PATIENT-SPECIFIC VASCULAR MODELS FOR HANDS-ON TRAINING IN TRANSCATHETER OPERATIONS

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Introduction

The diffusion of new transcatheter approach to treat heart pathologies goes hand in hand with the need for surgeons to acquire new skills, other than those involved in conventional open-heart surgery. In this context, the need for an adequate surgical training phase is growing. If carefully designed, in vitro simulators can provide realistic platforms for training operators in these challenging procedures.
We aimed to design and develop training-oriented vascular models with realistic anatomy and haptic feedback.

Methods

A computer tomography image derived from a female patient with aortic arch aneurysm was used as a starting point.
Semi-automatic segmentation of the aorta and common iliac arteries was performed using ITK-SNAP software to obtain a 3D computational model (Figure1-A).
The model was used to design the internal and external mold through CAD modelling (Fusion 360, Autodesk) (Figure1-B).
The molds were 3D printed (Ultimaker 3, Ultimaker B.V.) by PLA (Figure1-C); the surfaces were cured by sanding and covered with epoxy resin, in order to minimize the surface roughness of the vessel and obtain greater transparency of the polymeric model (Figure1–D).
Once this process was completed, the mold was assembled, and Sorta Clear 18 silicone (Smooth-On, Inc.) was injected into the mold. Polymerization at room temperature lasted for 24 hours (Figure1-E).
Two models were obtained. The inner surface of one model was coated with Parylene-C [1] in order to improve the haptic feedback during the insertion of endovascular instruments, by reducing friction (Figure1-F).

Results

Figure 2 shows one of the two silicone models that were used to simulate a transcatheter procedure by an experienced operator. The test involved the insertion in the phantoms of a guide wire (0.35mm), a catheter pigtail (6Fr) and the delivery system of Medtronic (Enveo) Evolut R TAV.

The haptic feedback during the procedure in the Parylene-coated model was considered more realistic than those with the uncoated model.

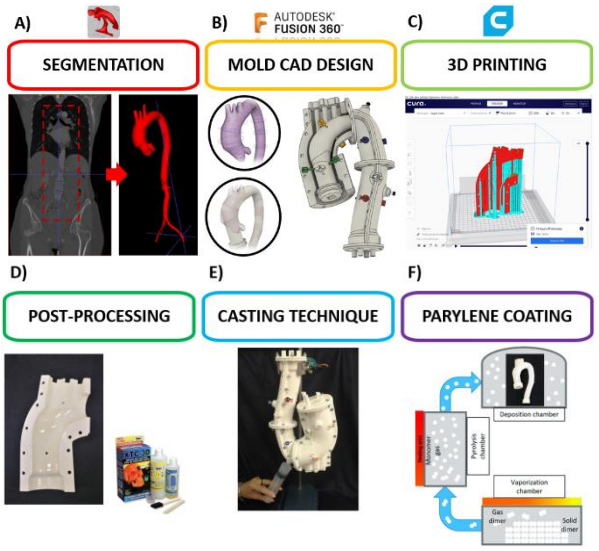

Figure 1: Workflow process for patient-specific vascular model.

Figure 2: Patient-specific silicone model obtained with the described method.

Discussion

The proposed method is an effective way to produce patient-specific, transparent vascular models with silicone casting technique. The silicone models are a promising tool for realistic surgical trainings in transcatheter procedures.

References

1. Cosseddu, P., et al. “Tactile Sensors With Integrated Piezoelectric Polymer and low voltage Organic Thin-Film Transistors” 13th IEEE Sensors Conference, SENSORS 2014, Valencia 2-5 November 2014.