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RESEARCH NEWS

Algorithms for liver surgery – performing operations more safely worldwide

Four complex, interwoven vascular systems pass through the liver. Surgically removing tumors is therefore often a great challenge. The Fraunhofer Institute for Medical Image Computing MEVIS has developed algorithms that analyze patients' imaging data and calculate surgical risks. This makes liver cancer surgery safer and easier to plan.

Every year, 750,000 people worldwide develop liver cancer, and many more develop liver metastases caused by other cancers. Surgery still offers the best chance of recovery. However, even minor changes in the surgical resection can have a dramatic impact on the surgical outcome: One wrong cut can interfere with the inflow or outflow of blood in the liver and impair organ function. The complex, entangled vascular anatomy is difficult to reconstruct mentally based on CT or MRI images alone.

Researchers at the Fraunhofer Institute for Medical Image Computing MEVIS in Bremen have developed software that analyzes a patient's radiological images. It generates a detailed three-dimensional model of the liver and its vascular systems. Supply and drainage areas of the blood vessels are calculated and help determine the risks of possible tumors resection strategies.

Surgeons can use this information to prepare their surgery accurately by planning the optimal resection virtually. The analysis of vascular anatomy in the vicinity of the tumor also helps locate critical sections of the planned procedure. The surgeon receives a risk map of the resection path and knows where there is little room for deviations from the optimal cutting plane, such as where the planned resection corridor is particularly narrow.

The software generates suggestions for performing resections. "However, these are only proposals. Ultimately, the decision has to be made by the surgeon," says Dr. Andrea Schenk, Head of Liver Research at the Fraunhofer MEVIS. Studies have shown that liver surgery is more efficient and safer with the MEVIS analysis. In addition, blood loss can be reduced. In individual cases, the analysis algorithms allow safely performing even delicate operations which would have been considered too risky without the software.

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Breakthrough innovation in living donor liver transplantation

In living donor liver transplantation, the organ is divided in the donor, and a part is transplanted into the recipient. After the surgery, the two parts in the recipient and donor have to work and grow again. The MEVIS analysis of the liver shows physicians the functional limitations that may result from the unavoidable transection of large vessels following the division, thereby enabling predictions of postoperative liver function in the donor and recipient. The surgical procedure can thus be optimized to minimize the risk of post-operative organ failure.

However, it is not only algorithms and computer science expertise that are decisive for the quality of the MEVIS analysis. Intensive exchange with surgeons and other clinical experts is also very important. "Only through this exchange did we learn what software featured are needed in practice and how we can improve our system," explains Alexander Köhn.

The researchers from Bremen use hospital visits to investigate doctors' practical problems . They are faced with the challenge of bringing the planning data from the MEVIS analysis to the operating theater. MEVIS expert Köhn has developed an iPad app in close collaboration with doctors from Yokohama University in Japan. The surgeon can wrap the tablet in a sterile sheet and take it into the operating room to view all planning data during the operation.

The app even goes one step further by combining the planning data with augmented reality. To do so, the doctor turns on the iPad camera and directs it at the patient's liver. The three-dimensional image of the patient's liver, previously generated using the algorithms, is superimposed onto the image of the camera and shows the position of the blood vessels and tumors beneath the liver surface.

2018 Joseph von Fraunhofer Award

Since 1998, the Fraunhofer researchers have been working on image-processing algorithms for use in medicine as part of a long series of projects. The method is now widely known by physicians as MEVIS analysis and has become established in practice. Together with her colleagues Zidowitz and Köhn, team leader Andrea Schenk has received the 2018 Joseph von Fraunhofer Award. In addition to scientific excellence, the award also acknowledges the practical effectiveness of surgical support, the many years of expertise on the part of the MEVIS team in liver surgery, as well as the character of the research project as a role model in society.

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Dr. Stephan Zidowitz, Alexander Köhn and Dr. Andrea Schenk have developed algorithms that analyze patient image data and calculate surgical risks. Liver cancer surgery is thus easier to plan and safer. © Kay Michalak

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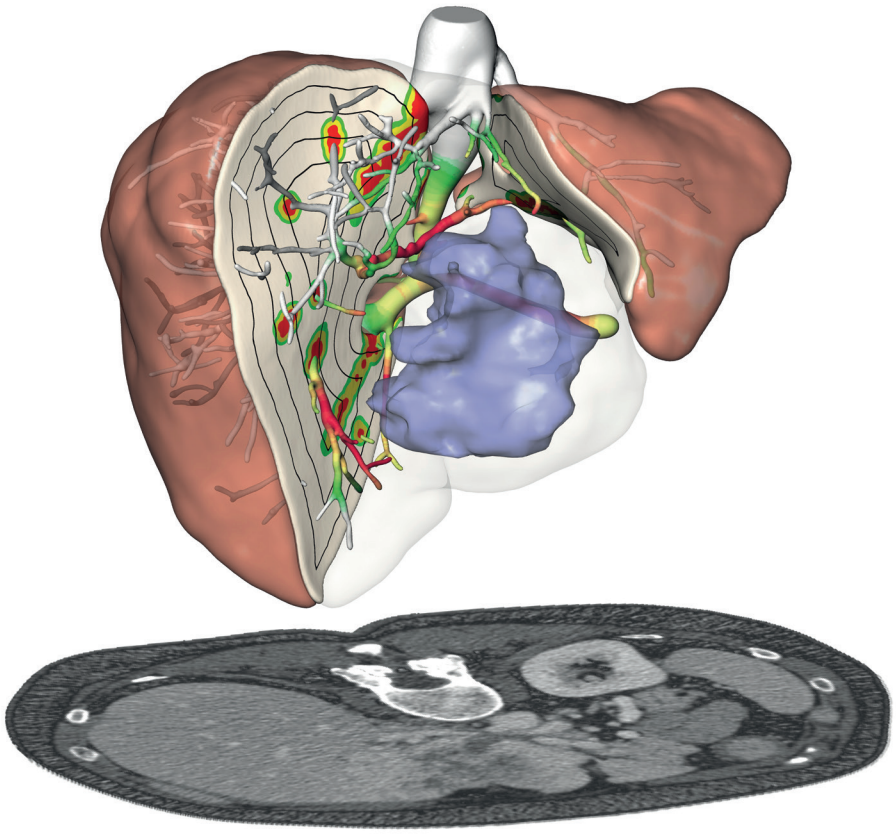

Planning and risk analysis for the surgical removal of a centrally located liver tumor.
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