UNIVERSITÀ DEGLI STUDI DI PAVIA

Facoltà di Ingegneria

Dipartimento di ingegneria Civile e Architettura

Corso di laurea in **Bioingegneria**

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

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Relatore: Prof. Ferdinando Auricchio
Correlatore: Ing. Stefania Marconi

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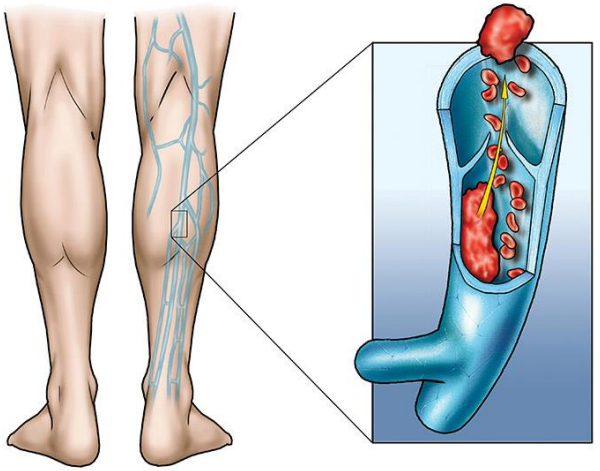
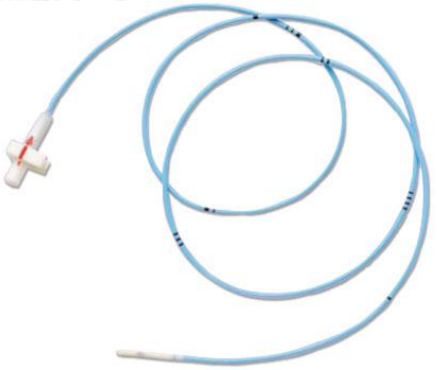
Design of a new device for vascular surgery

in collaboration with Dr. Fabio Melchiorre, Azienda Ospedaliera San Paolo, Milano

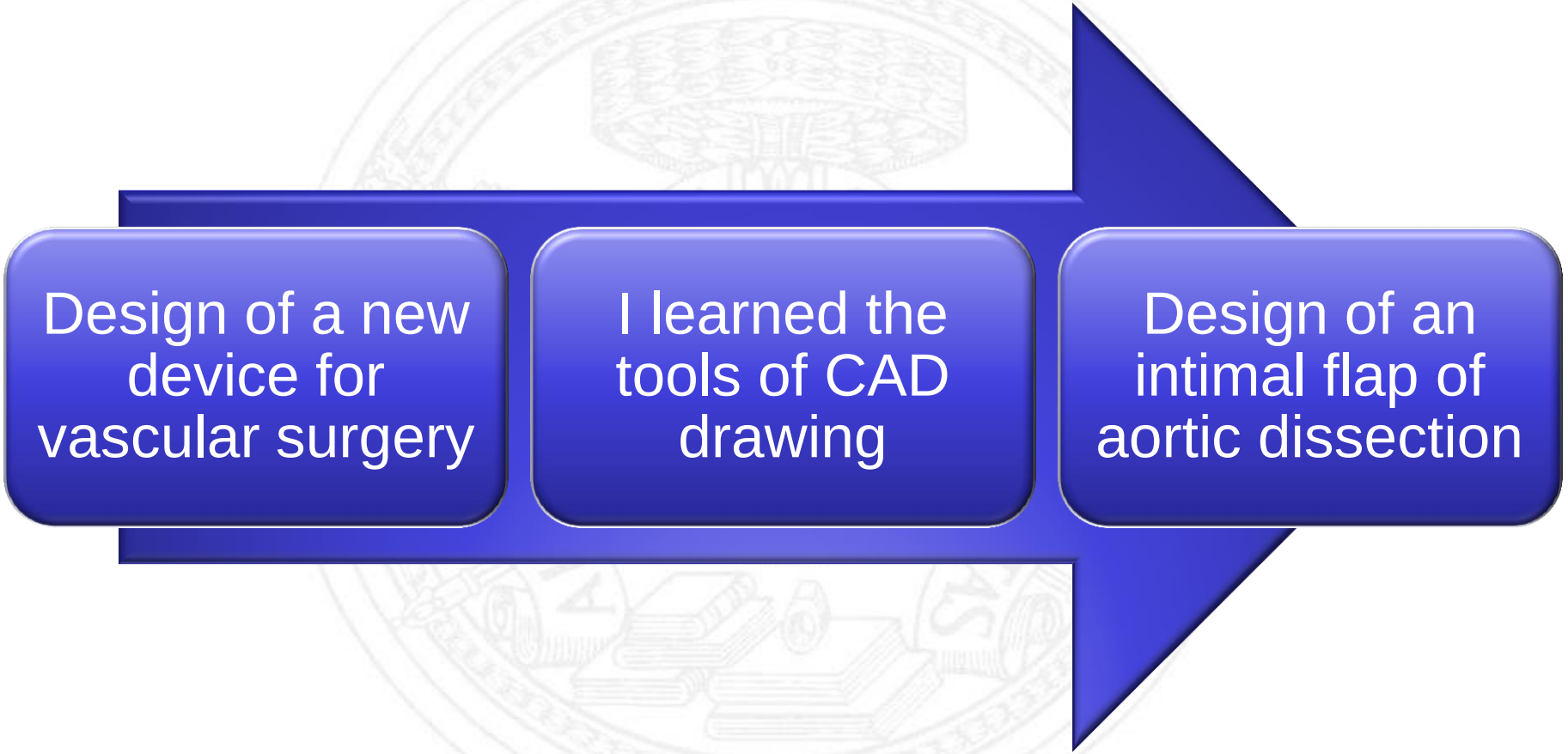
Steps followed during the project

- Analysis of pathology
- knowledge of current surgical procedures
- Discussion with the physician
- 3D cad design with Solidworks
- 3D printing





Secrecy patent


Design of a new device for vascular surgery
I learned the tools of CAD drawing
Design of an intimal flap of aortic dissection

Outline

- Pathology
- Introduction to the project
- Dissection model
- Project intimal flap

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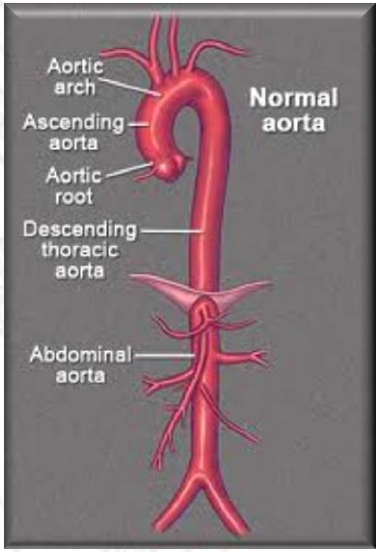
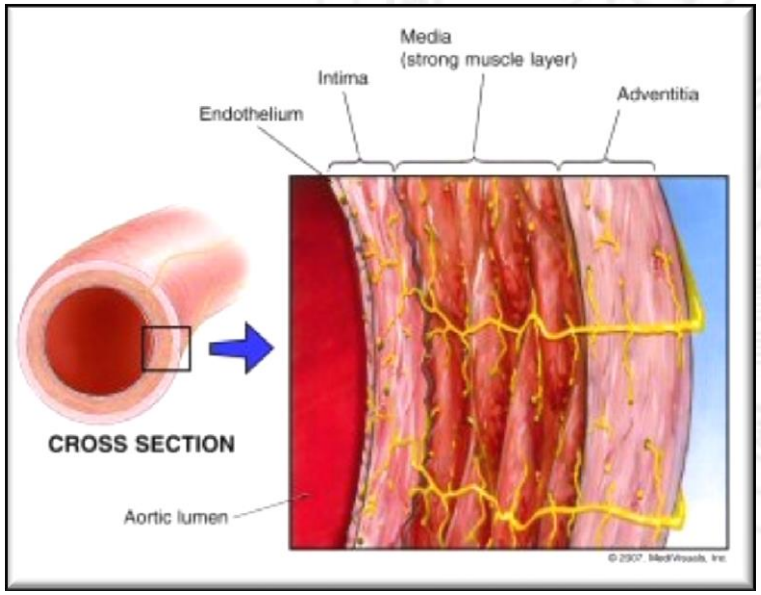
Aortic dissection:

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:

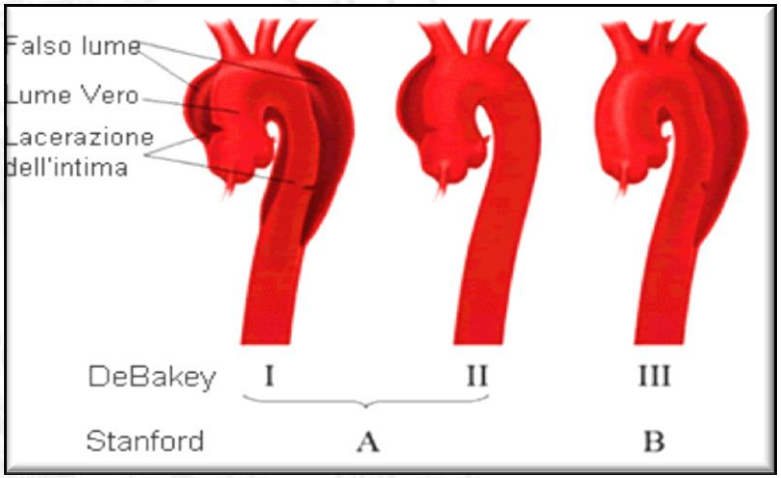
Tunica Intima: thin coat of cells;

Tunica Media: abundant elastic fibers;

Tunica Adventitia: the collagen fibers.

Aortic dissection

Wall intimal laceration → The blood penetrates into tunica media → Separation of the layers → False lumen → Dilatation vassel → Vessel rupture



Causes:

- Arterial hypertension
- Congenital defects
- Arteriosclerosis
- Inflammations of the aorta
- Aortic aneurysm
- Traumatic injuries

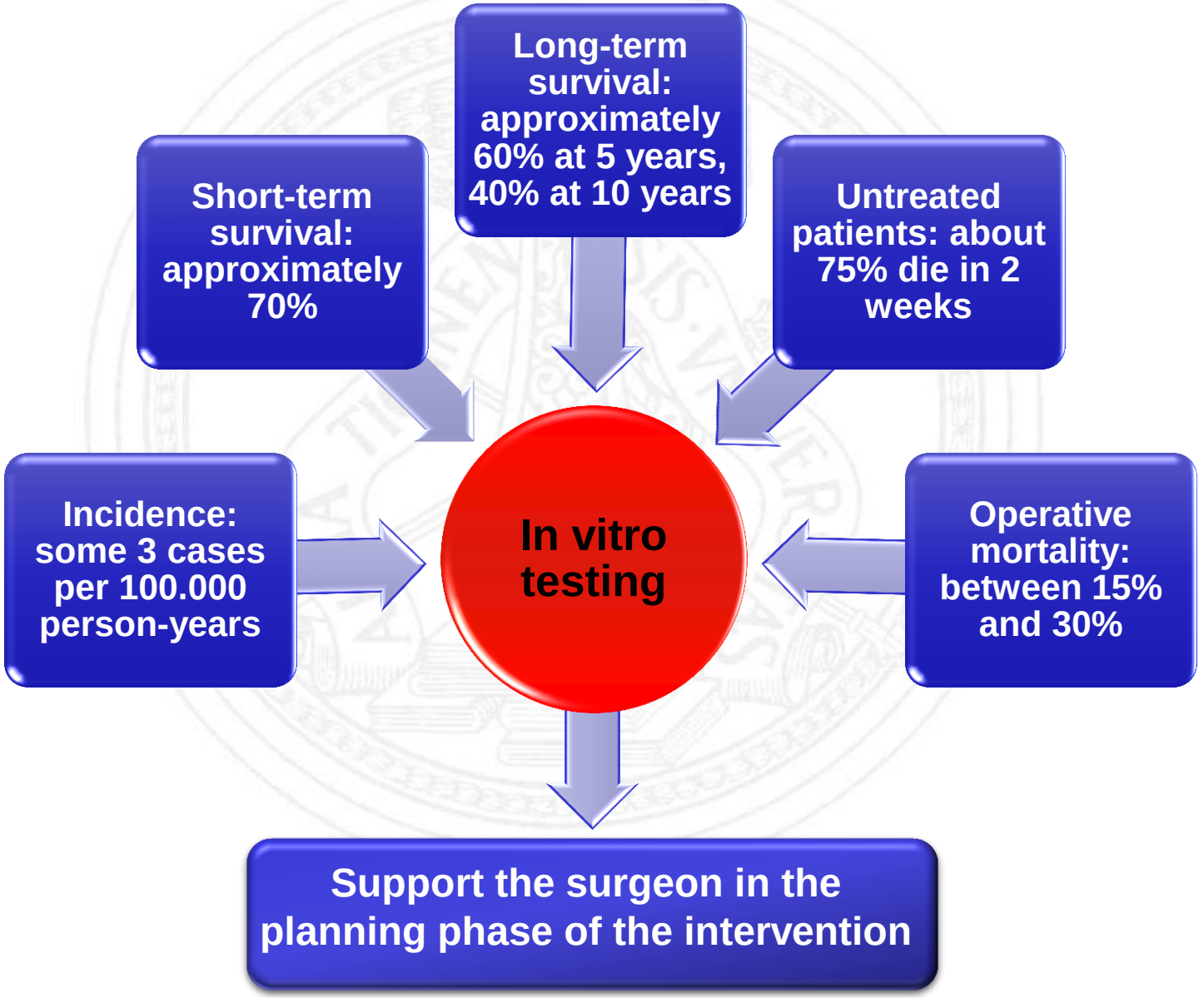
Complications:

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

Therapies:

- administration of drugs
- surgery

Why investigate aortic dissection?



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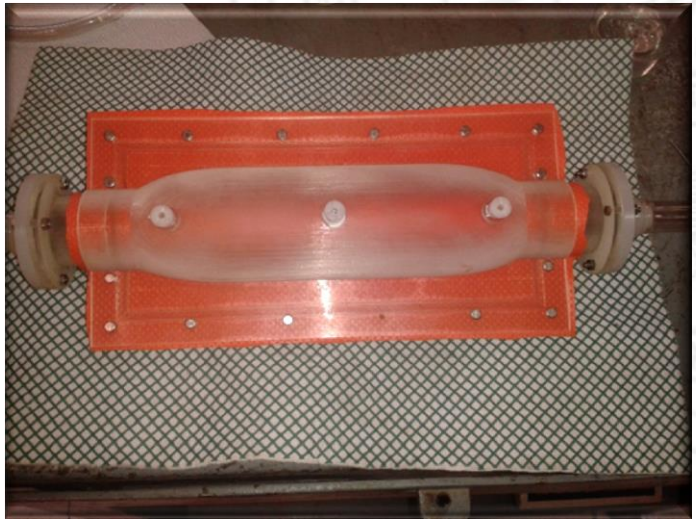
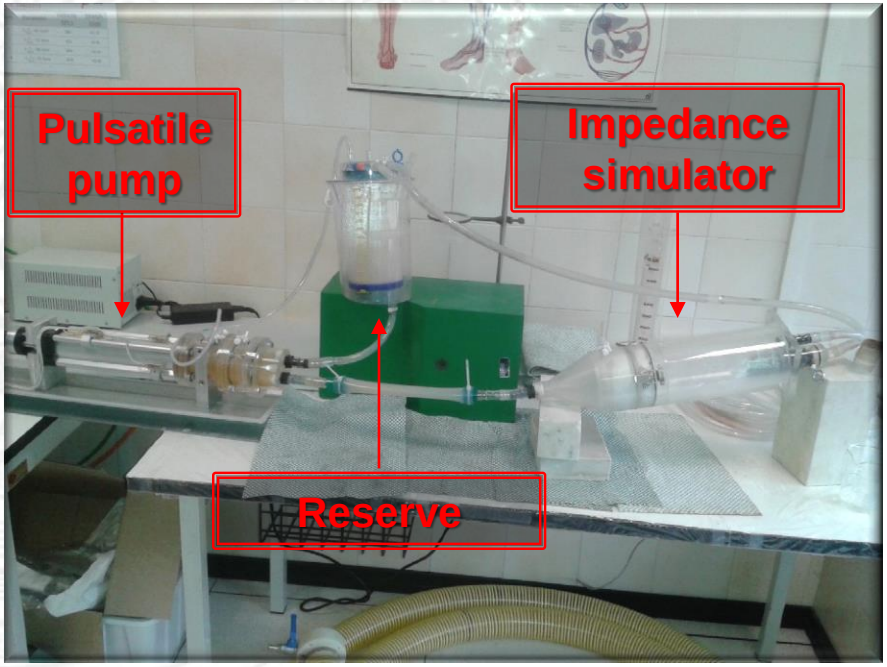
with collaboration of IRCCS San Donato: Dr. Santi Trimarchi

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



Model of aortic dissection

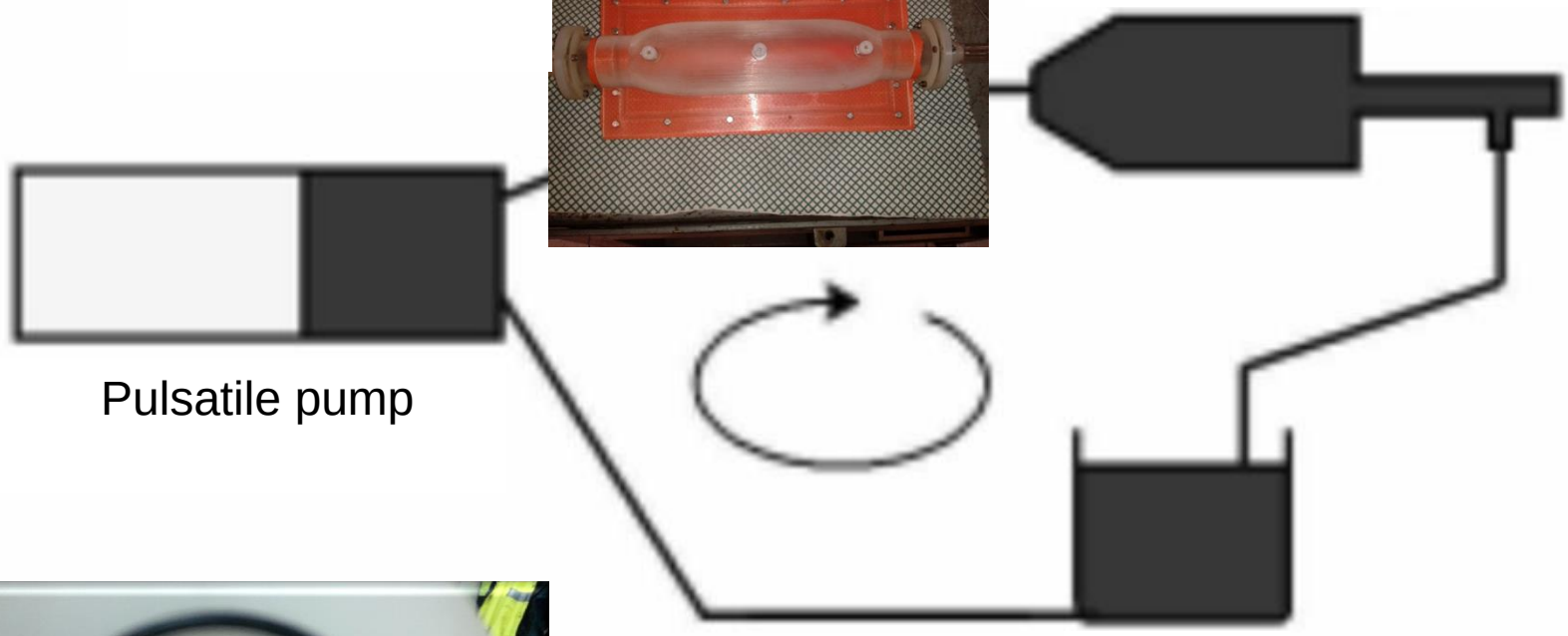


Circuit simulation systemic

Goal

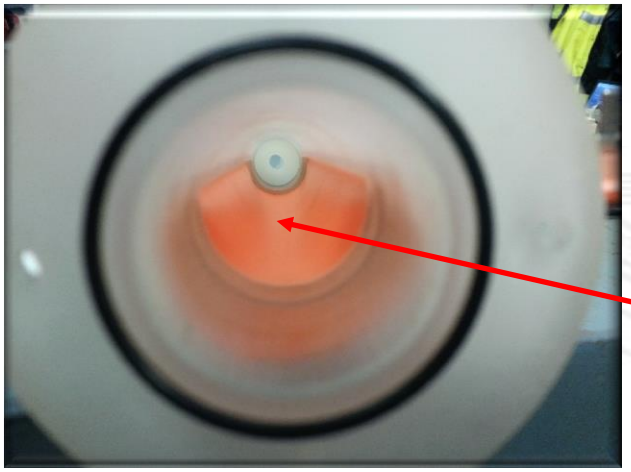
Model of aortic dissection

Impedance simulator



Pulsatile pump

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…)

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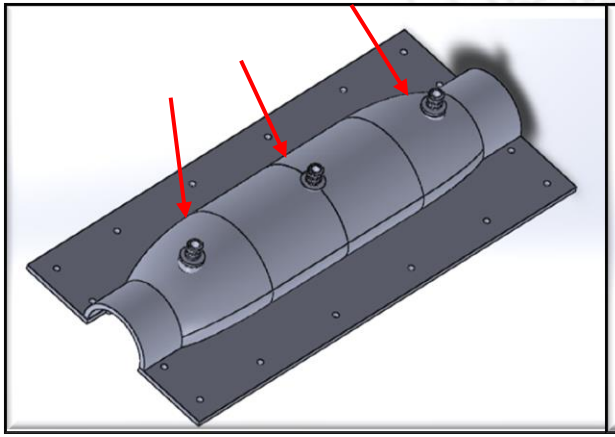
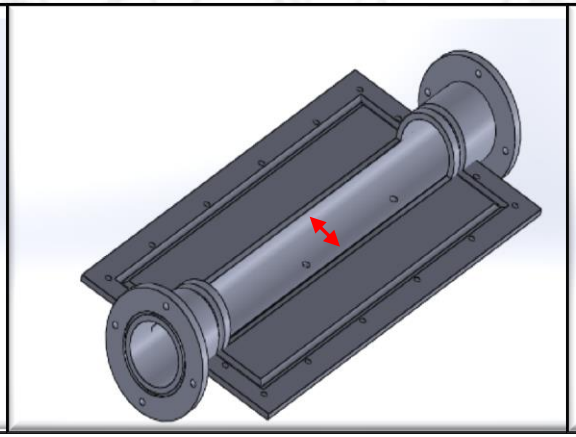
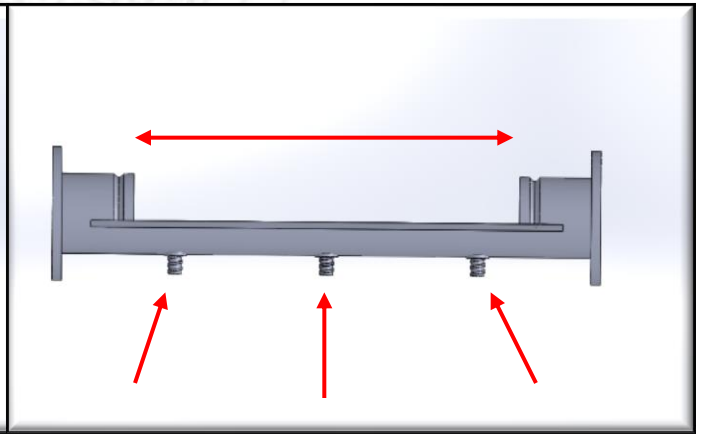
Dissection model

- 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







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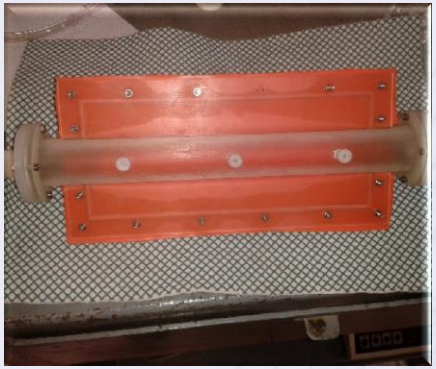
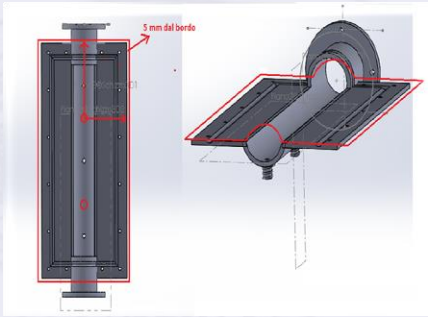
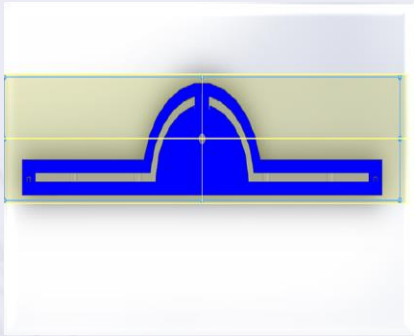
Steps followed during the project:



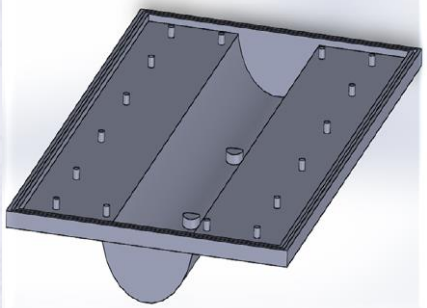
Start from the dissection model



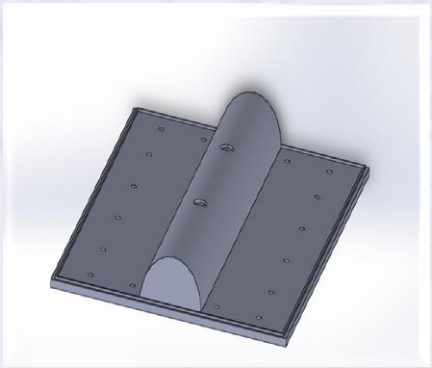
Design a membrane that perfectly adapts to the existing model



Design a mold

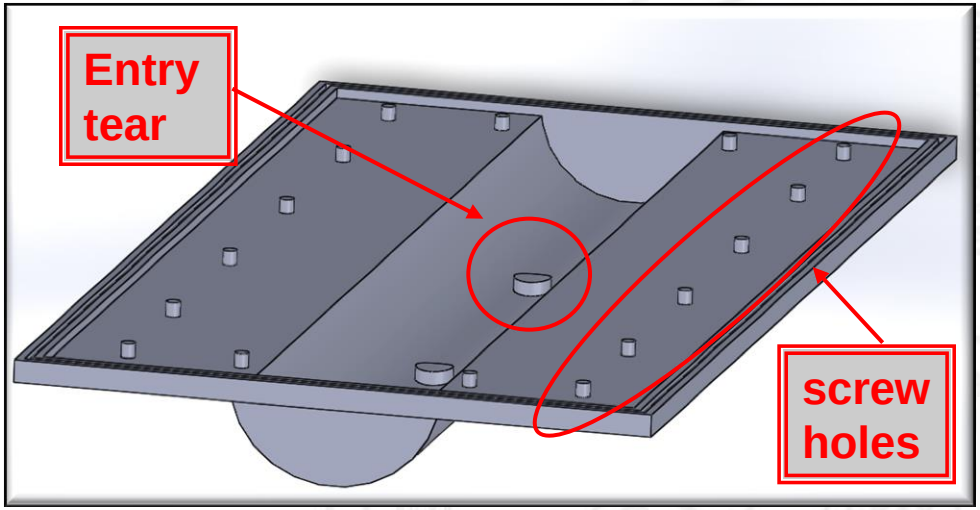


First part: container for the casting process

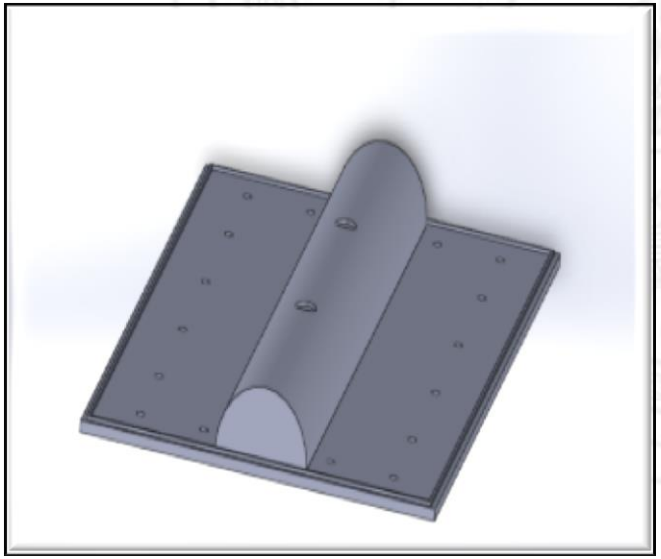


Second part: closure of the mold

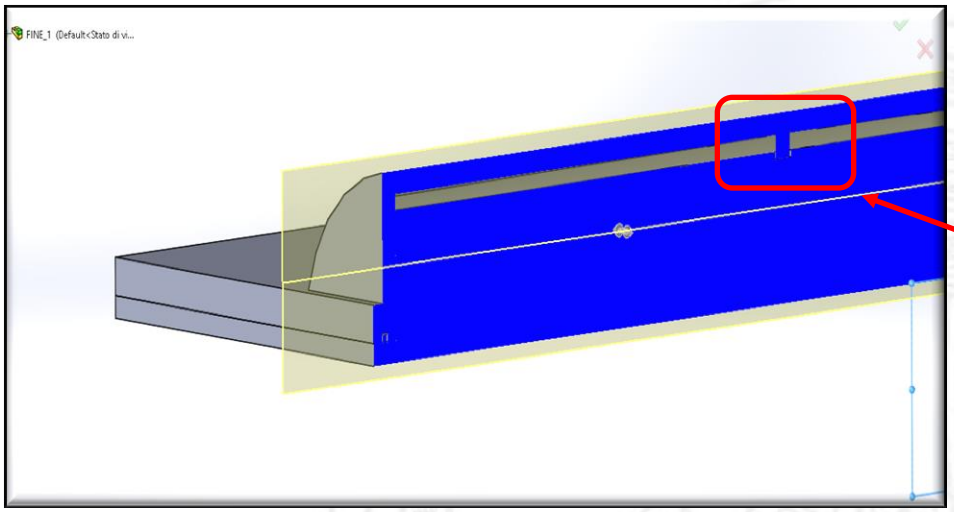
Characteristics of individual parts



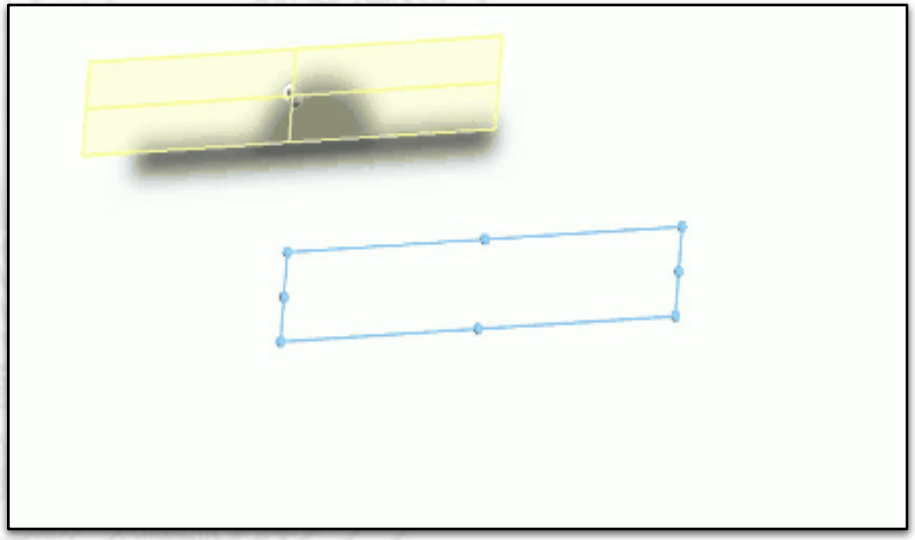
- Intimal flap length: 260mm
- Intimal flap width: 130mm
- Position of the entry tears variable

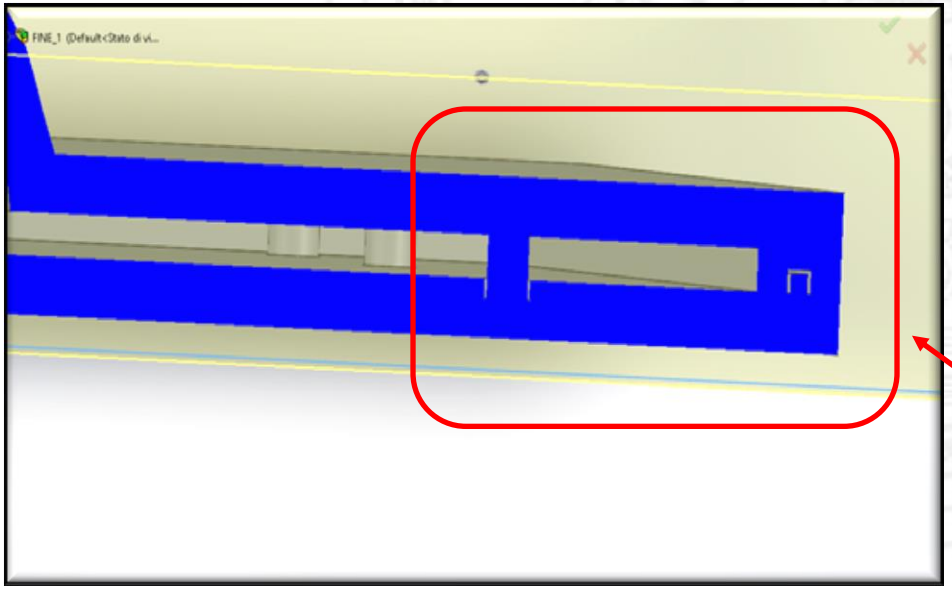


Some details



Entry tear





Closing system

Conclusion

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

Giuseppe Ruvolo