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Computerunterstützte Planung und Bewertung der Radiofrequenzablation von Lebertumoren

Computer-supported Planning and Assessment of Radiofrequency Ablation of Liver Tumors

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Among minimally invasive and parenchyma-saving treatments of liver cancer, radiofrequency ablation (RFA) is one of the most promising techniques but also one that is most controversially discussed. The assessment of treatment results is difficult but the key to establish well-defined standards and a basis to compare different treatments. Planning helps minimizing the risk of under-ablation and thus reducing the recurrency rate.

A software assisting the surgeon or interventional radiologist in planning and assessment of RFA is required to support the following, besides 2D/3D visualization of liver, tumors, and vessels:

Planning:

* visualization of anatomical structures which influence puncture strategy or which are at risk due to thermal effects
* quantification of liver volume, maximum diameter of tumors, diameters of vessels in the vicinity of tumors as well as distances between tumor and vessels
* interactive placement of probes in tumors and simulation of thermal effects caused by their RF cur- rent to rehearse different strategies

Assessment:

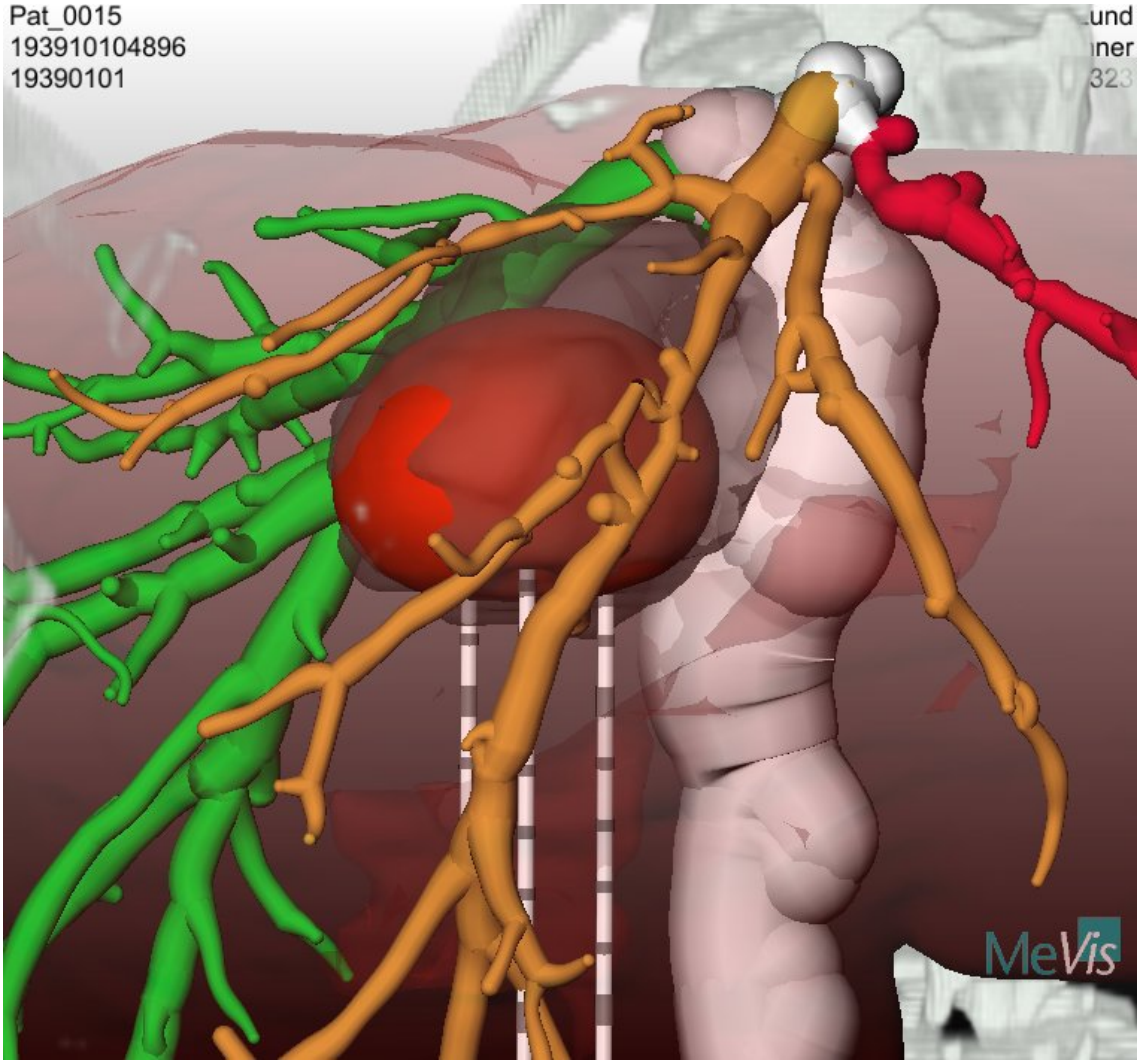
* registration of pre- and post-interventionally acquired data
* comparison of tumor and coagulated region after intervention by means of visual assessment and quantification

We have developed a software application called RFA-Assistant that realizes the assessment and planning support on the basis of CT-data. Besides the visualization of liver and tumors, bones and vessels in the vicinity of the tumors are shown. For tumors close to the liver surface adjacent organs (e.g. stomach, bowel, gall blader) are displayed to allow for a better judgement of possible harmful thermal influences.
A color-coding of the vessels' diameters in the immediate vicinity of the tumors helps to estimate the ves- sels' cooling effects visually.

The measurement of diameters and spatial distances in 2D and 3D brings a new quality to image guided planning and assessment of RFA. Diameters of tumors as well as distances between tumors and vessels are measured automatically.

The software assists the physician in planning the optimal position and orientation of the probe, such that the final heat distribution and the tumor overlap entirely. An initial suggestion of the probe's position made by the software can be modified interactively, whereby the visualization of important ana- tomical structures prevents the planning of non-feasible punctures. The thermal effects of the RF-current can be simulated and visualized in the planning phase. Based upon the chosen probe location and includ- ing the cooling effects of larger vessels, the coagulated region is calculated. Numerous tissue parameters which are influenced by the constitution of the liver (e.g. steatosis, cirrhosis) affect the heat distribution.
Therefore it is difficult to precisely predict the size of the coagulation, as initial studies by other authors have shown. We aim at an estimation of the region that will be definitely coagulated with the chosen ablation parameters.

Finally, pre- and post-interventional data can be registered, quantized and compared to assess the results. The chosen safety margin may be visualized and compared to the achieved size of the coagulated region, thus evaluating the success of the RFA.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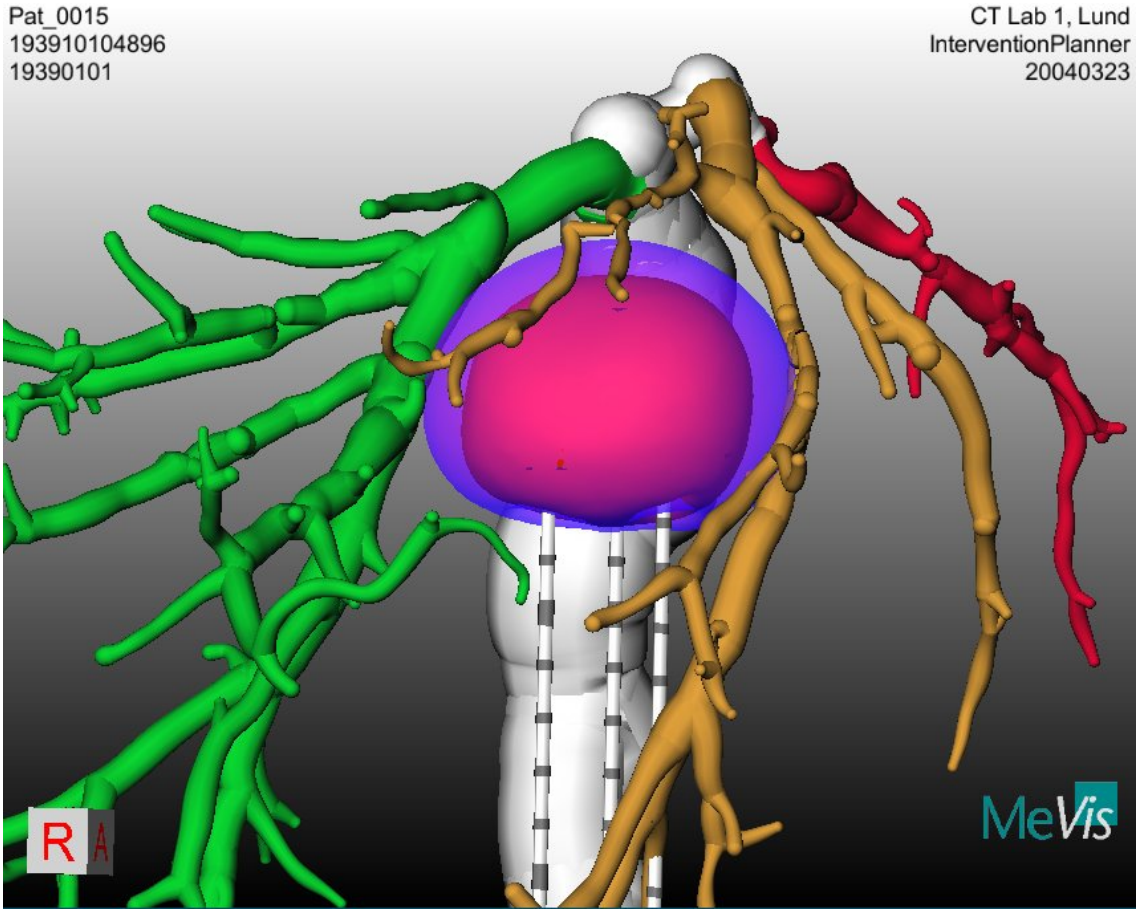
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