Modelle für die Visualisierung und Interaktion für die Ausbildung in der Leberchirurgie

Computerized Models, Visualization and Interaction for Liver Surgery Training

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Purpose

To support liver tumor surgery training with the focus on preoperative decisions and therapy planning. Medical doctor's should exercise decisions concerning respectability of a patient. The variability of tumor locations and the intrahepatic vasculature should be conveyed.

Material and Methods

The LiverSurgeryTrainer is based on the following data: CT data, information concerning clinical examinations, image analysis results, such as liver and tumor segmentation, intraoperative video sequences and histologic examinations. These information are available for 4 datasets, representing benign and malignant tumors (hepatic carcinoma and metastasis from colorectal carcinoma). Intraoperative video is carefully edited and annotated to convey maximum information in a short amount of time. Video compression was chosen such that the image quality is not degraded. Image analysis was provided by MeVis Bremen where preoperative 3d visualizations have generated to support therapy planning. This includes also an analysis of vascular structures and vascular territories which would be affected if the tumor is removed with a certain security margin. Based on this information, an educational software was developed.
In cooperation with the clinical partner, the information is structured in a sequential sequence starting with the case selection, information concerning diagnosis, operability, and resectability and the surgery (Fig. 1).

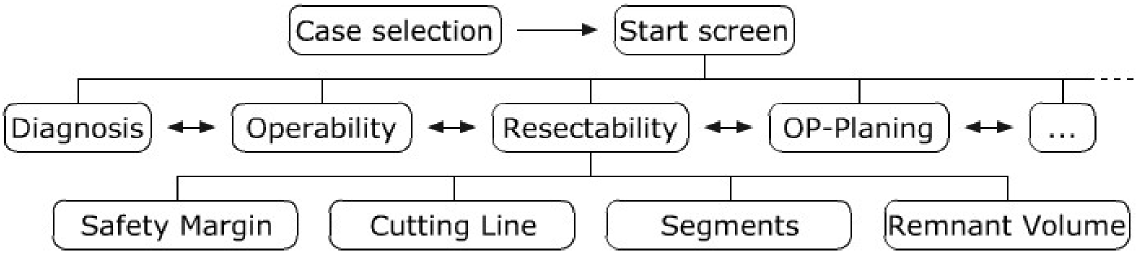
Results

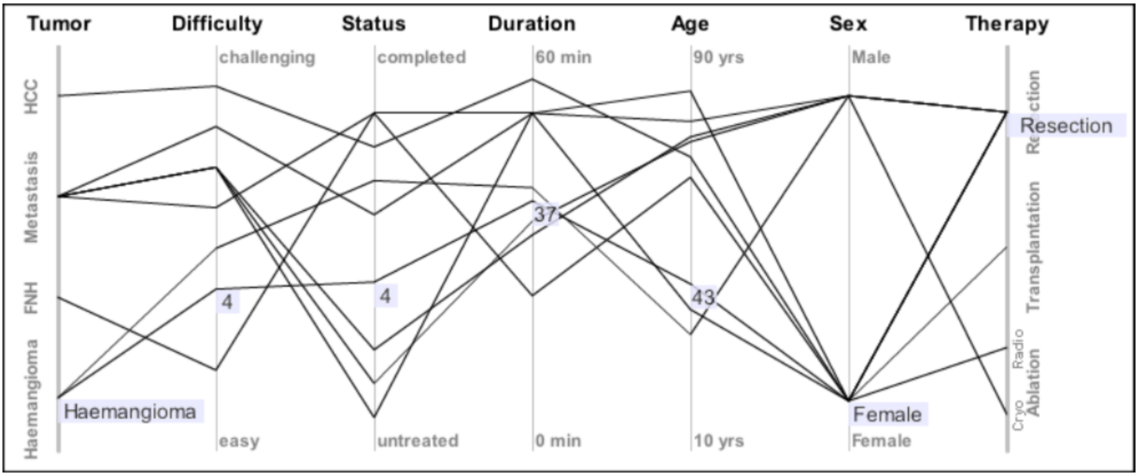
A prototype of the Liver Surgery Trainer was developed using Macromedia Director. The case selection is realized with parallel coordinates where the diagnosis and the therapy are the main axis (Fig. 2). As the case is executed a patient documentation is gradually filled with information concerning this particular step. Users may add, remove and annotate this documentation which represents their result. To enable communication on a case, a fictive name is assigned (Fig. 2).

A set of standardized 2d and 3d visualizations is produced per case. Over and above, the predefined visualizations, the interactive exploration of the 3d models is supported. Special emphasis techniques are employed to focus on relevant areas. These techniques include silhouette and feature lines which are generated automatically and follow in their appearance illustrations from traditional textbooks (Fig. 3). A dedicated vessel visualization technique was developed to convey the branching pattern of intrahepatic vasculature.

Conclusion

The information space consisting of dedicated preoperative visualizations, annotated operation videos supports the exploration of real cases. Novel visualization techniques have been developed to convey branching patterns and shape information. The interactive patient documentation is the primary result of computerized liver surgery training. The incorporation of training facilities, such as virtual resection and puncture training for tumor ablation is intended. Many aspects of the LiverSurgeryTrainer can be easily adapted for the design of other case-based surgery trainers.


Case selection
Start screen
Diagnosis
Operability
Resectability
OP-Planing
...
Safety Margin
Cutting Line
Segments
Remnant Volume


Tumor
Difficulty
Status
Duration
Age
Sex
Therapy
HCC
Metastasis
FNH
Haemangioma
challenging
easy
completed
untreated
60 min
0 min
90 yrs
10 yrs
Male
Female
Resection
Transplantation
Radio
Cryo
Ablation
Haemangioma
4
4
37
43
Female
Resection