DESIGN OF A PATIENT-MATCHED UROLOGICAL SURGERY TRAINING MODEL USING NOVEL FABRICATION TECHNIQUES

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Background

- 3D printed patient-matched surgical training models for pyeloplasty training allow surgeons to develop pyeloplasty skills without cadavers or animal models.
- However, these 3D printed models require considerable resources and time to produce, especially given each model's single-use nature and thus limited teaching utilisation.

Aim

- To design and fabricate a patient-matched pelvic-ureteric-junction-obstruction (PUJO) model that reduces the high cost, time, labour and materials associated with current 3D printed pyeloplasty models.

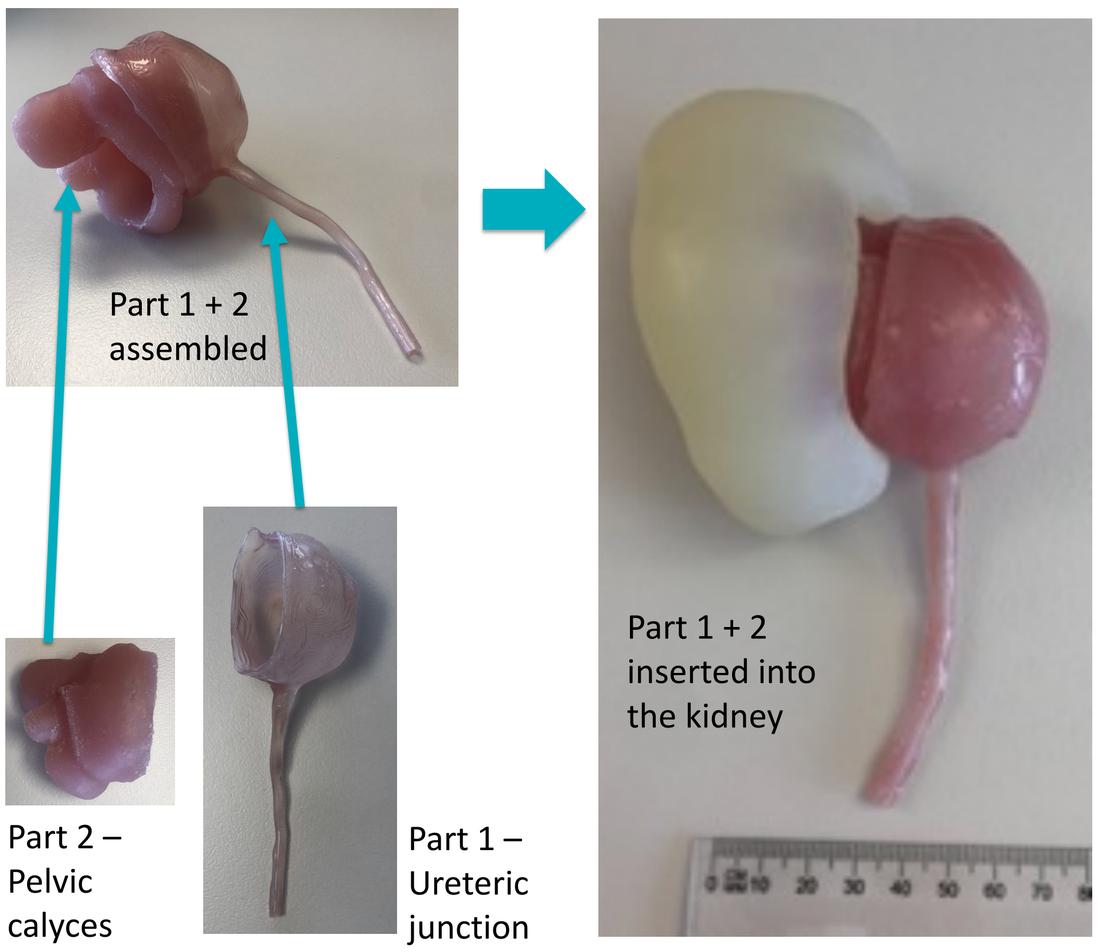
Methodology

1. Design a patient-matched PUJO model that uses easily accessible materials which are suturable
2. Prototype and compare possible fabrication methods and materials of PUJO models
3. Validate PUJO model by qualitative testing

1. Design Concept

A reusable 2-part model

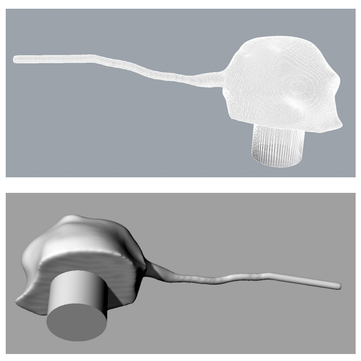
- The 2-part PUJO model consists of: ureteric junction (part 1) which is a 'sleeve' that stretches over the reusable pelvic calyces (part 2).
- Only the ureteric junction sleeve must be replaced for each pyeloplasty, whilst the pelvic calyces is reused.



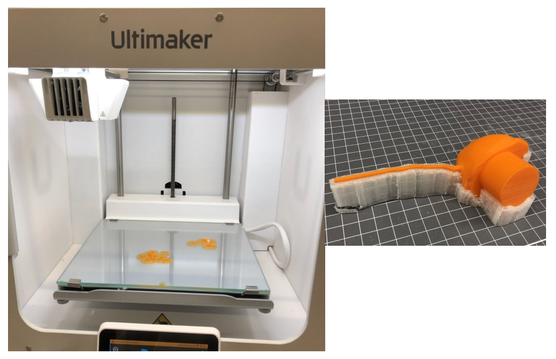
2. Production

From CT scan to dip-coated model

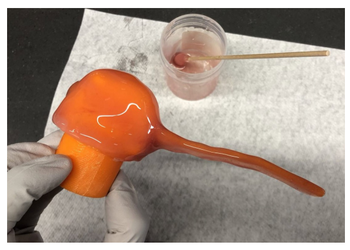
- Part 1 was fabricated using a 'dip coating' process – a process that is easily reproducible, low cost and time efficient.
- Dip-coating means that the 3D printed aspect of the model, the mould, is reusable
- Silicone was chosen as it is widely accessible and inert with proven success in suturability and tissue mimicry.



1. A CT scan of the PUJO was manipulated in the 3D modelling program *Rhinoceraus* and *Fusion360* to generate a mould.



2. The mould was 3D printed in polylactic acid filament using the *Ultimaker3* 3D printer



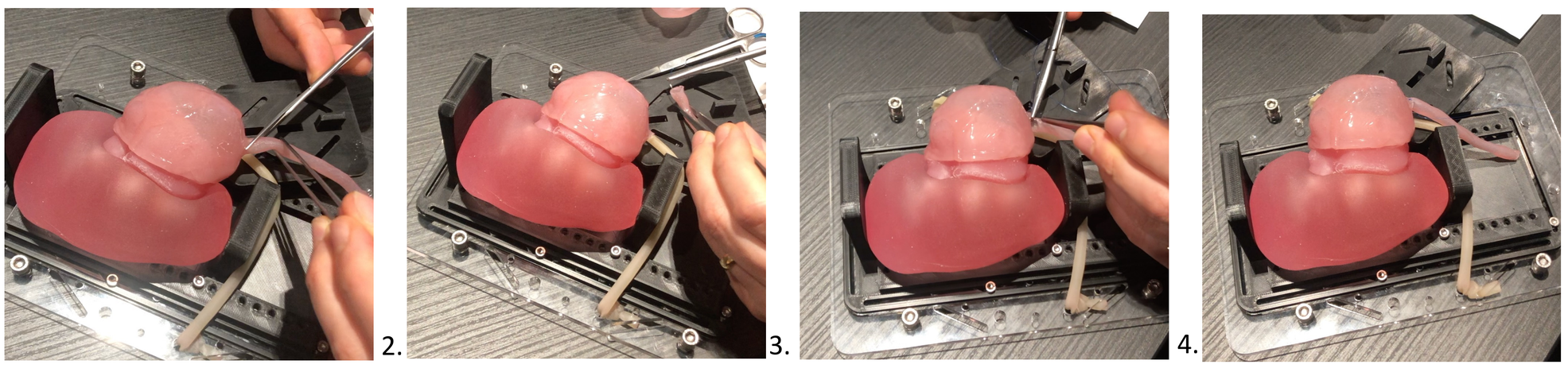
3. The 3D printed mould was then dip coated in silicone

4. The dip-coated silicone is removed from the mould, ready for use

3. Design testing

Preliminary surgical testing and results

- Preliminary surgical testing proved that the 2-part concept design, silicone material choice, and dip coating technique were appropriate, and more feasible and effective than existing 3D printed methods.



1. 2. 3. 4. Preliminary surgical testing showing the pyeloplasty performed on model

Table 1. Comparison between this project's model and existing models*

	Dip-coated model	Other 3D printed models
Comparison of production feasibility		
Cost per renal pelvis and ureter	$0.74	$120
Production time per model	20 minutes dip-coat 4 hours to 3D print initial mould	12 hours
Materials and tools	Silicone Ultimaker 3D printer	3D printed resin Stratasys J750 printer

**Existing models created by Herston Biofabrication Institute*

4. Future direction

Further testing and verification

- Future studies aim to streamline the fabrication processes, and validate the model's surgical realism through a qualitative questionnaire.

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