Progetto di un flap intimale di dissezione aortica per simulazione in vitro

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Design of a new device for vascular surgery in collaboration with Dr. Fabio Melchiorre, Azienda Ospedaliera San Paolo, Milano

Steps followed during the project

- Analysis of pathology
- Knowledge of current surgical procedures
- Discussion with the physician
- 3D cad design with Solidworks
- 3D printing
Design of a new device for vascular surgery

I learned the tools of CAD drawing

Design of an intimal flap of aortic dissection
Pathology

Introduction to the project

Dissection model

Project intimal flap
 Pathology

 Introduction to the project

 Dissection model

 Project intimal flap
Aortic dissection:

Is a disorder affecting the biggest and most important artery of the human body: the aorta

- Diameter 20-25 mm (large)
- Wall thickness 2mm
- High elastic component

Structure:

**Tunica Intima:** thin coat of cells;

**Tunica Media:** abundant elastic fibers;

**Tunica Adventitia:** the collagen fibers.
Aortic dissection

Causes:
- Arterial hypertension
- Congenital defects
- Arteriosclerosis
- Inflamations of the aorta
- Aortic aneurysm
- Traumatic injuries

Complications:
- Aortic insufficiency
- Ischemia
- Stroke
- Internal bleeding
- Death

Therapies:
- administration of drugs
- surgery
Why investigate aortic dissection?

**In vitro testing**

- **Incidence:** some 3 cases per 100,000 person-years
- **Short-term survival:** approximately 70%
- **Long-term survival:** approximately 60% at 5 years, 40% at 10 years
- **Untreated patients:** about 75% die in 2 weeks
- **Operative mortality:** between 15% and 30%

Support the surgeon in the planning phase of the intervention
Outline

- Pathology
- Introduction to the project
- Dissection model
- Project intimal flap
with collaboration of IRCCS San Donato: Dr. Santi Trimarchi

- Study of vascular fluid dynamics using in vitro models
- Validation of computational models
- Support the surgeon
- Investigate specific diseases
Goal

Model of aortic dissection

Pulsatile pump

Impedance simulator

Riserve

improve the actual membrane
Why create an intimal flap?

**Current membrane:**
- Impermeable sheet
- Not physiological geometry
- Absence of entry tears

**Objectives:**
- Evaluate the structural strength of the model
- Measure the pressure values in the 2 lumen are (not connected)

**Intimal flap:**
- Include the entry tears
- Better approximation of the real geometry

**Objectives:**
- Measure the pressure values in the 2 lumens (connected)
- Vary the structural characteristics of the flap (entry tears size...
 Pathology
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Dissection model

- Anatomical parameters supplied by the surgeon
- 3D CAD design
- 3D printer
- Testing under the pulse simulator
- Study of pressure in the true and false lumen

• Relationship between true and false lumen is 1:3
• True lumen diameter: 30mm
• True lumen length: 204mm
Outline

- Pathology
- Introduction to the project
- Dissection model
- Project intimal flap
Start from the dissection model

Design a membrane that perfectly adapts to the existing model

Design a mold

Second part: closure of the mold

First part: container for the casting process

Steps followed during the project:
Characteristics of individual parts

- Intimal flap length: 260mm
- Intimal flap width: 130mm
- Position of the entry tears variable
Some details

Entry tear

Closing system
I developed a support for the realization of a membrane for intimal flap.

The membrane created by this method:

1. Allows a better adherence to physiopathological reality
2. Allows to include specific patterns of position / size of the entry tears
3. Allows to test different materials and investigate the response during in vitro tests
Future developments:

1. Collecting data relating to mechanical properties of the intimal flap (from the literature or from experimental tests)
2. Search for materials able to correctly reproduce the mechanical properties.
3. Choice of the number, position and size of entry tears (given by physician)
4. Mold 3D printing
5. Intimal flap casting
6. In vitro simulation
Thanks for your attention