Abstract

Introduction Patients with liver cancer are only curatively treated by surgery. Liver resection surgeries are the gold standard to treat these patients. Image guided navigation approaches are not regularly used in this kind of surgery because the involved registration of preoperative imaging data to the surgical site leads to difficulties with deformations. Therefore the aim of this thesis is to conceptualize, implement and evaluate a new approach to navigate in tissue sparing resections which works without registration. This method should intraoperatively reconstruct the liver and create a surgical plan to resect tumors near the liver surface.

Methods The reconstruction of the liver is done in two steps. First, the surface is reconstructed from a sample of points which were taken from tracked ultrasound after analysing whether the ultrasound probe is on the liver surface or not. Secondly, the tumor is reconstructed as a sphere. The location and diameter of this sphere are determined from the tracked ultrasound images. After freezing an ultrasound image which shows the largest diameter of the tumor, it is semi-automatically segmented. The center of the segmentation is the tumor center and the diameter is estimated from the segmentation contour. Using the created 3D liver model a plan to resect the tumor is created by fitting a resection shape which respects the safety margin around the tumor. Finally, to test the resulting approach, two experiments are performed. One experiment to evaluate the accuracy of the reconstructed surface was done on a liver phantom. A usability test was conducted with three surgeons as an experiment to evaluate the software applicability in the operating room.

Results The accuracy experiment of the reconstructed liver surface shows a median error of 2.57 mm. Most of the accessible liver surface has been reconstructed exactly but large errors are visible at the edge of the reconstructed surface. The usability test shows that the surgeons find the software useful and that they could imagine to use such a system in the operating room.

Conclusions A method to create an intraoperative model of the liver which can be used to plan resections of tumors near the surface was developed. Experiments to evaluate the method show results that are good in this prototype status and look promising for the future development of this project. It has to be further tested if such an approach is applicable in clinics.