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3D Printed Biliary Anatomy for Surgical Planning

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Title: 3D Printed Biliary Anatomy for Surgical Planning

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Background: Studies demonstrated that 3D-printed livers from CT or MRI data can be accurate models of actual patient anatomy. However, it has yet to be established if 3D printing offers improvements to clinical outcomes in surgery. This project seeks to optimize these applications for use at Jefferson by producing 3D-printed models from patient CT scans to guide liver resection surgeries.

Methods: A liver transplant attending was interviewed about challenges encountered during hepatectomies. A publicly available abdominal computed tomography scan was used to render a liver and its vasculature in 3DSlicer. The liver surface was cut into two halves in MeshMixer to allow visualization of the underlying vasculature. These models were printed using an Ultimaker S5.

Results: We successfully 3D printed a model of a liver capsule containing branches of the right and left hepatic arteries. The processing time included 3 hours to render liver anatomy and 31 minutes to edit the model into a form best suited for visualization of internal structures. The printing time was 47 hours and 25 minutes. 232g of PLA, 51g of Breakaway, and 24g of polyvinyl alcohol were used to create the model.

Conclusions: Creation of 3-D printed models of biliary anatomy is feasible, time-efficient, and inexpensive. In future work, we plan to encapsulate the hepatic vasculature and biliary tree (and potentially also the tumor when applicable) into a translucent silicone model of the liver parenchyma, using a 3D-printed liver shell as a mold. This silicone model could be used pre-operatively and intra-operatively to help plan and guide the surgery. Measurable endpoints will

include procedure time and intra-operative blood loss. This work has the potential to improve surgical outcomes for patients while facilitating the work of the surgeons.