed on an overlay of reconstructed XperCT data and the fluoroscopy image. Correct needle positioning was confirmed with a second XperCT.

Results

The proposed technique is routinely applied for vertebral body biopsies, for facet joint and nerve root infiltrations. Correspondig cases are demonstrated.

Conclusion

The Xperguide system for image guided percutaneous interventions is practicable and turned out to be an interesting alternative to CT guided procedures.

Single Fluoroscopic Image based 2D/3D Reconstruction of A Scaled, Patient-specific Vertebral Model

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Keywords Lumbar vertebra · 2D/3D reconstruction · Fluoroscopy

Purpose

Accurate three-dimensional (3D) models of lumbar vertebrae can enable image-based 3D kinematic analysis. The common approach to derive 3D models is by direct segmentation of CT or MRI datasets. However, these have the disadvantages that they are expensive, time-consuming and/or induce high-radiation doses to the patient. In this study, we present a technique to automatically reconstruct a scaled 3D lumbar vertebral model from a single two-dimensional (2D) lateral fluoroscopic image.

Methods

Our technique is based on a hybrid 2D/3D deformable registration strategy combining a landmark-to-ray registration with a statistical shape model-based 2D/3D reconstruction scheme. Fig. 1 shows different stages of the reconstruction process.

Four cadaveric lumbar spine segments (total twelve lumbar vertebrae) were used to validate the technique. To evaluate the reconstruction accuracy, the surface models reconstructed from the lateral fluoroscopic images were compared to the associated ground truth data derived from a 3D CT-scan reconstruction technique. For each case, a surface-based matching was first used to recover the scale and the rigid transformation between the reconstructed surface model and the ground truth model before the distances between the two discrete surface models were computed.

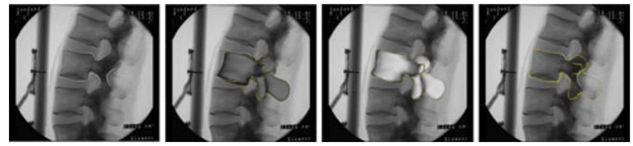

Fig. 1 Different stages of the reconstruction process. Left: the smoothed contours; left middle: the landmark-based initialization of the mean model (grey) of the PDM; right middle: the reconstructed model (white); right: the apparent contours (yellow) extracted from the reconstructed model vs. the image contours (white)

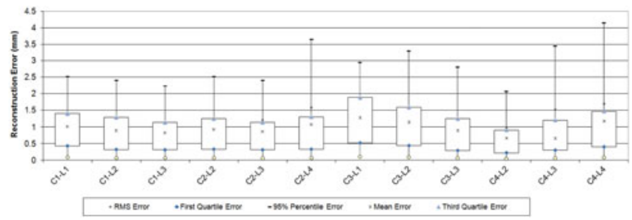

Fig. 2 Errors of reconstructing surface models of all twelve vertebrae when a surface-based iterative scaled rigid registration was used to match the reconstructed surface model to the ground truth model. An average mean reconstruction error of 1.0 mm was observed

Results

Our technique could successfully reconstruct 3D surface models of all twelve vertebrae. After recovering the scale and the rigid transformation between the reconstructed surface models and the ground truth models, the average error of the 2D/3D surface model reconstruction over the twelve lumbar vertebrae was found to be 1.0 mm. The errors of reconstructing surface models of all twelve vertebrae are shown in Fig. 2. It was found that the mean errors of the reconstructed surface models in comparison to their associated ground truths after iterative scaled rigid registrations ranged from 0.7 mm to 1.3 mm and the root-mean squared (RMS) errors ranged from 1.0 mm to 1.7 mm. The average mean reconstruction error was found to be 1.0 mm.

Conclusion

An accurate, scaled 3D reconstruction of the lumbar vertebra can be obtained from a single lateral fluoroscopic image using a statistical shape model based 2D/3D reconstruction technique. Future work will focus on applying the reconstructed model for 3D kinematic analysis of lumbar vertebrae, an extension of our previously-reported image-based kinematic analysis. The developed method also has potential applications in surgical planning and navigation.

Methods for computing transversal iliosacral screw corridors in CT-data of the pelvis

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