A New Endoprosthesis With Sensing Capability

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Outline

• Aneurysm
• Treatment options
• Thoracic “home made” stent-grafts
• Thoracic commercial devices
• Future trends
• The new endoprosthesis
• Conclusions and future work
Aneurysm

An **aneurysm** is a permanent and irreversible localized dilatation of an artery, having at least a 50% increase in diameter compared with the common one.

Are among the top 10 of causes of death, both in Europe and USA.
Treatment options

Open surgery

It is an invasive procedure in which the diseased segment of the aorta is replaced by a synthetic prosthetic graft.
Treatment options

Endovascular aneurysm repair (EVAR)

It is a minimally invasive procedure in which a stent-graft is guided from the femoral artery to the affected segment to prevent wall rupture.
Thoracic “home made” stent-grafts

Early stent-grafts were custom designed for each patient by the surgeons Dake & colleagues used **stainless steel z-shaped stent** elements covered by a **woven polyester graft**.


Thoracic commercial stent-grafts

Devices available in the USA (FDA approved)

- **Gore TAG**
  (W.L. Gore & Associates, USA)

- **Talent Thoracic**
  (Medtronic Vascular, USA)

- **Zenith TX2**
  (Cook Medical, Denmark)
Thoracic commercial stent-grafts

Devices available Europe (CE marked)

**Gore TAG**  (W.L. Gore & Associates, USA)

**E-Vita thoracic**  (Jotec, Germany)

**Zenith TX2**  (Cook Medical, Denmark)

**Relay**  (Bolton Medical, USA)

**TAArget**  (LeMaitre Vascular, USA)

**Valiant**  (Medtronic Vascular, USA)
Future trends: Stent-Graft

Rigberg’s stent-graft

Proposes to replace currently used grafts by a graft made of thin-film nickel titanium.

Advantages:

• small profile when compressed

Future trends: Stent-Graft

Kuribayashi’s stent-graft or origami stent-graft

It is a single component device. A Nitinol sheet is folded using a folding pattern as the one used in the Japanese art of origami.

Disadvantages:
• high price

Future trends: Surveillance

Thus far, there are two devices with sensing capabilities that have been evaluated for abdominal aortic aneurysms.

The Impressure is sewn to the stent-graft while the EndoSure is placed inside the aneurysm sac as an independent step of the EVAR procedure.

Impressure sensor (Remon Medical Technologies, Israel)

EndoSure (CardioMems, USA)
The new endoprosthesis

**Smart Stent-Graft**

- Thin
- Flexible
- No internal power supply
- Multiple sensors

A smart stent-graft can be decomposed in the following components:

- Smart stent-graft
- Stent
- Graft
- Sensor
- Telemetric system

Design based on already available commercial devices

To be developed
The new endoprosthesis

The subtract, made of polydimethylsiloxane (PDMS), will be fabricated using acrylic molds.
The new endoprosthesis

Two different approaches will be used to manufacture the electric components (the capacitor and the inductor).
The new endoprosthesis

sensor \quad = \quad subtract \quad + \quad electric \quad components

Aligned Carbon Nanotubes (ACNTs) \quad Inkjet metal printing
The new endoprosthesis

Carbon Nanotube (CNT)-based flexible capacitive sensor
The new endoprosthesis

Flexible Pressure Sensor

Composed of 3 thin layers (< 400 µm):

- Defines the inductor and the electrodes
- Defines the dielectric (air)

Current on the external device changes with blood pressure
Conclusions and future work

• Stent-grafts are in a mature stage and the devices of the future will have more functions than the protection of the blood vessel;

• In the future, stent-grafts will be able to provide information about the devices performance and the patient’s health.

• Future work:
  • Design, fabrication and test of a capacitive sensor for stent-graft monitoring;
  • Development of a passive telemetric system for implant readout;
  • Study of the best sensor placement location.
Thank you!