Liver transplantation: how can computer models help to shorten the waiting list?

Today, the medical world is confronted with an increasing shortage of donor organs, especially for liver transplantation. Due to this lack, 584 patients died in 2011 in the Eurotransplant region while waiting for a new liver. Scientists are therefore in search of solutions to expand the donor pool, such as including donor organs of suboptimal quality and investigating better preservation methods for donor livers. Moreover, new transplantation techniques (such as living donor liver transplantation) are gaining ground, and researchers are looking into better treatment options and prevention of liver diseases (e.g. cirrhosis).

In all of the above, the liver’s blood circulation plays a vital role. Disturbed blood flow and perfusion of the liver due to an intervention or a disease may damage the liver cells, possibly leading to a loss of liver function. The big question is thus how to detect and prevent liver damage, e.g. when performing a (living donor) liver transplantation or machine perfusion preservation of a donor liver. To this end, we developed computer models to simulate the complex blood circulation through the liver to gain insight into the liver hemodynamics at the macro-, meso- and microscale level.

A combination of innovative techniques led to 3D visualisations of the complex architecture of the liver’s three vascular trees, going from the largest vessels up to the smallest microscopic vessels (called sinusoids). With these data, we developed computer models to study the forces acting on liver blood vessels and cells in the case of healthy livers as well as for livers undergoing machine perfusion preservation or a surgical procedure. Hereby, different scenarios were simulated to try to understand how livers react in different hemodynamic circumstances.

This research will contribute to the optimization of surgical procedures and preservation techniques for donor livers, which may - in the long run - lead to a shorter waiting list for liver donor organs.

Summary

Scientists are looking into new liver transplantation techniques to expand the donor pool. Hereby, liver blood circulation plays a crucial role. We developed computer models to simulate liver blood flow and perfusion to help optimizing these methods.