COMPUTATIONAL FLUID DYNAMICS INVESTIGATION ON LIVER TRANSPLANTATION ANASTOMOSES

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ABSTRACT

During liver transplantations there are several anastomoses that must be made before the transplantation is completed and the liver graft can function properly [1]. Some of these are the portal vein anastomosis and hepatic artery anastomosis. A common postoperative problem of the hepatic artery, which supplies oxygenated blood to the liver is hepatic artery thrombosis (HAT) [2]. To limit complications such as HAT, a surgical technique, known as hepatic artery patch, is applied during hepatic artery anastomosis. This is a technique often used when there is a difference in the size of the two connected arteries. Additionally, a very interesting case of anastomosis is the piggyback technique, which is a type of anastomosis used in liver transplantation. It involves joining the donor's inferior vena cava directly to the recipient's hepatic veins. This technique includes many variations such as the side-to-side piggyback [3].

Although there are several literature findings based on clinical data on which anastomosis is better in liver transplantation to avoid thrombosis, there is little data on these anastomoses under the prism of a computational fluid dynamics (CFD) study. In this study, three types of anastomoses are studied (the hepatic artery anastomosis using hepatic artery patch, the original piggyback technique, and the side-to-side piggyback technique). From the first anastomosis, the geometric characteristics (e.g., diameters, angle and length of connection) that the patch should have, in relation to the blood inlet and outlet artery, are studied. Normal and abnormal hepatic pulsatile flows are considered together with a Carreau-Yasuda model for blood rheology [4]. A commercial CFD solver, i.e., ANSYS, is suitable for complex geometries [5] and is employed to generate solutions for unsteady laminar and turbulent flow. Solutions are obtained and averaged over at least ten flow pulses. Peak endothelial wall normal and shear shear-stresses as well as minimum oxygenation levels and the presence of recirculation zones are the criteria that can associate with thrombosis. In this CFD approach the two piggyback techniques are compared in terms of potential thrombosis risk. The results of the simulations are compared with clinical studies from the existing literature on the risk of thrombosis.

KEYWORDS: Hepatic Artery Anastomosis, Piggyback Technique, Thrombosis, Liver Transplantation, Computation Fluid Dynamics

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