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DEVELOPMENT OF AN INTERACTIVE, PATIENT-SPECIFIC PLANNING TOOL FOR PARTIAL NEPHRECTOMY PROCEDURES

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Background

Partial nephrectomy is the recommended treatment for small renal cell carcinomas. Selective arterial clamping (SAC) can be applied to ensure a bloodless resection of the tumour. Ideally, this selective clamping blocks the entire blood supply to the tumour, while inducing no ischaemia in the healthy kidney tissue. However, based on the preoperative CT-scans it is difficult to decide whether or not an artery should be clamped. Clamping too few arteries can lead to excessive bleeding during surgery, but clamping too many can impair the postoperative renal function. Hence, a dedicated tool would be most welcome to facilitate surgical planning.

Methodology

An interactive preoperative planning tool was created, visualizing the perfusion zone of each selective artery in 3D (Figure 1). Segmentations of the kidney parenchyma, tumour(s) and arteries are used as input. A fully-automatic region growing algorithm calculates the 3D perfusion zone of each branch, using the centerline points of the arterial tree as seeds.

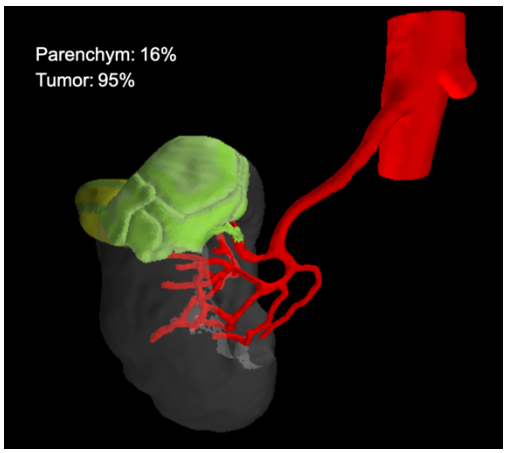

Figure 1: Virtually clamping of the upper branch illustrates that 95% of the tumour's blood supply is cut off, while only 16% of the healthy parenchyma will become ischemic.

Results

First tests in the OR showed that the planning tool is promising and helps to determine clamping strategies. Bloodless tumour resection was obtained in some cases, but the predictions did not always correspond fully to reality. Therefore, the next steps will focus on optimizing the algorithm (e.g. by taking geometrical vessel characteristics into account) and extensive validation through ex-vivo porcine and human kidney experiments.

Conclusion

Once the perfusion tool is optimized and validated, implementation in clinical practice will follow to assist surgery and increase SAC applicability during partial nephrectomies.

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