PATIENT SPECIFIC MEDICAL DEVICES AND SOLUTIONS AT THE POINT OF CARE

SIMULATION, TRAINING, AND PHANTOM SOLUTIONS BROCHURE

3D LIFEPRINTS
SIMULATION/PHANTOM SOLUTIONS

ABOUT US

3D LifePrints is a medical 3D printing company that uses 3D technologies to provide **innovative solutions** to the medical sector. Our primary focus is the supply of patient specific medical devices, such as: **anatomical models**, **surgical guides** and **bespoke titanium implants**. Our products are best supplied as a **Point of Care service** from a **3D printing Hub embedded** within a host hospital.

We currently have a number of embedded Point of Care Hubs in the UK, including at **Wrightington Hospital**, **Alder Hey Children's Hospital**, **Oxford University Hospital**, and **Leeds General Infirmary**. Our Hubs provide a full spectrum of personalised medical services to the clinical teams as well as a range of high-fidelity simulation devices for training and research.

Disciplines covered include **Cardiothoracic**, **Oncology**, **Neurosurgery**, **ENT**, **Oral and Maxillofacial**, **Plastic, Trauma** and **Orthopaedic**, **Urology** and **Vascular**.

3D LifePrints' Hubs provide a complete solution of **staffing**, **hardware** and **software** into your institution delivering a multi-disciplinary service.

Working closely with your clinicians, our bio-medical engineers utilise patients' scan data to design and manufacture patient specific medical solutions, which can be **delivered immediately**.

Our embedded team **takes care of the strict Regulatory and Quality requirements** applying to the creation of medical devices.

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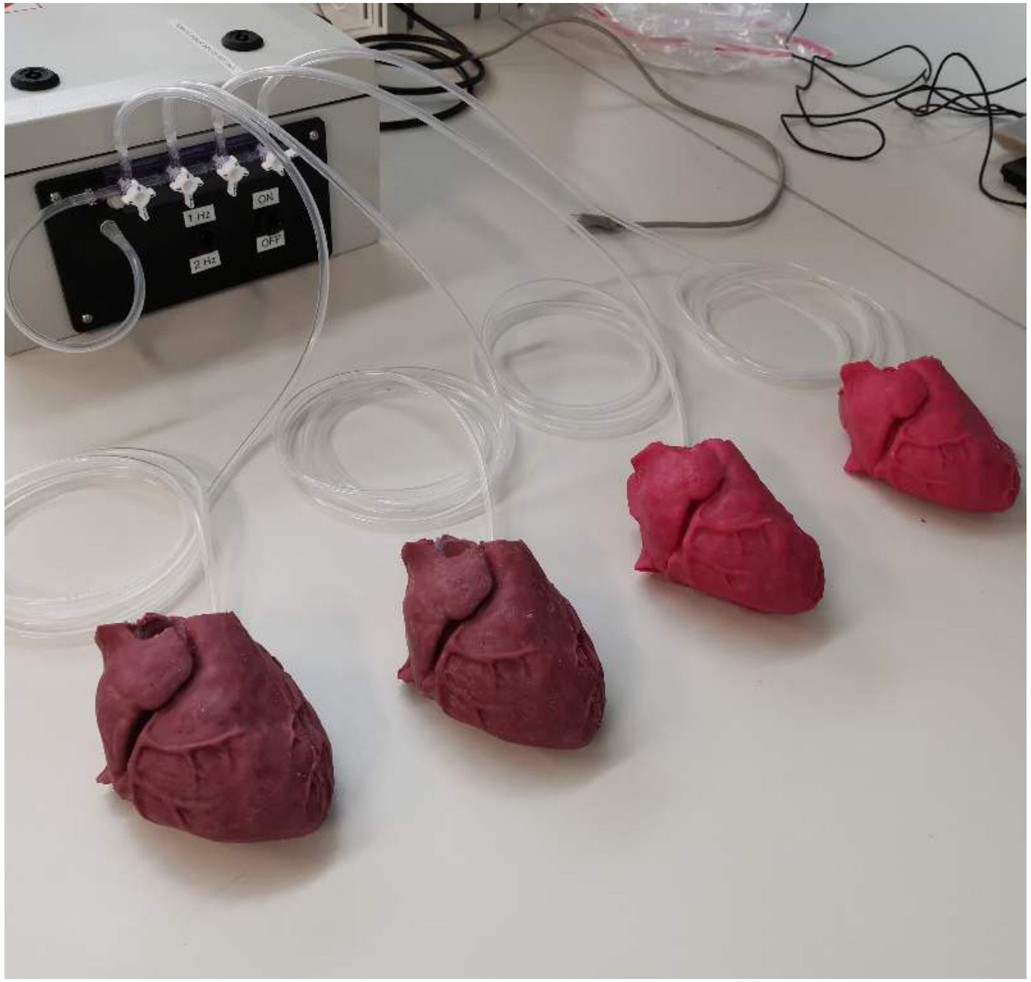
BEATING HEART SIMULATOR



3D LifePrints created an anatomically accurate beating heart that can be cut and sutured, while beating, in order to allow surgeons to train in the field.

A mechanism was designed to create the artifical 'heart beat' capable of varying speeds to mimic different physiological situations.

THIS SOLUTION CONSISTS OF:

- Anatomically accurate adult sized heart (based on patient scans) with realistic tissue mimicking properties
- The heart model has pledgeted suturing and cutting capabilities while beating to allow the surgeons to interact with the models for training purposes
- Solution can provide variable heart beating speeds to mimic a number of clinical scenarios for up to 4 hearts at the same time
- Suitable for use in challenging environmental conditions, simple to assemble and transport

KIDNEY SURGICAL SKILLS SIMULATOR

Medical professionals in hostile environments still require cutting-edge surgical training. This kidney model can be used to show life-saving surgical techniques around the world.

THIS SOLUTION CONSISTS OF:

- Highly anatomically accurate and made of materials which mimicked the behaviour of human tissue when subject to cutting and suturing, allowing the trainee to practice a partial nephrectomy
- Tough outer renal capsule differentiated in colour and feel from the kidney parenchyma
- Hollow collecting system with suturable shell, compromised of the minor and major calyces, renal pelvis and ureter
- Renal vein and artery were enter and exit from the renal hilum

PAEDIATRIC BRONCHOSCOPY TRAINER

This custom simulator allows for the instruction and practice of conducting a flexible bronchoscopy on a paediatric patient.

With this device, hospitals are able to repeatedly provide training for clinicians in the practical inspection of paediatric airways and improved navigational technique through the patient's smaller and more delicate structures.

THIS SOLUTION CONSISTS OF:

- A reusable anatomically accurate model with tissue mimicking properties
- A transparent housing unit to allow beginners to have full visual oversight to aid initial procedural learning
- An optional cover for more advanced practitioners to train using only the bronchoscope

PAEDIATRIC CHEST DRAIN SIMULATOR

The insertion of a chest drainage tube into infants may be required for multiple reasons such as following lung surgery or due to a build up of fluid in the pleural space caused by a lung infection.

Correct placement of the tubes is extremely important, as if performed incorrectly there could be serious ramifications, such as laceration of an intercostal vessel, organ perforation or nerve phrenic damage. This tissue mimicking simulator includes all the external anatomical landmarks necessary for insertion of a chest drain.

THIS SOLUTION CONSISTS OF:

- A replaceable and self-healing skin and fat pad
- A 3D printed rigid rib cage, used to locate the third and fourth intercostal space
- A replaceable lung, which can be filled either with air or liquid to simulate different clinical situations

PAEDIATRIC JUGULAR ACCESS SIMULATOR

Securing stable vascular access is an important skill required by clinicians. Sick children, complex surgeries, chronic illnesses, multiple hospitalisations and prolonged treatments can make vascular access challenging.

Obtaining vascular access in children may require multiple attempts and can be stressful for the child and family as well as the care provider.

The simulator is designed to lie flat on a table. Solution contains model of a 5-10kg baby, extending from ear to chest area.

THIS SOLUTION CONSISTS OF:

- One X baby main body (realistic external baby anatomy made in silicone)
- Replaceable inner section containing: External jugular: ID 2mm, OD 3mm (silicone) with circulating fluid Carotid: ID 4mm, OD 6mm (silicone) Internal jugular: ID 6mm, OD 8mm (silicone) with circulating fluid Sternocleidomastoid muscle (in flexible material) Clavicle and sternum (in hard material and encased in silicone)
- Suitable for ECMO training (Replaceable internal section being fully operable and replaceable)
- Four X replaceable skin pads in silicone. Replaced each time after ECMO training will last 3-5 times with normal use for cannulation

PAEDIATRIC NASAL CAVITY SIMULATOR

This simulator was developed to test the usability of nasal vaccine sprays in infants ranging from 3–24 months. The nasal cavity was generated from a patient CT scan and was printed in a tissue-mimicking polymer to create a high fidelity, anatomically accurate procedural simulator.

THIS SOLUTION CONSISTS OF:

- A rigid face holder
- A removable flexible nasal cavity, with accurate internal anatomy

CRICOTHYROIDOTOMY TRAINER

This cricothyroidotomy trainer is used to train clinicians in performing an emergency thyroidotomy procedure to allow air into a persons lungs if their airway is obstructed.

The device allows the trainee to palpate the thyroid cartilage and cut through a synthetic silicone skin pad into the airway; an additional blood pack can be used to improve the realism of the trainer.

An endotracheal tube can then be introduced, and verification of its placement can be seen where the tube exits a hole at the bottom of the neck.

THIS SOLUTION CONSISTS OF:

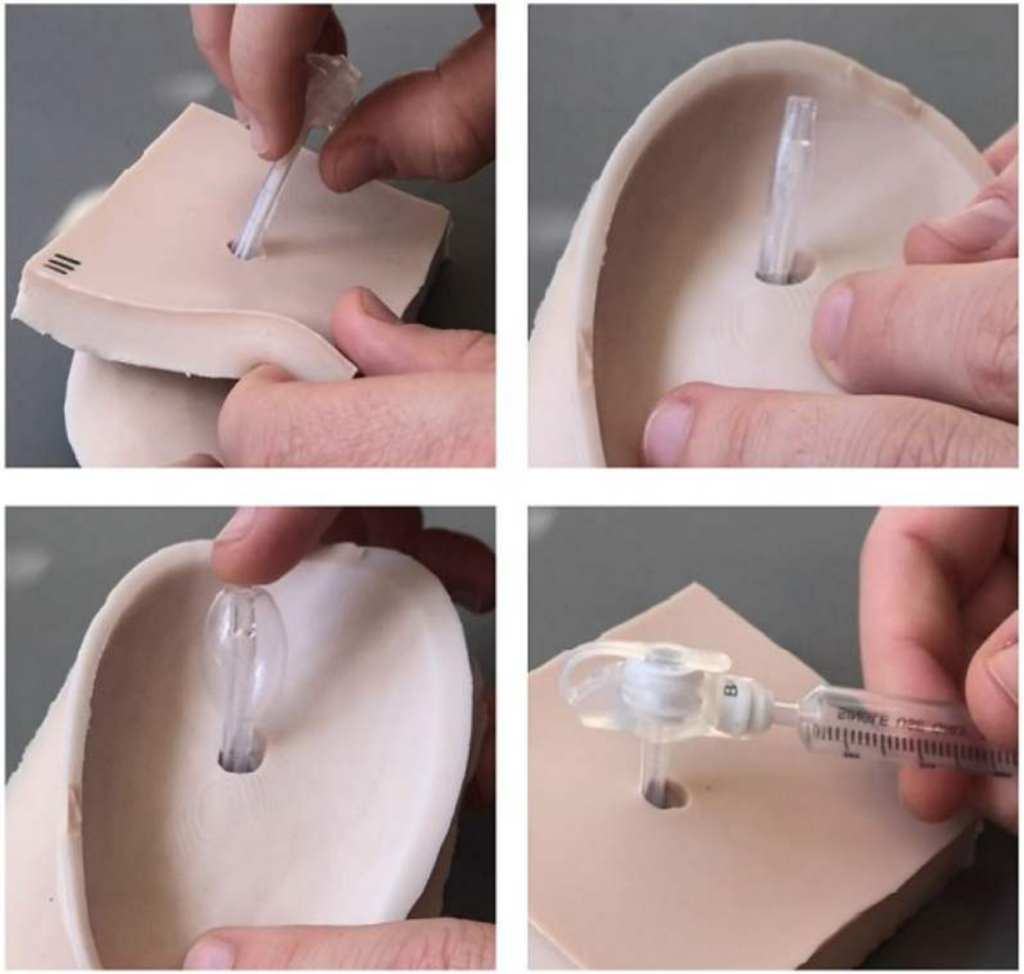
- A shell to mimic a persons neck region
- A synthetic silicone skin pad
- A replaceable blood pack

PARENTAL STOMACH / PEG TRAINER

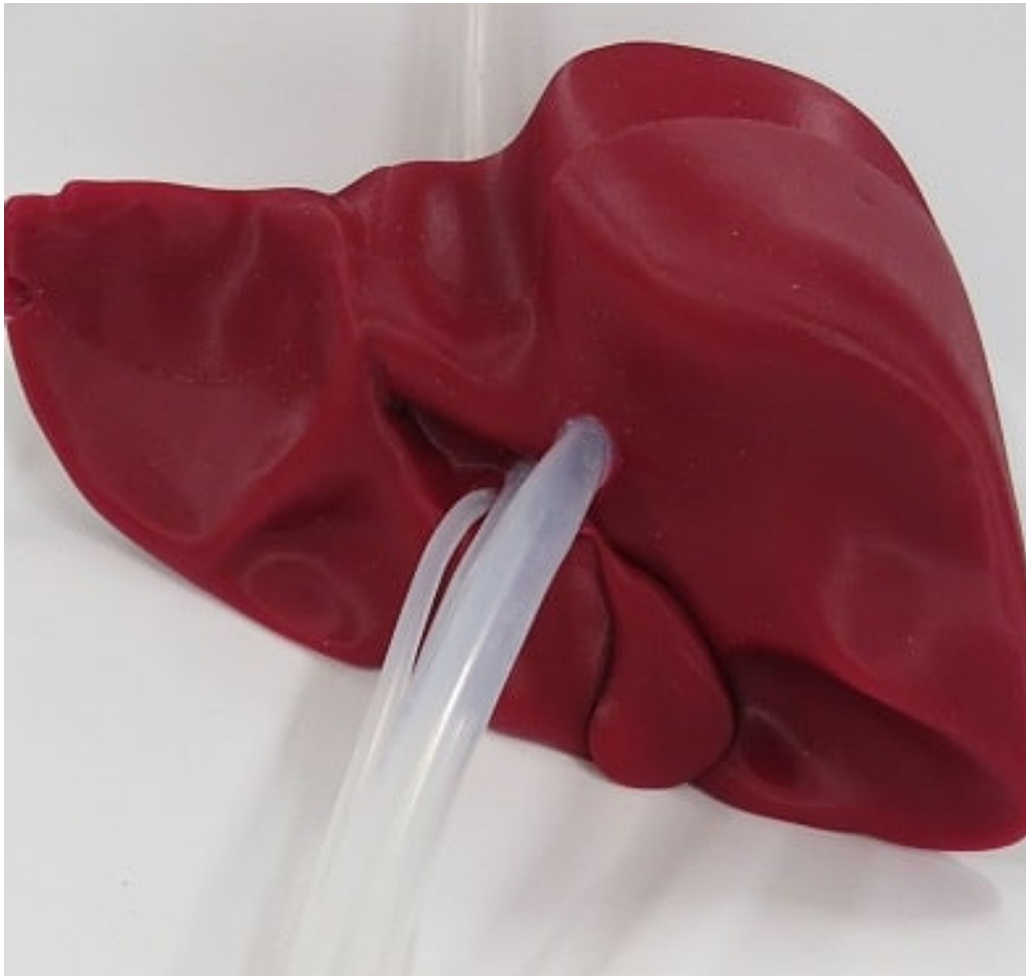
Insertion of feeding tubes into their children is for many parents a daunting task. Often their children stay in hospital for extended periods until the parents can show sufficient proficiency and confidence that they can change the tubes in an emergency at home. This PEG trainer is an aid for parents to teach them how to change their children’s PEG tubes safely and efficiently.

THIS SOLUTION CONSISTS OF:

- A reusable flat bi-layered silicone skin and fat-mimicking pad
- A curved section underneath that mimics a bi-layered stomach



LIVER SIMULATOR



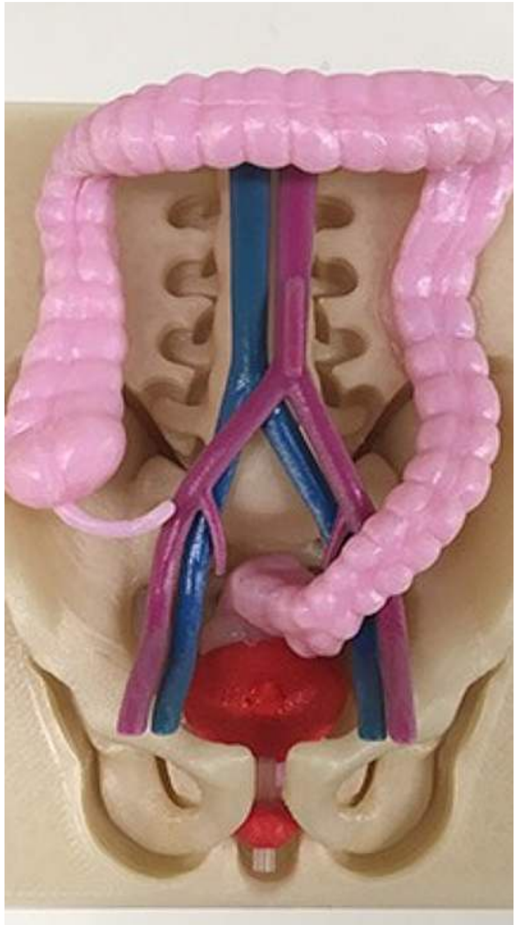
When moving livers from a donor to the intended patient, current conventional methods are to store the liver at 4°C in order to minimise liver degradation for up to 24 hours. During this period, liver functions can be degraded and some livers are unfortunately discarded before transplantation.

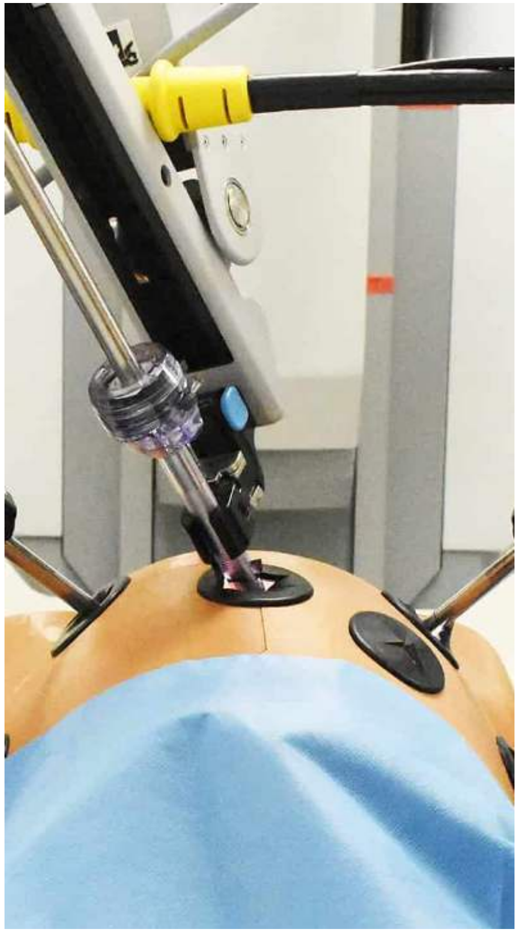
This high fidelity silicone liver simulator contains functional fluid dynamic properties to simulate connection of the organ to a perfusion machine. It can also be hooked up to a peristaltic pump to simulate pulse and demonstrate the effectiveness of a mobile organ transplant machine.

THIS SOLUTION CONSISTS OF:

- Patient realistic / accurate size silicone liver
- Internal anatomical details
- Plastic pipes

ABDOMINAL LAPROSCOPIC / OPEN SURGERY SIMULATOR



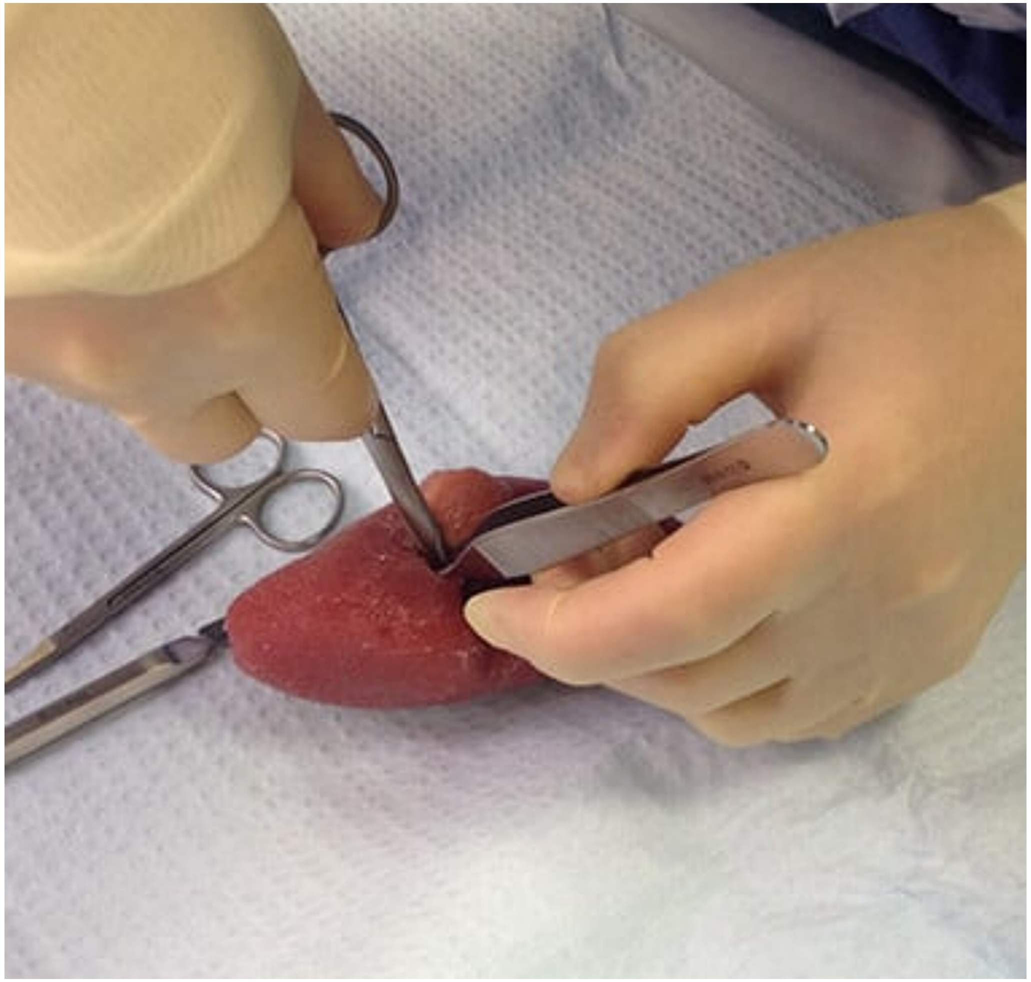


This 3D-printed functional abdomen simulator can be used to run pre-clinical device tests in a realistic anatomical environment in a dry lab scenario. Surgeons are able to use this simulator with a robotic-assisted laparoscopic surgical system like the DaVinci system for a variety of purposes for such as scanning lymph nodes.

THIS SOLUTION CONSISTS OF:

- A choice of two abdominal covers – a regular cover for open surgery and an insufflate cover for use with laparoscopic surgical systems
- Tissue-mimicking anatomical features including:
- Arterial & venous blood supply
- Pelvis, colon, sigmoid colon, bladder, prostate
- Ureters and urethra
- Lymph node packages & obturator

KIDNEY SURGICAL SKILLS SIMULATOR



This high-fidelity kidney simulator can be used for a variety of training purposes. It provides a clinician with the ability to practice surgical skills such as cutting, suturing, vessel clamping and grafting. Realistic tumour can be embedded in the model to allow the user to simulate a partial nephrectomy.

THIS SOLUTION CONSISTS OF:

- A human realistic in size/shape kidney
- Tumours based on MRI scans
- Vasculature
- Ureters
- Internal calyx system

A video of the simulator can be found here:

KIDNEY SURGICAL SKILLS SIMULATOR VIDEO

CRANIOTOMY SURGICAL SKILLS SIMULATOR

This surgical simulation solution can be used to provide a clinician with a system to practice their surgical skills for procedures such as a lobe resection, lesionectomy, craniotomy or ventriculostomy. All layers of the model can be customised to the users needs.

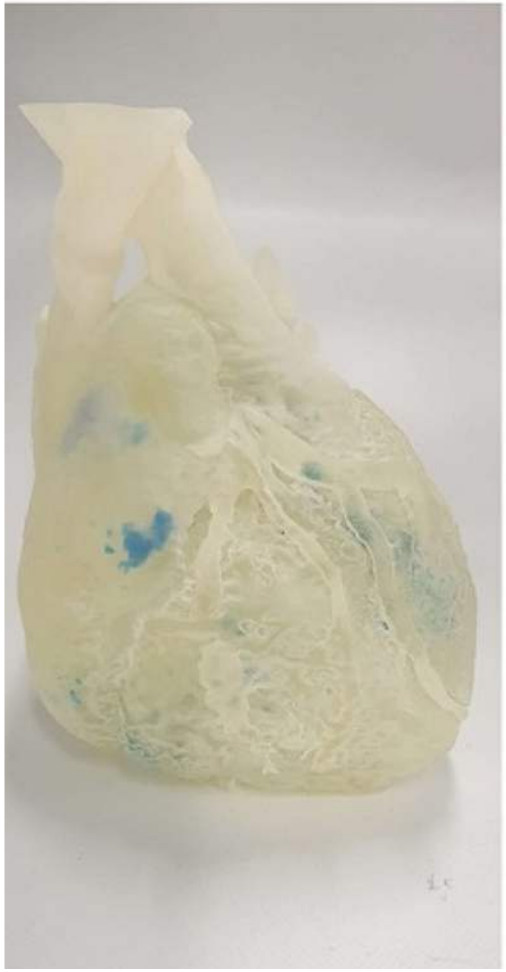
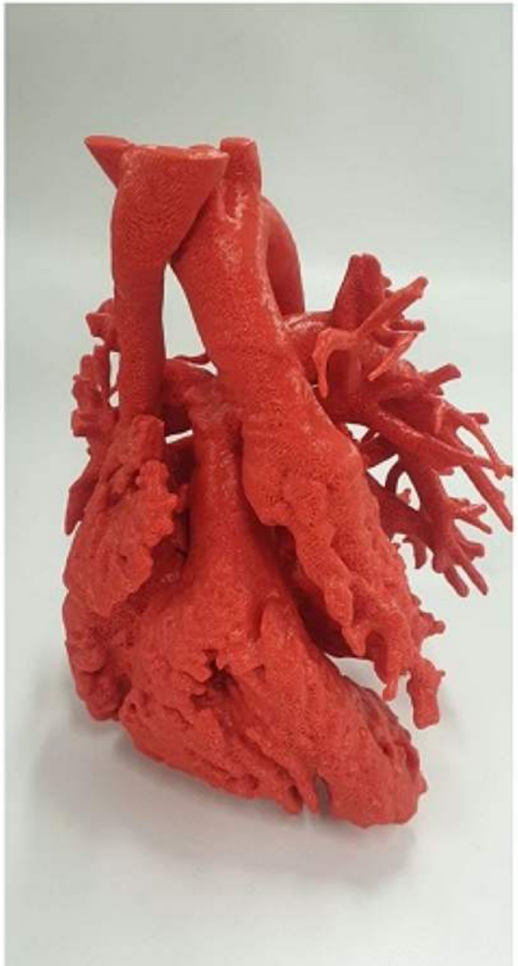
THIS SOLUTION CONSISTS OF:

- A full adult skull
- A realistic skin covering for skull
- Soft dura layers
- A silicone brain which contains fluid-filled ventricles

Videos of the simulator can be found here:

CRANIOTOMY SIMULATOR VIDEO 1
CRANIOTOMY SIMULATOR VIDEO 2

HEART / SENNING PROCEDURE SIMULATOR

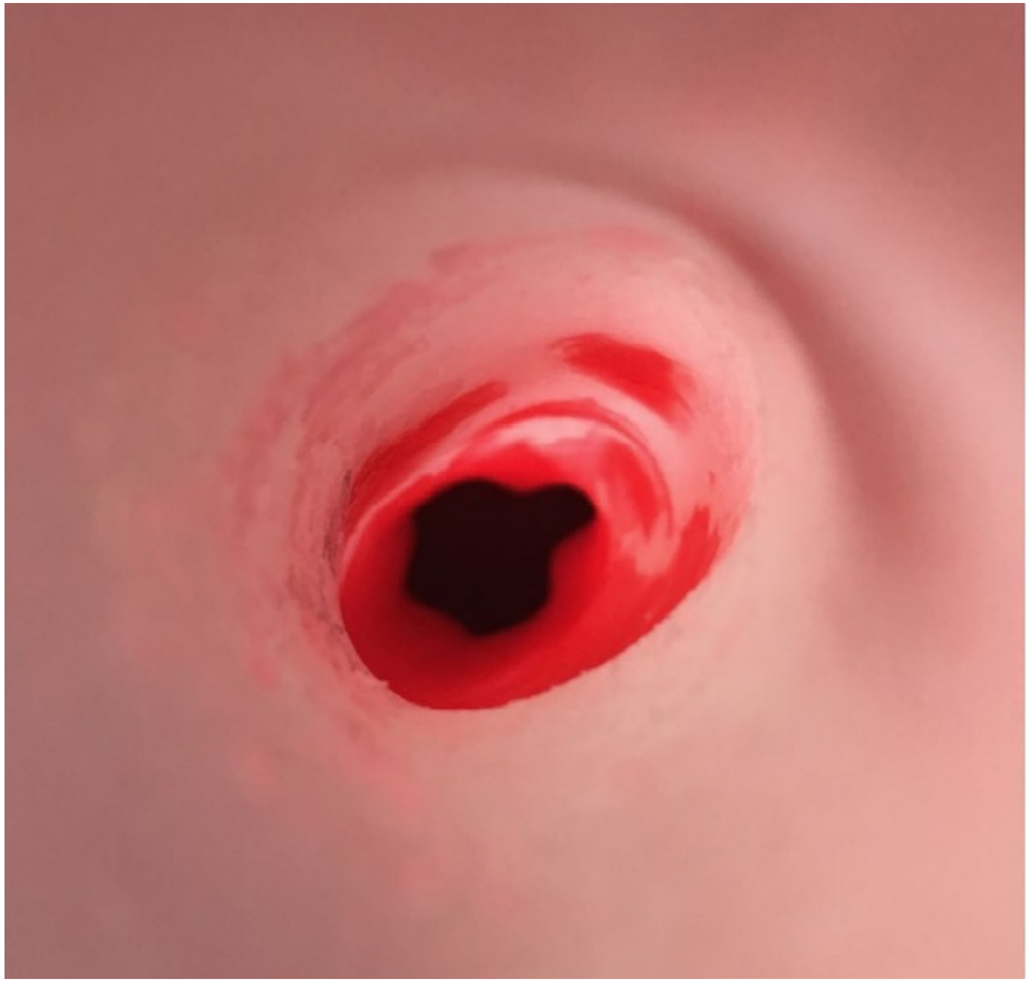
This realistic simulator can be used to both simulate and demonstrate the complex Senning procedure as part of a double switch operation for congenitally corrected transposition of the great arteries (TGA) to surgical trainees and other clinicians.

The first model (left) represents a hollow heart and therefore captures both the external and internal patient specific morphology of the heart (as a result of the subtraction of the blood volume).

THIS SOLUTION CONSISTS OF:

- A patient-specific heart manufactured in a soft translucent tissue-mimicking material (left)
- A patient-specific heart model that represents the blood volume and therefore offers unparalleled visualisation of how the internal chambers and main vessels are affected by TGA

BARRETT'S OESOPHAGUS SIMULATOR

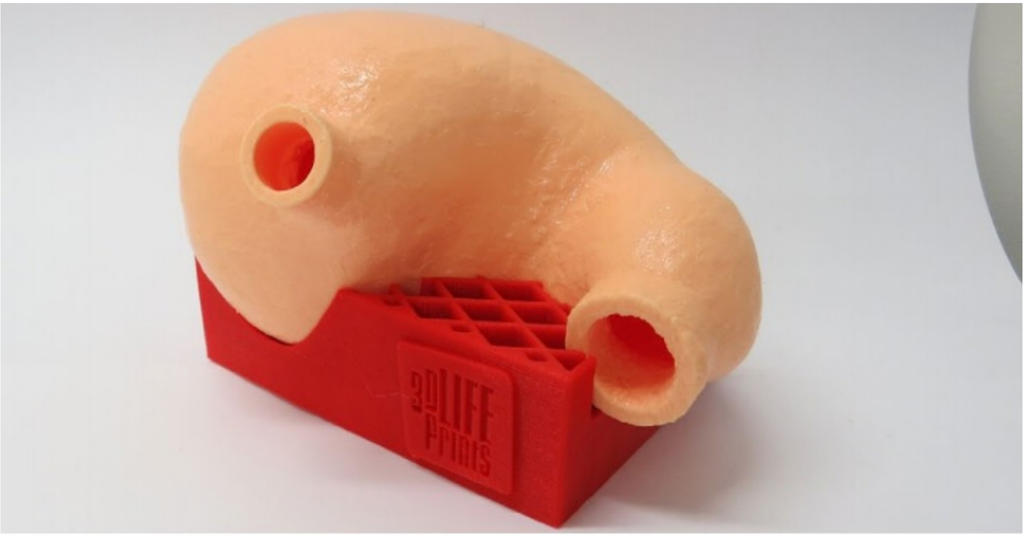


Barrett’s oesophagus is associated with an increased risk of developing esophageal cancer and an endoscope is generally used to determine if you have the condition. Few trainers exist to train clinicians to effectively This soft silicone esophagus model was created as an endoscopy trainer.

THIS SOLUTION CONSISTS OF:

- 10-12 cm long oesophagus with gastric fold at the bottom
- The areas of tissue containing the Barrett’s esophagus abnormality have a visual colour difference along with a coarser surface appearance
- The model can be extended to include a partial stomach

MEDICAL PEG TRAINER



These PEG training models are used to familiarise students with the technique of inserting a PEG tube and understanding methods of PEG feeding.

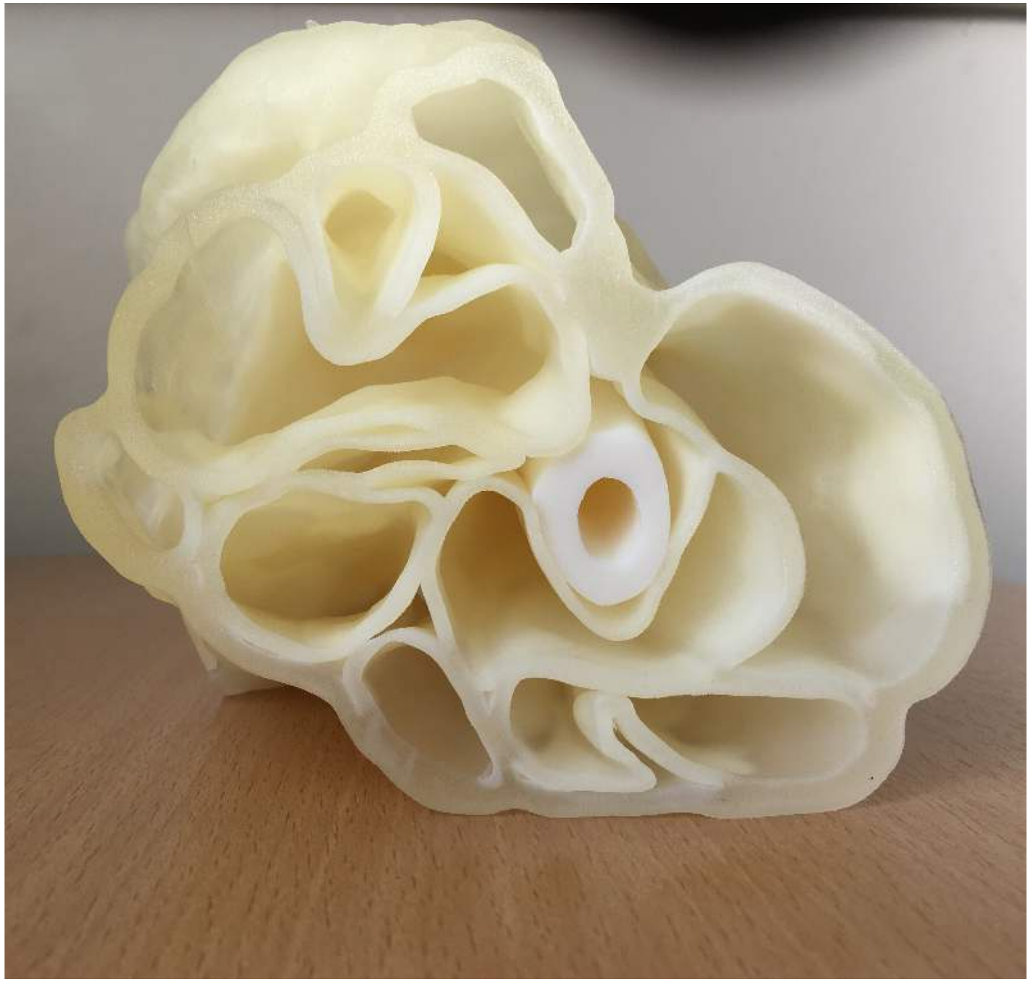
THIS SOLUTION CONSISTS OF:

- A set of three skin, fat muscle and stomach pads with a premade channel for users to insert the PEG tube through. The first difficulty level is a straight hole through the tissue to insert the tube. The second difficulty is a misaligned hole through the tissue to insert the tube. The third and final difficulty level is an oblique channel through the tissue for the user to navigate the tube through
- A fully inflated silicone stomach for anatomy teaching and discussion. This model can also be used for endoscopic foreign body retrieval procedures

Videos of the simulator can be found here:

PEG TRAINER VIDEO 1
PEG TRAINER VIDEO 2

FASCIA TRAINING



The fascia lata is the deep fascia of the thigh. It encloses the thigh muscles and forms the outer limit of the fascial compartments of thigh, which are internally separated by intermuscular septa.

THIS SOLUTION CONSISTS OF:

- 3D pinted left thigh section
- Fascia in soft material
- Leg bone in harder material
- Based on MRI

Video of the trainer can be found here:

FASCIA TRAINER VIDEO

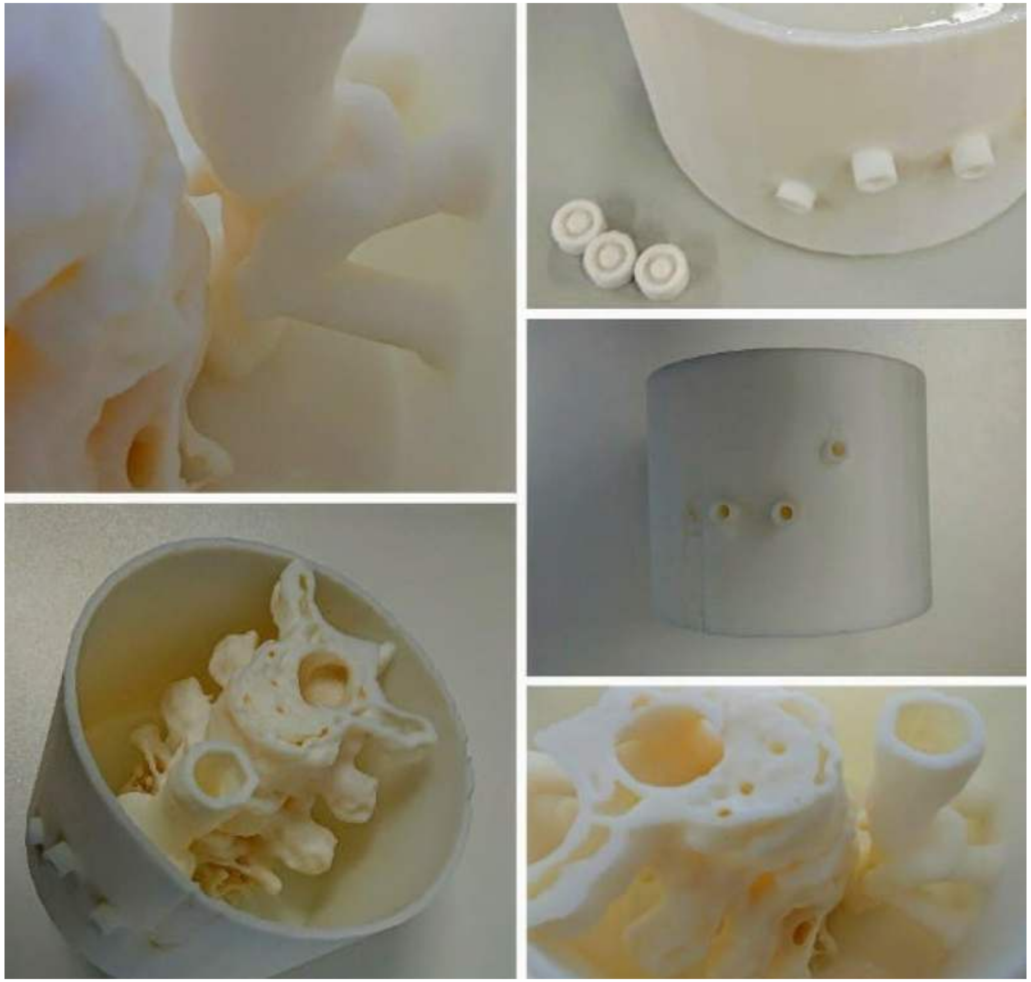
THYROID RESEARCH PHANTOM

SUMMARY

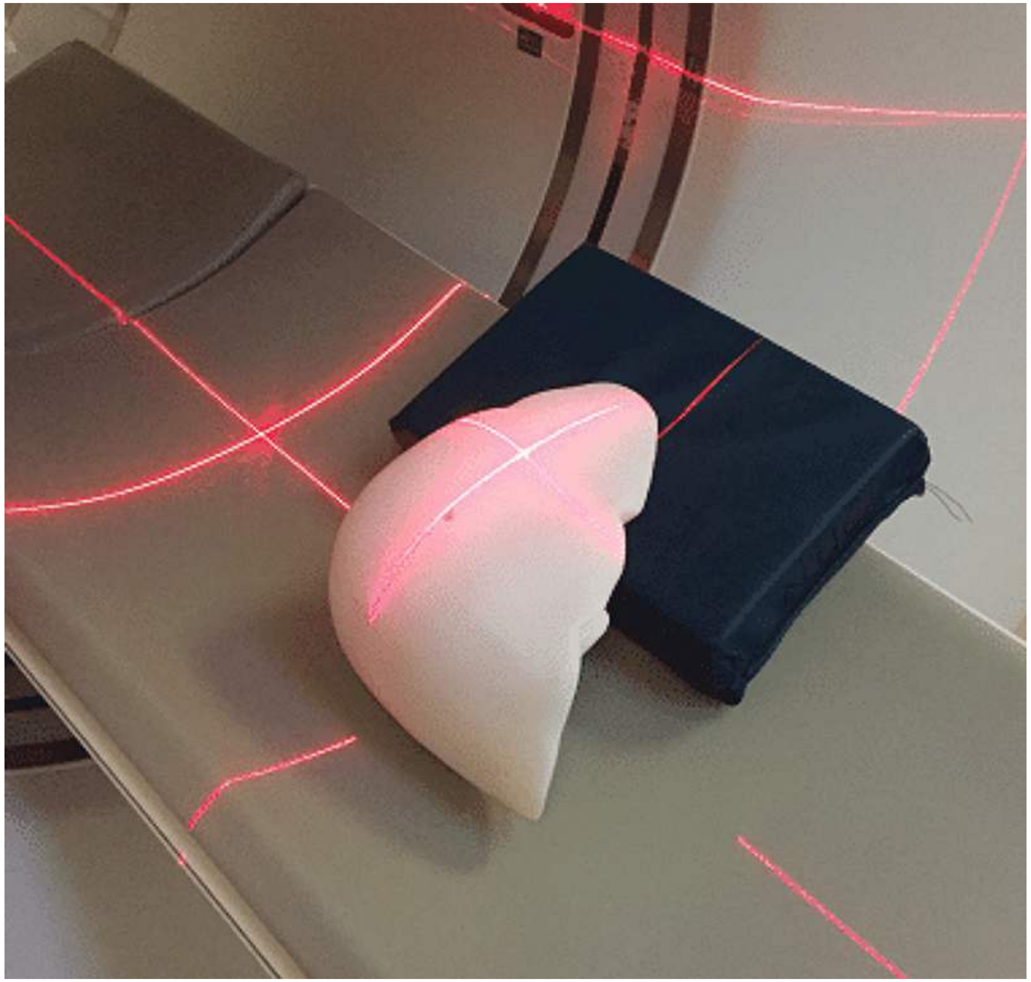
This simulator was created for the development of a radiotherapy protocol to accurately model radiation exposure to the tissues surrounding the thyroid gland (trachea, oesophagus, neurovascular structures and spinal cord) and improve the accuracy of radiation therapy in terms of the correct dosage limits.

THIS SOLUTION CONSISTS OF:

- A cylinder to mimic the shape of the neck
- Channels to connect the thyroid and outer shell and allow the cavity to be filled with radioisotope
- A shell filled with a bio-mimetic medium that approximated the radiopacity of the neck tissue.



LIVER RESEARCH PHANTOM



SUMMARY

The identification of the boundaries separating the liver and the tumour is particularly important, in this case, for identifying a more accurate and case-specific radiation dosage than with traditional 2D visualization of CT or MRI scans. A 3D model helps the clinician understand the irregularities of a tumour before a treatment pathway is decided, reducing the risk of radiation exposure to surrounding tissues, as well as reduced damage to kidneys. Having the 3D model also means that clinicians have a better sense of the shape and size of the tumour, giving them more confidence in treatment planning.

The 3D model contained three chambers suitable for holding radioisotope samples, with the chambers varying in size (4mm, 11m, and 40mm diameters) to mimic different-sized tumours. The 3D-printed phantom was then scanned (Phillips PET/CT) in the correct anatomical orientation and used as part of a surgical plan. By using the measured dosage and known cavity volume for the patient, the surrounding exposure on the liver could be estimated.

SPINE PHANTOM

SUMMARY

This scoliotic spinal imaging phantom is used to help define a novel and optimised CT scan protocol for paediatric patients with scoliosis in order to allow clinicians to maximise image quality whilst minimising radiation exposure for patients in future diagnostic and treatment pathways.

The scoliotic spine 3D printed in a material with comparable Hounsfield Unit (HU) ranges for adult bone. Similarly, for the brain, it was printed in two materials, both of which the spinal component was housed – was printed in PLA. This helped provide realistic anatomical dimensions for recreating realistic attenuation properties. Finally, a specialised gelatin was poured into the hollow torso and set around the spinal component. The specialised mix mimicked soft tissue and therefore scanned at appropriate HU ranges.

The scoliotic phantom was initially CT scanned with just bony and soft tissue components, housed within the torso. It was then subsequently scanned with the addition of metalwork (spinal screws) inserted into the vertebrae.

The imaging phantom realistically modelled curvature of the scoliotic spine, appropriate anatomical dimensions and correct HU value ranges for skeletal and soft tissue components. In addition to this, the imaging phantom provided options for scanning with and without metalwork.

Ultimately, the combination of these factors has given the Orthopaedic department at Alder Hey Children's Hospital a clinical imaging research tool that can be scanned indefinitely until a fully optimised scan protocol for paediatric, scoliotic patients is defined. Once achieved, it is envisaged that patients' radiation exposure can be minimised while maximum quality images are obtained. The new protocol can also be shared globally to ensure scoliotic patients worldwide receive the same treatment.

SKULL AND BRAIN PHANTOM

SUMMARY

This phantom contains full craniofacial skeletal structures, a brain with grey and white matter differentiation, dentition with amalgam fillings, and a removable, titanium orbital floor implant.

The phantom was requested for research into craniofacial CT imaging protocols involving metal artifact and validating electron density measures from dual energy CT.

The skeletal craniofacial structures were 3D printed in bone like material, which scanned at the correct Hounsfield Unit (HU) ranges for adult bone.

The brain was printed in a material mimicking grey and white matter, both of which represented grey and white matter respectively, scanning at the correct HU values.

A remobavle phantom-specific, titanium orbital floor implant was also 3D printed, as wasdentition containing amalgam.

The imaging phantom realistically modeled adult bony craniofacial and brain anatomy, both of which scanned with appropriate HU ranges. By combining these structures with metallica based objects (implants and fillings) that would be encountered in real patients, researchers at the University of Nebraska Medical School will have access to a research tool that can be scanned indefinitely, to explore a range of scan protocols and parameters, which could in turn influence clinical practice.

Additionally, by using know data for the phantom material constituents, dual energy CT-based electron density measurements can be validated.

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