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CLINICAL MODEL

THYROID PHANTOM

PURPOSE: SIMULATION

MODEL SOURCE
MRI and CAD.

TECHNOLOGY USED
Polyjet printing.

DESCRIPTION
The thyroid is a small gland found in the neck, responsible for producing hormones. It is surrounded by vital and sensitive structures that can be affected during thyroid radiotherapy. To better understand this interaction, a 3D printed phantom was developed and printed using Polyjet technology. The phantom contains structures for the cervical vertebrae, trachea and thyroid gland - obtained from an MRI scan. The thyroid gland has been designed as cavities to mimic the location and volume of liquid isotope during therapy. An anatomically correct phantom gives a better understanding of the radiation exposed to the surrounding tissues.

OUTCOME / BENEFITS
Benefits include:
- An anatomically correct radiological phantom provides a more accurate environment to assess the radiation exposure to surrounding tissues.
- Structures such as the trachea can be modelled into the phantom to create an air space, whilst dense areas like vertebrae can be designed to mimic the dense composition of bone.
- Material choices of the phantom can be chosen in accordance to the radio-opacity of the soft and hard tissues in the neck.
To aid in an accurate dosage measurement, an anatomically correct (ICRP) liver phantom was 3D printed with 3 chambers for holding radioisotope. The three chambers varied in size (4mm, 11mm and 40mm diameters) to mimic different sized tumours. The phantom was then scanned (Phillips PET/CT) in the correct anatomical orientation. By using the measured dosage and known cavity volume, the surrounding exposure could be estimated.

**Outcome / Benefits**
Using specialist medical segmentation software, we can provide patient specific 3D print's that identify the boundaries separating the liver and tumour – providing a more accurate and case specific dosage of radiation. A 3D model helps the clinician understand the irregularities of a tumour before a treatment pathway is decided. Benefits include:

- Reduced risk of radiation exposure to surrounding tissues.
- Reduced damage to kidneys.
- Better understanding of the shape and size of the the tumour(s).
CLINICAL MODEL

ROBOTIC ASSISTED LAPROSCOPIC SURGERY SIMULATOR

PURPOSE : SIMULATION

MODEL SOURCE
CAD Modelled.

TECHNOLOGY USED
Multi material FDM printing and silicone casting.

DESCRIPTION
3D printed functional abdomen simulation model for Da Vinci system - insufflated & regular abdomen covers, arterial & venous blood supply, pelvis, colon, sigmoid colon, silicone bladder & prostate, ureters/urethra, lymph nodes & obturator nerves.

OUTCOME / BENEFITS
The use of this 3D printed simulator gave an unparalleled opportunity to run the pre-clinical device tests in a realistic anatomical environment in a dry lab scenario. Surgeons were able to trial LightPoint’s new lymph node scanning system with the DaVinci robotic-assisted laparoscopic surgical systems.
The surgery is virtually planned: the tumour resection is performed and the reconstruction is made with the patient’s own fibula. The cutting guides for the fibula, mandible and the osteosynthesis plates are virtually designed. The holes in the guides correspond to the screws in the titanium plates, which help the surgeon reposition the parts in the exact position.

The use of 3D virtual planning and 3D printing of cutting guides and implants for this procedure has been shown to provide many benefits such as:

- Less time needed for the reconstruction process (no plate bending)
- Less ischemia time as the reconstruction can be performed while the fibula is still supplied by blood
- Improves patient outcomes and lowers rehabilitation times
- Optimal positioning of dental implants
CLINICAL MODEL

LIVER CANCER MODEL

PURPOSE: PRESURGICAL PLANNING

MODEL SOURCE
CT scan.

TECHNOLOGY USED
Multi colour polyjet printing.

DESCRIPTION
In this composite pre-surgical assessment 3D printed model, the patient’s liver, hepatic artery, portal vein, IVC and tumour thrombus were segmented from CT. Each structure was assigned a bold colour to aid visualisation and discussion. This is the first in a series of 3D printed models for a university’s surgical skills unit.

OUTCOME / BENEFITS
CLINICAL MODEL

KIDNEYS FOR PARTIAL NEPHRECTOMY TRAINING

PURPOSE: TRAINING

MODEL SOURCE
MR scan.

TECHNOLOGY USED
Multi colour polyjet printing.

DESCRIPTION
A kidney with a tumor was dual-colour printed in soft silicone with varying densities across sections of the model for surgical training use. The models are created in collaboration with Lazarus 3D, using their advanced silicone 3D printer.

OUTCOME / BENEFITS
A simulated partial nephrectomy was carried out on the model, showing potential to simulate surgeries and thereby improve surgical skills. Feedback from the surgeon was positive in that the 3D model provided an accurate representation with high fidelity for simulating the removal of the tumour.
CLINICAL MODEL
OVARIAN CYST REMOVAL SIMULATOR

PURPOSE: SIMULATION

MODEL SOURCE
MR scan

TECHNOLOGY USED
Multi colour polyjet printing.

DESCRIPTION
This model is made in silicone to replicate the look and feel of human tissue. It is intended for use in a laparoscopic simulator. The model has a large cyst contained within one of the ovaries.

OUTCOME / BENEFITS
“At the end of the day, the more you practise the better a surgeon you become. Being able to use 3D printed models that mimic tissues from bone to vessels provides us with an incredible opportunity to create high fidelity simulation models”.

Partial nephrectomy was carried out on the model, showing potential to simulate surgeries and thereby improve surgical skills. Feedback from the surgeon was positive in that the 3D model provided an accurate representation with high fidelity for simulating the removal of the tumour.