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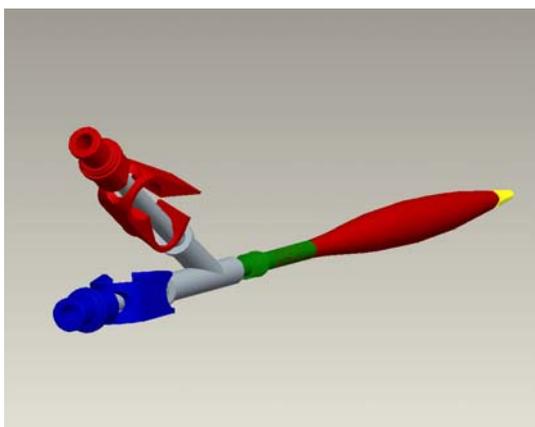
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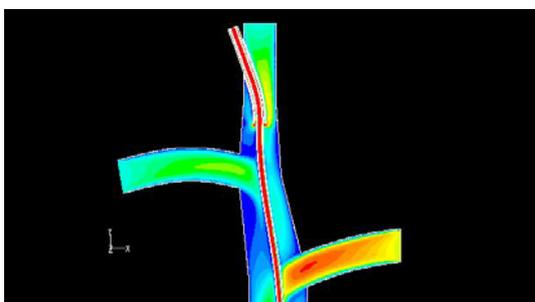
## CTI Medtech Event 2007

### Help for tiny heart patients

The development of the heart in the womb is very complex and exposed to various influences, which can trigger deformities. Every year, more than 800 babies are born with a heart defect in Switzerland. In most cases, these can be diagnosed early on and corrected in an uncomplicated procedure, before resultant injuries arise. But, in the case of many deformities, open-heart surgery is unavoidable.



Computer-optimised geometry of the coaxial smart cat®. Photo: CHUV



Simulated blood flow speeds of a coaxial smart cat® in the upper hollow vein by means of Computational Fluid Dynamics (CFD). In the outer, jugular part of the smart cat®, the blood is aspirated, in the lower caval part, it is fed in again. Photo: CHUV

#### Innovative malleable cannula

The heart-lung machine invented by American surgeon Dr. John Gibbon makes such operations possible. For the duration of the operation, it replaces the pumping function of the heart, thus ensuring the blood circulation and, by means of the so-called oxygenator, assumes the function of the lungs. During the operation on the arrested heart, cannulas connect the patient to the machine, take care of the venous reflux to the machine and the forerun to the patient in a large artery, usually the aorta. The cannulas have to meet high demands, have a smaller diameter than the access vessels into which they are pushed and, at the same time, allow sufficient blood to pass through. To increase the blood flow, previously surgeons would resort to pumps or vacuum, directing the blood into the machine and back to the body with clamps and slings, which is not without its problems.

It is this situation that Professor Ludwig von Segesser wanted to improve. Together with his team of researchers, the Senior Consultant in Cardiovascular Surgery at the Lausanne University Hospital CHUV, developed the idea of the smart canula®, a flexible cannula based on a woven material tolerated by the body. The folded cannula is pushed into the vessel with a guide wire. Once it is in the correct position, the surgeon removes the wire. The cannula opens up and, by clinging to the vessel wall, can make optimum use of the available space. "The smart canula® is the first and, to date, only cannula worldwide to adapt flexibly to the target vein and,

in doing so, allow more blood to flow through," Professor von Segesser is pleased to explain. Because of the clever design, gravity is sufficient for the cannula to let the blood flow back to the heart-lung machine, without aids such as pumps or vacuum. Even slings are unnecessary as the grid structure improves the drainage of the vessels, the walls of which, however, seal up over long distances. smart canula® cuts costs as it adapts to different vein dimensions, so hospitals no longer have to keep various sizes in stock.

### 'Mini format' challenges

However, to enable little patients to benefit from the clever cannula concept too, a miniature version had to be developed. With the help of the CTI and supported by his team of researchers at the CHUV, the heart surgeon began tackling the smart cat® project. The American Steven Taub contributed his knowledge of medicinal active substances, the Spanish physicist and engineer Dr. Ikher Mallabiarena his know-how in Computational Fluid Dynamics (CFD) of blood cleansing procedures. It was a huge challenge as the developed cannula could not be reduced 1:1 to the smaller scale.

First of all, the team had to study the geometry and design of the components and analyse the blood flow with computer simulation. After several attempts, they came up with the first prototypes. The scientists then tested the performance of those prototypes with the specially developed test facility. Above all, they had to ensure that no thrombosis could occur. The material also had to be biologically tolerated and economical to produce.

Meanwhile, the smart cat® has taken shape and is now also showing additional application potential. The mini cannula is ideal for use in blood cleansing processes such as, for example, for haemo-filtration in the case of acute renal failure. "Despite the tiny access opening of smart cat®, the blood flow rate is very high," sums up Professor von Segesser. "That improves filtration, shortens treatment time, promises faster healing and fewer complications."

Now, the first operations in paediatric heart surgery have been successfully carried out at the CHUV. As the operations show, smart canula® offers very young heart patients considerably more comfort and shortens operating times. At any rate, 1% of newborns a year in Switzerland, who come into the world with heart defects, are benefiting from it.



The cardio-vascular surgery research team at the CHUV: Head of Department Professor Ludwig von Segesser (middle), Head of Research Steven Taub (left) and Dr. Ikher Mallabiarena, EPFL Engineer in Microtechnology. Photo: Elsbeth Heinzelmann

#### CTI 7142.2 MTS

The smart cat®, a vascular access device with superior performance

#### CHUV

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