AORTIC VALVE SURGERY TOOL

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Overview

The development of this product was part of my 6-month internship at BETIC IIT Bombay.

The parabolic geometry of this aortic valve template was created by Ashwini Vispute as part of her Masters dissertation. The project was carried forward by me, in designing and fabricating an easy-to-use surgical device.

Team

Arvind Bhallamudi (Product design and fabrication)
Ashwini Vispute (Template design)
Dr. Rupesh Ghyar (Project guide)
Dr. Anvay Mulay (Cardiologist)

About the Surgery

Aortic valve replacement is a type of open heart surgery where the failing valves are replaced with artificial valves which can be mechanical or autologous..

In autologous replacement, the valve is recreated by using the vestigial fold of the pericardium tissue. The tissue is marked, cut and folded in specific manner to mimic the function of the aortic valve.

Pericardium tissue cut and folded to mimic the aortic valve

Design Goal & Features

A device providing a correctly sized template to mark the pericardium tissue

Bio-compatible

Should not cause adverse reactions

Prompt

Enable quick and efficient surgery

Compact

Take up minimum space; be handy

Ergonomic

Easy to hold/use with precision

Tool Design

In this phase of the surgery, the surgeon performs two steps. First, the diameter of the aorta is checked. Then a corresponding template is placed on the tissue for marking. Tools were designed for both steps, keeping in mind what position the surgeon needs to hold them in.

1 **Sizer**

To check the diameter of aorta

2 **Template**

To mark the tissue

Proof of Concept

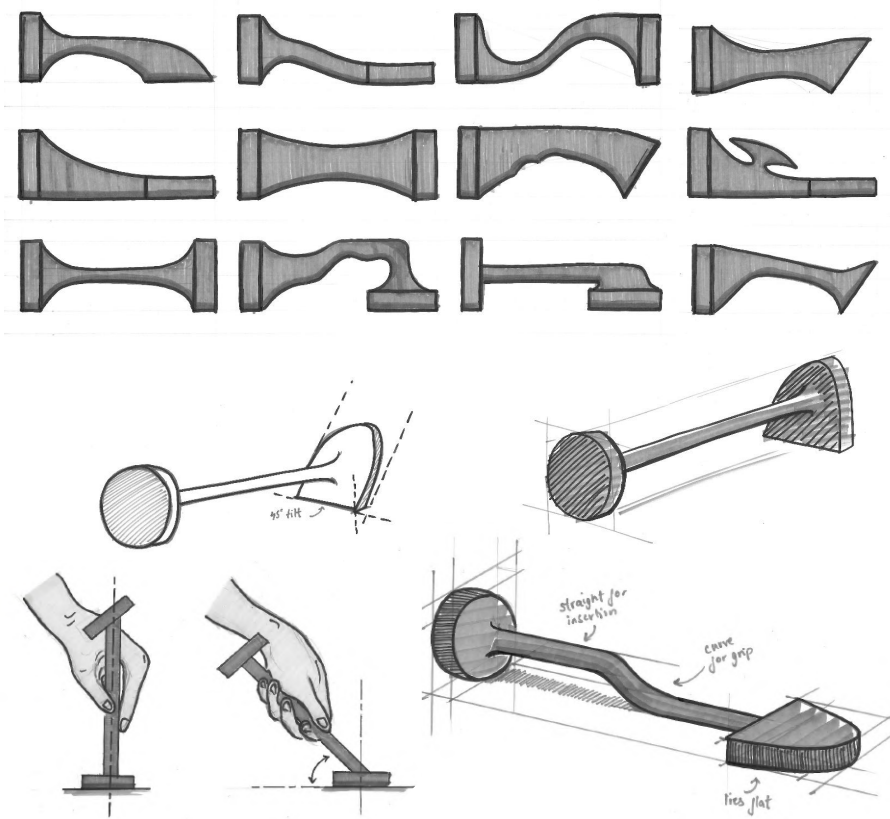
For treating patients having different sizes of aorta, the kit was designed with five sizes, for valve diameters ranging from 19 mm to 27 mm.

To test the geometry, the tools were designed and prototyped for clinical immersion at Fortis Hospital, Mumbai.

Initial prototypes made by 3D printing in biocompatible ABS-M30i

Idea Development

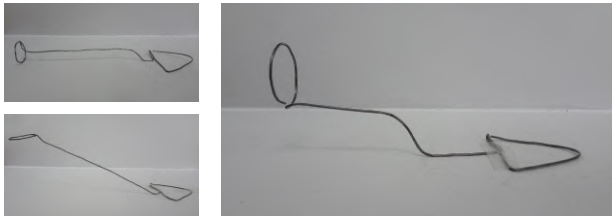
Initial trials led to an insight for combining the sizer and template into a single handheld tool. This allowed a more efficient way of performing the operation.



Mock Models

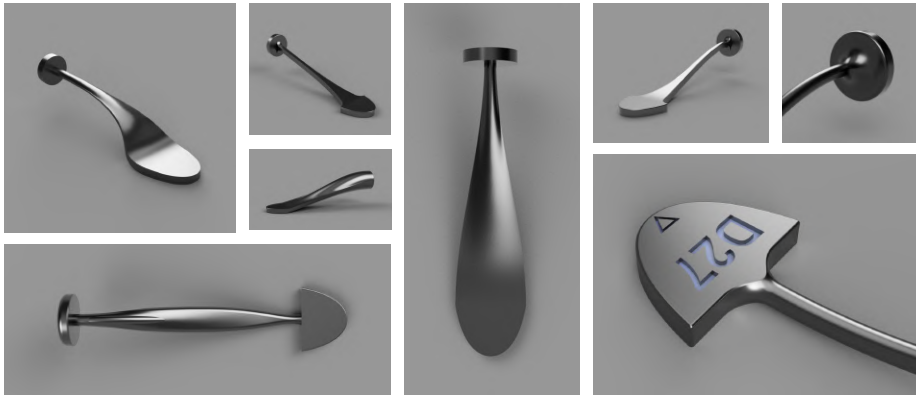
To create an ergonomic combined tool, some of the ideas were tested by making simple wire models. The orientation and grip was evaluated for both sides of the tool.

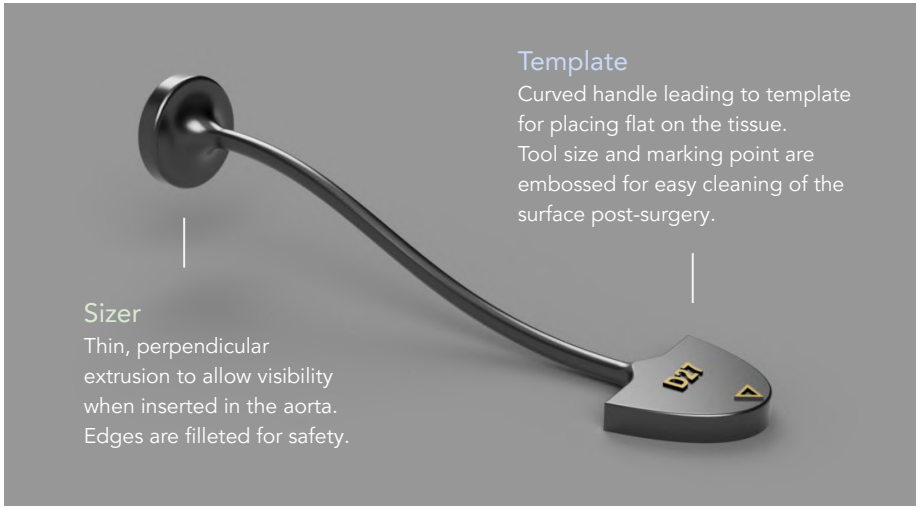
Considering how comfortably the tool can be gripped and used in the two steps of the operation, one concept was selected and improved. It was 3D modelled using *Fusion 360* and *Solidworks*, and prototyped by 3D printing.



Testing ergonomics on different handle shapes

CAD Ideation & Detailing





Materials Used

The final product was 3D printed in ABS-M30i which is biocompatible, sterilizable and appropriate for surgical use.

A tool stand was laser-cut in acrylic, to hold the tools on a table in the operating theatre.

Clinical Immersions

Open-heart surgery at Fortis hospital, Mumbai.