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Patient-specific 3D Printed Liver Models for Pre-operative Planning and Improved Patient Adherence

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Project Background: 3D anatomical relationships in the liver are not always visually accessible for surgeons performing resections even with advanced imaging options. Firm understanding of these relationships is essential for timely procedures, which can improve patient outcomes and lower hospital expenses. Patient-specific 3D modeling has existed for some time, though it is costly. New cost-effective techniques have surfaced which may yield opportunities for more effective preoperative planning in liver surgery and improved patient adherence.

Methods: Digital patient-specific 3D reconstruction of a liver was completed by interpolating data from MRI scans using 3D Slicer, a segmenting program. The liver model was processed and 3D printed as a shell to be used as a mold. The liver shell, associated vasculature, and tumor were printed using polylactic acid (PLA) filament on an Ultimaker S5 3D printer. Transparent silicone was used as a cast, giving the model a solid form yet still allowing examination of the inside contents.

Results: One completed liver model was used in pre-surgical consultation of a patient with hepatocellular carcinoma undergoing liver resection and during the surgical procedure as a guide for the surgical team. A follow-up survey concerning qualitative aspects of the model administered to the surgical team suggested high accuracy of the model compared to the anatomy observed during the procedure.

Conclusion: Cost-effective techniques in producing patient specific 3D anatomical models appears not only feasible, but highly effective in improving communication between the surgical team during the procedure and also between the surgeon and the patient during pre-surgical consultation. Future research may be conducted concerning the model's visual clarity as well as impact on patient adherence post-op.