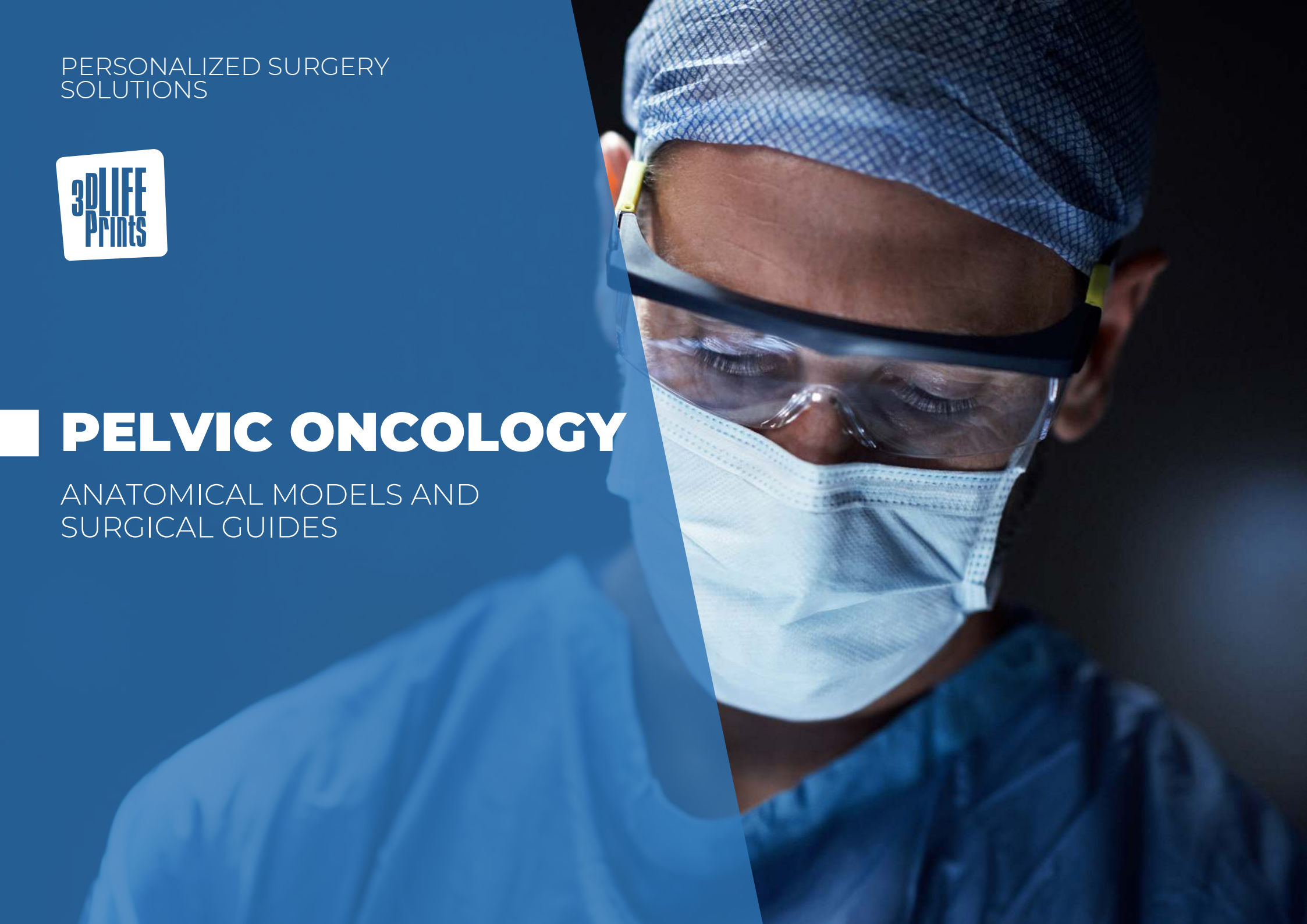
PERSONALIZED SURGERY
SOLUTIONS

3DLIFE Prints

PELVIC ONCOLOGY

ANATOMICAL MODELS AND SURGICAL GUIDES



POINT OF CARE 3D SERVICES

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: **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**.**

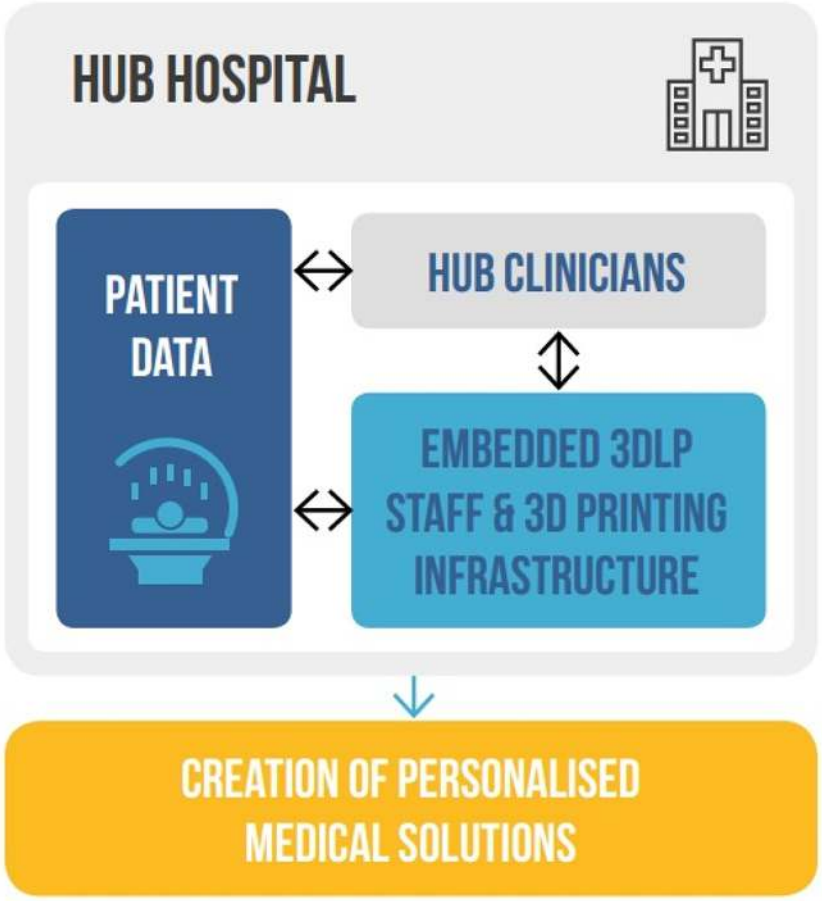
We currently have a number of embedded Point of Care Hubs in the UK, including at Wrightington Hospital, Alder Hey Children's Hospital, Oxford University Hospital, and Leeds General Infirmary. Our Hubs provide a full spectrum of personalised medical services to the clinical teams as well as a range of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

We are certified under ISO 13485. Our embedded team takes care of the strict Regulatory and Quality requirements applying to the creation of medical devices.



Case Summary

An 8-year-old patient presented with a Ewings Sarcoma in the right PI region of the pelvis.

The tumour encompassed almost the whole Illium but was fully contained. A PI/PII type resection without reconstruction was determined following chemotherapy and radiotherapy.

Description

3D LifePrints were asked to design and manufacture three patient specific 3D printed guides that attached to the patient's pelvis and navigated the osteotomies to a margin of 4mm. A 1:1 scale model of the pelvis and tumour with guides attached (Non-Sterile) was included.

Three cuts were required to remove the ilium without disturbing the sarcoma found in and around the bone. The first pre-planned cut was made through an anterior incision, separating the ilium from the pubis. The second, from a posterior approach, separated the ischium from the ilium. The third, and most challenging cut, resected the sacrum from the ilium. Care had to be taken during the sacral cut to avoid the delicate neurovascular structures found at this location. The surgeon could be confident knowing the pre-planned cutting planes avoided these sensitive structures.

Blade – 1mm (20mm) (Misonix Bonescalpel)

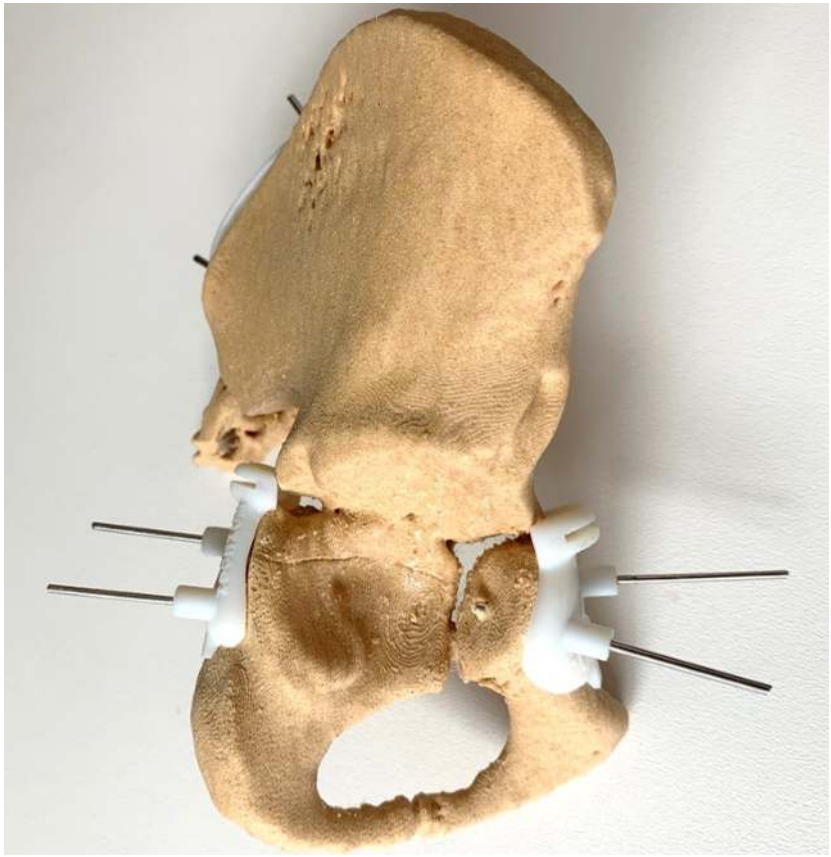
Fixation – 1.6mm K Wire

3D LIFEPRINTS

CASE STUDY

ONCOLOGICAL PRE-SURGICAL PLANNING, VIRTUAL SIMULATION, SURGICAL GUIDES

SPECIALITY: ORTHOPAEDIC ONCOLOGY
PROCEDURE: PI & PII HEMIPELVECTOMY
DEVICE: 3D PRINTED PATIENT SPECIFIC ANATOMICAL MODEL AND SURGICAL GUIDES (POLYAMIDE)



OUTCOME / BENEFITS

Identifying the triradiate cartilage during surgery can prove difficult and time consuming. 3D LifePrints were able to use the CT and MRI scans provided to create patient specific guides that translated the careful pre-operative planning into bespoke assistive devices.

Each guide fitted securely, though the sacral guide initially was compromised by soft tissue. The final resection was exactly as planned with clear margins. It was noted that the model itself was of immense value in mapping the tumour throughout the procedure, negating the need to constantly refer to scans.

Case Summary

This patient presented with a chondrosarcoma and a last minute request was made to 3D Lifeprints to provide sterilisable surgical cutting guides to aid in a PII/PIII resection of the right hemipelvis. The scans were segmented, surgery planned, and model and guide approved, manufactured and sterilised inside 72 hours of receipt of the scans and instruction.

Description

Upon receiving the patient's PET CT scan, 3D LifePrints segmented the imagery to build the virtual model of the pelvis and tumour. The tumour boundary was grown by a 10mm margin, as instructed. The optimal cutting planes were then agreed upon by the surgeon and the biomedical engineer.

The first guide provided allowed for an accurate tri-planar cut through the acetabulum from the lateral aspect. The accuracy of the cuts allowed the surgeon to keep enough bone stock for an effective reconstruction. A second guide for the Pubic Symphysis was created but only used as a reference template for the osteotomy. The guides and models were designed and printed in 3D LifePrints' controlled environment facilities located within its Nuffield Orthopaedic Centre hub. Optimally, we would ask for 10-14 days to complete this service, having the facility onsite allows us to meet very tight turnarounds in emergency situations.

Blade - 0.89mm

Fixation - 1.6mm K Wire

3D LIFEPRINTS
CASE STUDY

ONCOLOGICAL PRE-SURGICAL PLANNING, VIRTUAL SIMULATION, SURGICAL GUIDE

HOSPITAL NUFFIELD ORTHOPAEDIC CENTRE
PROCEDURE PII/PIII HEMIPELVECTOMY
DEVICE 3D PRINTED PATIENT SPECIFIC ANATOMICAL MODEL AND SURGICAL GUIDE (POLYAMIDE)

OUTCOME / BENEFITS

Use of the model in pre-surgical planning, and the surgical guide in theatre, meant the surgical approach could be limited to posterior extensile Kocker Langenbeck approach. Significant operative time was saved and bone stock was preserved, excluding use of augments to support the Lumic Cup (Implantcast).

Clear margins were confirmed in post operative tests, confirming complete removal of the tumour tissue.

Case Summary

This pediatric patient required a partial pelvic resection, including the distal part of the iliac bone and superior part of the periacetabular bone, to remove metastatic thyroid carcinoma.

Description

3D LifePrints first created a virtual model of the patient's pelvis, including the tumour. The model was then printed in bone-like material.

Three surgical cutting guides were then designed following the completion of virtual surgery by the surgeon, in which the optimum cutting planes were determined.

The first guide provided the cutting plane to resect the inferior ilium, with the aim to retain continuity between the Ischium and Ilium and the greater sciatic notch. The second guide provided trans-acetabular cutting planes to connect the ilium resection to pubic resection. The third provided resection through the superior pubic ramus.

The surgical guides were printed in sterilisable material and delivered for surgery.

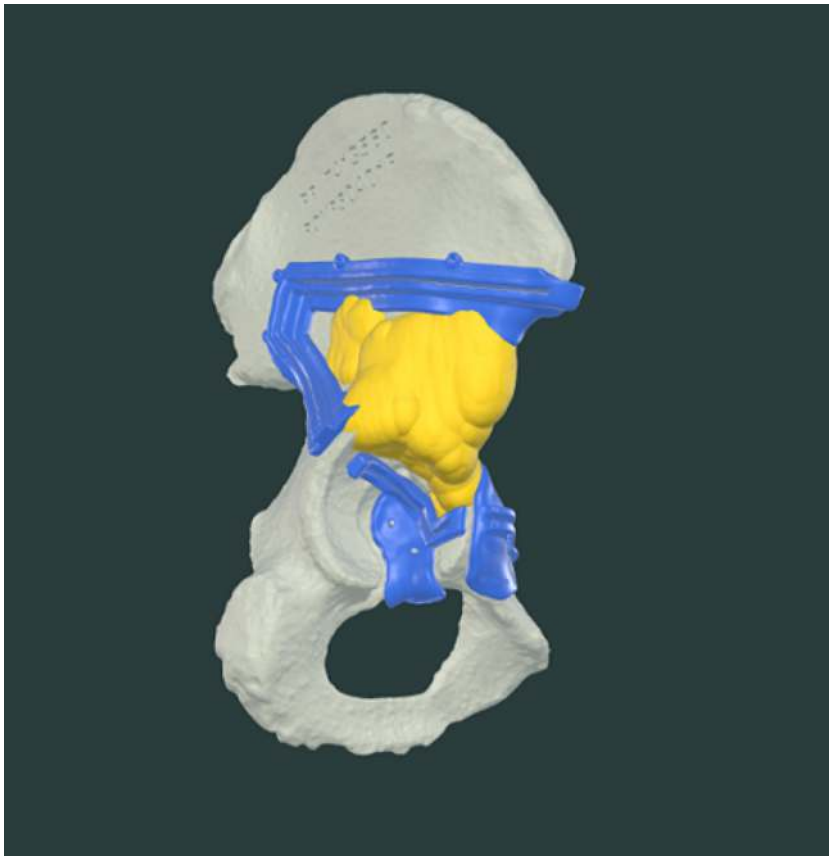
Blade – 1mm (20mm) (Misonix Bonescalpel)

Fixation – 1.6mm K Wire

3D LIFEPRINTS
CASE STUDY

ONCOLOGICAL PRE-SURGICAL PLANNING, VIRTUAL SIMULATION, SURGICAL GUIDES

HOSPITAL ROYAL NATIONAL ORTHOPAEDIC
PROCEDURE PI & PII HEMIPELVECTOMY
DEVICE 3D PRINTED PATIENT SPECIFIC ANATOMICAL MODEL AND SURGICAL GUIDES (POLYAMIDE)



OUTCOME / BENEFITS

3D LifePrints were able to combine the CT and MRI scans provided to create a detailed model and patient-specific guides that translated careful pre-operative planning into navigated osteotomies with accurate and clear margins. The printed anatomical model allowed for the surgical guides to be assessed before the operation, was helpful prior to surgery when discussing across disciplines, and was referred to throughout the complex resection.

The completed resection was noted to be accurate and as expected. The surgeon stated "the advantage of using guides was that I could achieve clear but close margins that conserved bone and enabled ice cream cone reconstruction. It wouldn't have been possible if I'd free-handed the cuts".

Case Summary

A request was made to 3D LifePrints by the Nuffield Orthopaedic Centre to provide sterilizable surgical guides to assist in the partial removal of a patient's pelvis (left side) due to it being compromised by tumorous tissues.

A fast-track service was required to meet the urgent surgery date for the resection of the sarcoma.

Description

3D LifePrints used Simpleware Medical ScanIP to segment the patient's latest CT and MRI scans to build a virtual model of the left hemipelvis. The sarcoma within was digitally grown by a 15mm margin and highlighted in order for the consultant to determine optimum surgical cutting planes.

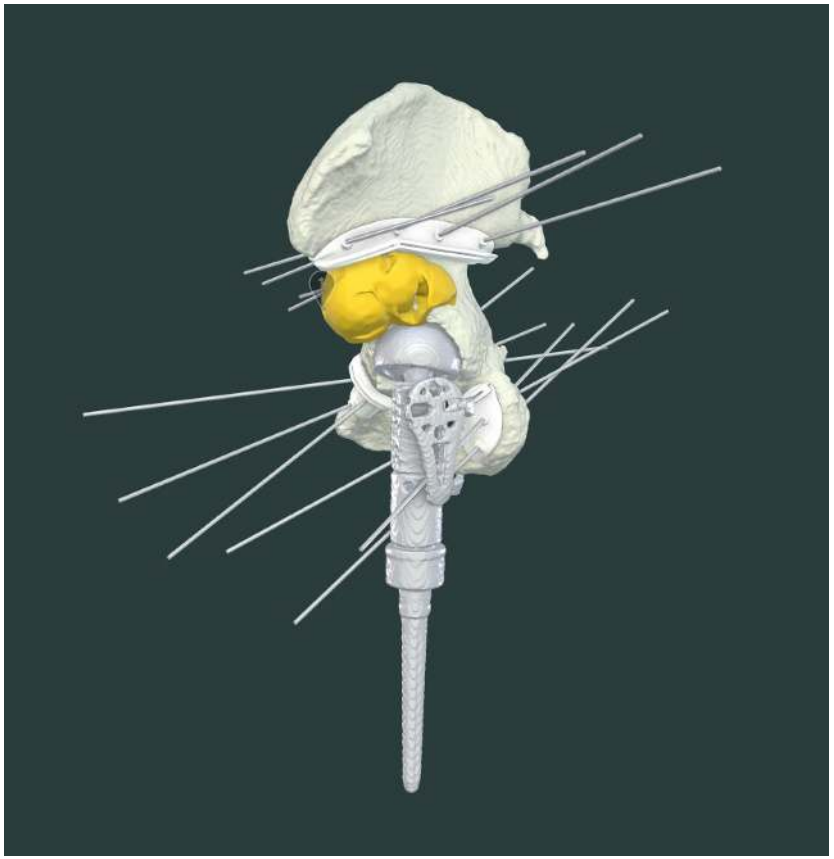
The first guide allowed for a bilateral cut through the ilium for the lateral aspect. The second guide allowed for a single cut through the pubis. The third guide directed a single cut through the ischium.

All three guides were printed in Biomed Clear, a clear, sterilizable material on a Formlabs 3B printer, at 3D LifePrints' controlled environment facilities, housed within its Nuffield Orthopaedic Centre hub (UK).

3D LIFEPRINTS
CASE STUDY

ONCOLOGICAL PRE-SURGICAL PLANNING, VIRTUAL SIMULATION, SURGICAL GUIDE

SPECIALITY: ORTHOPAEDIC ONCOLOGY
PROCEDURE: PI/II HEMIPELVECTOMY
DEVICE: 3D PRINTED PATIENT SPECIFIC ANATOMICAL MODEL AND SURGICAL GUIDES



OUTCOME / BENEFITS

- Rapid turnaround of the design and manufacture of the model and guides was achieved (within one week)
- Pre-operatively, the surgical team used the anatomical model and guides to engage the patient with thorough discussion regarding tumor re-recurrence and the metastasis of the tumour.
- Intra-operatively, the guides fitted optimally and allowed for a single posterior extensile approach to be used. Significant operative time was saved.

Case Summary

A patient diagnosed with a complex chondrosarcoma arising from an osteochondroma required surgery to partially remove areas of their pelvis (right side). The large tumour involved numerous soft tissue structures and surgery would require a multi-disciplinary team.

The orthopaedic surgeon requested surgical guides to help facilitate the safe and effective removal of the tumour and compromised anatomy, in the form of a hemipelvectomy from the right ilium (between the sciatic notch and the superior/inferior iliac spine) to the contralateral pubis.

Description

Following the segmentation of the patient's CT scan data and the development of an accurate virtual 3D model of both the pelvis and osteochondroma, two surgical guides were devised by the biomedical engineer once the optimum cutting planes were determined by the surgeon.

The first guide transected from the sciatic notch, while the second transected through the contralateral pubis.

A 3D print of the anatomy, plus demo guides for reference, were also printed to assist the surgeon's planning and for intra-surgical reference.

Blade – 1mm (20mm) (Misonix Bonescalpel)

Fixation – 1.6mm K Wire

3D LIFEPRINTS

CASE STUDY

ONCOLOGICAL PRE-SURGICAL PLANNING, VIRTUAL SIMULATION, SURGICAL GUIDES

HOSPITAL ROYAL NATIONAL ORTHOPAEDIC
PROCEDURE PI & P3 HEMIPELVECTOMY
DEVICE 3D PRINTED PATIENT SPECIFIC ANATOMICAL MODEL AND SURGICAL GUIDES (POLYAMIDE)

OUTCOME / BENEFITS

In this case, all cuts were successfully carried out as planned, with the surgeon complementary about both the guides and the engineer's work in designing the devices, describing it as an "excellent job".

The surgical team noted how valuable the model was as a visual reference throughout the surgery.

Case Summary

This patient presented with a non-symptomatic Grade 1 chondrosarcoma that had been picked up in a routine scan for a separate investigation. The tumor was small and localised in their left ilium, and the surgeon planned to do a targeted, bone-conserving resection that preserved the integrity of the ilium whilst maintaining safe margins.

3D LifePrints was asked to design and deliver a novel sterilizable surgical drill guide that allowed for this.

Description

Simpleware Medical ScanIP was used to segment both bony structures from the patient's CT scan (a 1 mm slice of the left ilium) and tumor structres from the MRI. These were combined in Simpleware to create a virtual model. The tumor was then grown digitally by 10mm to create a safe surgical margin and highlighted for better visualization.

The consultant determined their ideal path for resection and 3D LifePrints' devised a patient-specific, circular drilling channel guide for use in theater.
The surgical guide was printed in Biomed Clear, a biocompatible, sterilizable material on a Formlabs 3B Printer, and delivered to the surgical team alongside a 3D printed anatomical model for intra-operative reference. The guide was printed in 3D LifePrints' controlled environment facilities, located within its Nuffield Orthopaedic Centre hub (UK).

3D LIFEPRINTS
CASE STUDY

ONCOLOGICAL PRE-SURGICAL PLANNING, VIRTUAL SIMULATION, SURGICAL GUIDE

HOSPITAL: NUFFIELD ORTHOPAEDIC CENTRE
PROCEDURE: TARGETED RESECTION OF ILIUM
DEVICE: 3D PRINTED PATIENT SPECIFIC ANATOMICAL MODEL AND SURGICAL GUIDE

OUTCOME / BENEFITS

The surgery was extremely straightforward and completed within an hour. The guide fitted well and once the drill holes were made the surgeon was able to easily complete the osteotomy with a uni sawblade. The surgical team appreciated the level of precision the guides enabled and were able to salvage all of the sacroiliac joint, whilst also avoiding disturbance of any neurovascular structure. Sectioning of the tumor showed good margins.

Post-operatively, the patient experienced a quick rehabilitation period and was able to return home after 48 hours.

Case Summary

A 36 year old male with a complex spindle cell sarcoma required a partial resection of the pelvis (right side) to remove the tumorous tissues.

The surgeon requested the design and manufacture of sterilisable surgical guides to aid in the hemipelvectomy from the right ilium (between the sciatic notch and the superior/inferior iliac spine) to the contralateral pubis.

Description

3D LifePrints segmented the patient's data, merging CT and MRI scans to capture both bony and soft tissue, to develop a virtual model of the pelvis and tumour. The model was printed in bone-like material and resin (Tumour) and used by the surgical team for intra-operative reference.

Four surgical cutting guides were created from the surgeon's virtual plan. The first guided a bilateral cut through the ilium from the lateral aspect. The second ensured the sacral cut travelled parallel to, and intersects the anterior aspect, of the sacroiliac joint. The third navigated a cut through the contralateral pubis, parallel to the pubis symphysis; this was provided in two iterations that could be decided in surgery depending on soft tissue.

All four guides were printed in sterilisable material in 3D LifePrints' controlled envrionment.

Blade – 1mm (20mm) (Misonix Bonescalpel)

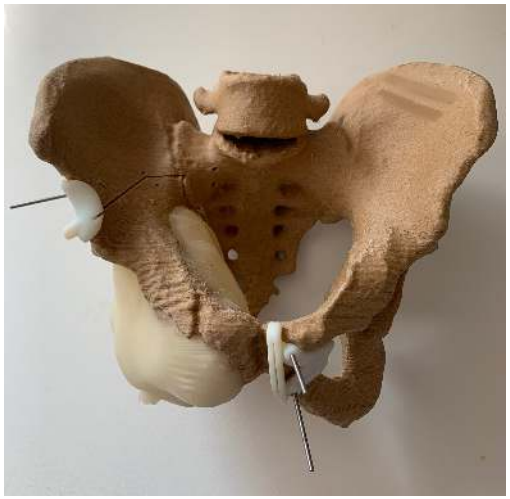
Fixation – 1.6mm K Wire

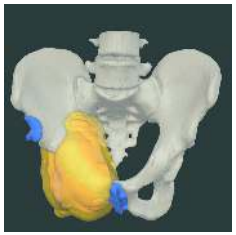
3D LIFEPRINTS

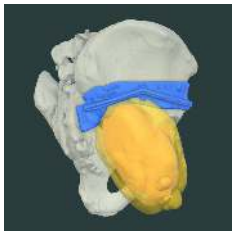
CASE STUDY

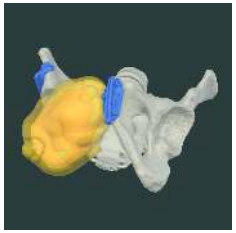
ONCOLOGICAL PRE-SURGICAL PLANNING, VIRTUAL SIMULATION, SURGICAL GUIDES

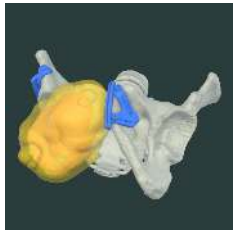
HOSPITAL ROYAL NATIONAL ORTHOPAEDIC
PROCEDURE PI & P3 HEMIPELVECTOMY
DEVICE 3D PRINTED PATIENT SPECIFIC ANATOMICAL MODEL AND SURGICAL GUIDES (CLEAR POLYAMIDE)

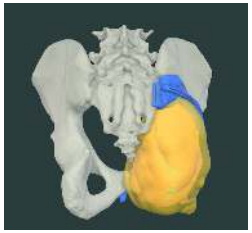












OUTCOME / BENEFITS

Use of the guides enabled the surgical team to carry out the pre-determined cuts as planned with clear margins. Less need to refer to digital scans was observed with the model providing adequate reference.

The surgeon also positively noted 3D LifePrints' decision to manufacture the guides in an ISO certified, 3D print biocompatible, transparent material, stating it was an improvement on previous opaque materials as it allowed visibility of the blades in relation to the bone when being used. The inclusion of the silhouettes (Guides) and the cutting planes on the model was also noted as valuable.

As 3D LifePrints engineers work more closely with the individual surgeon and a good relationship develops, surgical guides and models become more and more suited to the surgeon's preferences, The surgeon in this case confirmed the devices were "getting better every case".

CASE SUMMARY

A patient diagnosed with an Ewing's sarcoma in their left ilium required surgery to remove it from the pelvis. The surgical team were presented with the challenge of resecting the tumour with a safe margin in order to preserve as much of the sacroiliac joint as possible. A request was made for virtual simulation of the surgery, together with an anatomical model to be used for pre-surgical planning ahead of the live procedure. A patient specific Surgical Cutting Guide was also required to ensure accuracy of resection.

DESCRIPTION

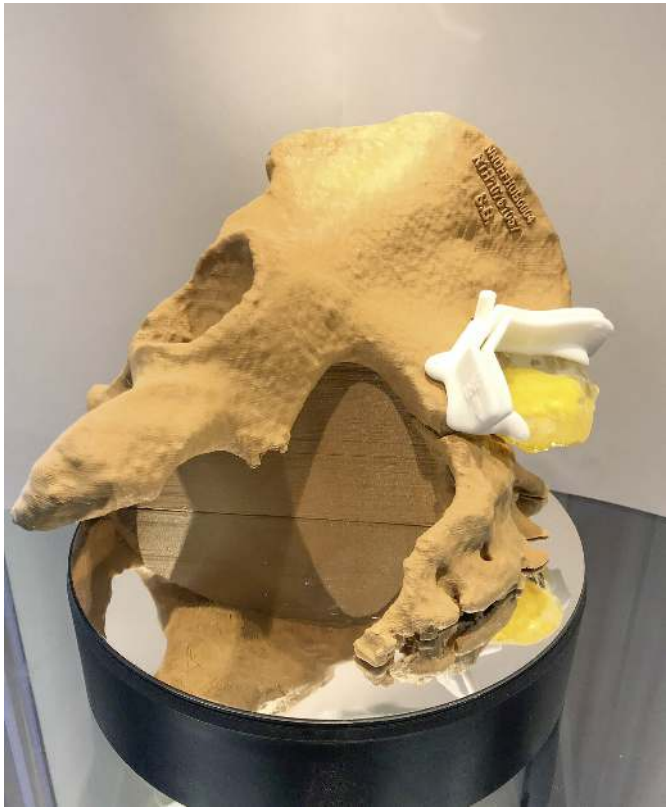
3D LifePrints first created a virtual model of the patient's left ilium including the tumour. In order to obtain a complete picture, a merging of imaging modalities was required. The boundaries of the tumour were only visible on MRI and so this imagery was overlain onto the CT data, which best shows the bone, to define the tumour's location and dimensions.

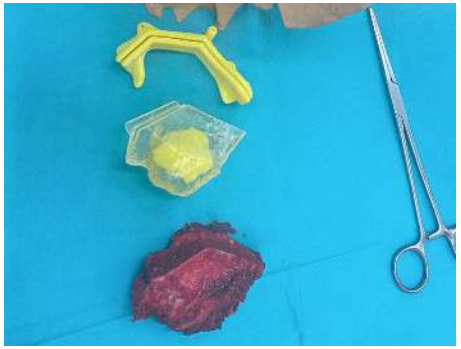
The tumour was then digitally grown by a 1cm margin, on request by the surgeon. This growth margin was then digitally applied, to show the ideal cutting locations on the bone. This allowed for the creation of a 3D printed surgical cutting guide for the left ilium, which was printed in sterilisable polyamide (above the yellow tumour model). The resected bone is beneath the model.

3D LIFEPRINTS
CASE STUDY

ONCOLOGICAL PRE-SURGICAL PLANNING, VIRTUAL SIMULATION, SURGICAL GUIDE

SPECIALITY ONCOLOGY
PROCEDURE RESECTION OF EWING'S SARCOMA AT THE ILIUM
DEVICE 3D PRINTED PATIENT SPECIFIC ANATOMICAL MODEL AND SURGICAL GUIDE





OUTCOME / BENEFITS

The surgical cutting guide ensured a safe and accurate resection of the tumour and allowed a larger portion of healthy bone to be left untouched. The surgeon commented "[The use of the 3D Model] avoided the use of further surgical dissection and bone cuts". For the patient, this meant less time under anaesthetic, lower risk while in surgery, and an opportunity for a better outcome post-surgery derived from the personalised treatment.

In-House Workflow

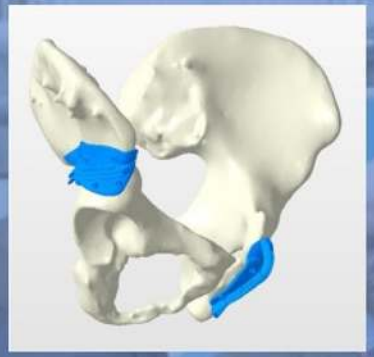
Surgical Guide In-House Workflow

Planning

In-house engineer engages with the surgeon and clinical team prior to surgery to understand deadlines and objectives. Perhaps by attending MDT meetings.

Segmentation

Multiple scan modalities segmented to reconstruct patient's anatomy in 3D. Patient DICOM data remains on-site and secure



3D Design

Engineer designs patient-specific devices to accurately translate the surgeon's virtual plan. Devices reviewed side by side and authorised by surgeon

Manufacture

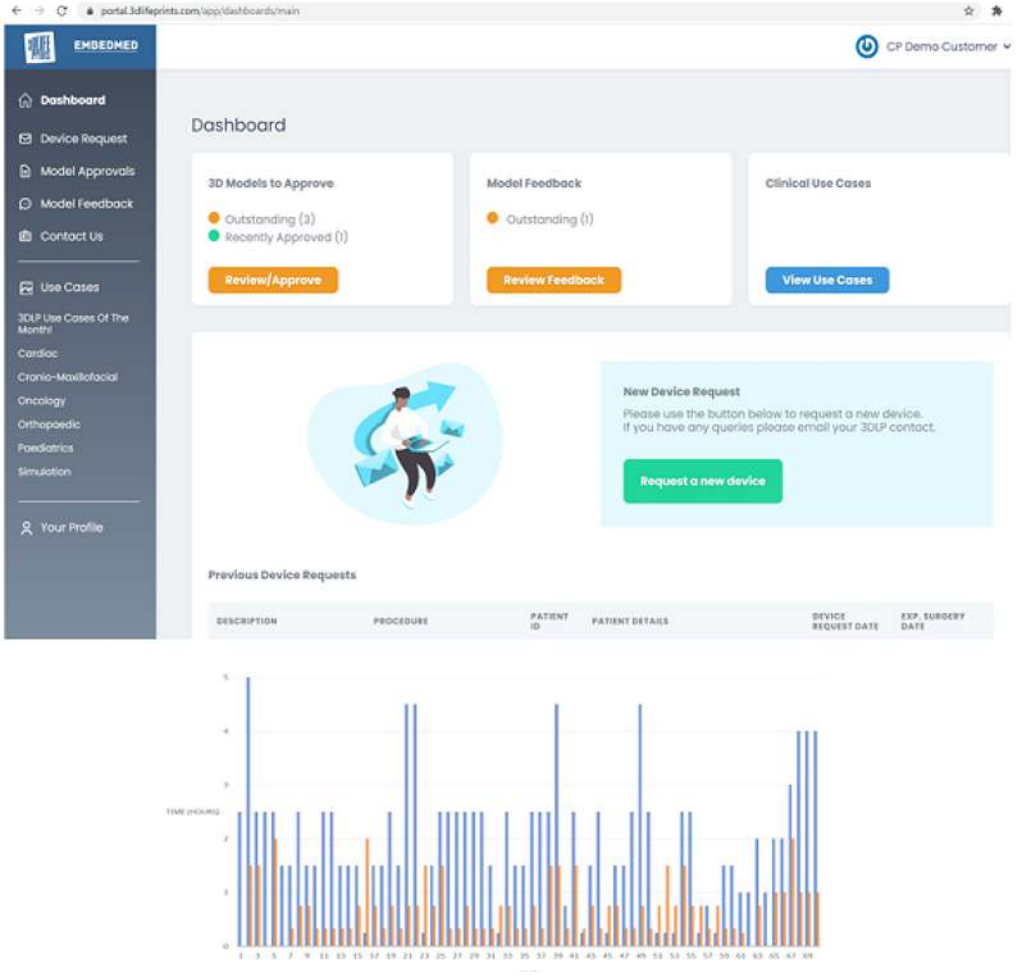
Approved designs are manufactured in an on-site 'controlled environment', in sterilisable material, alongside an anatomical model and demo guides for testing and reference

Hand Delivery

Devices are hand-delivered for sterilisation before use in theatre. Engineer on-site to assist in device use in surgery if necessary

Digital Platform EmbedMed™ & Analytics

- **Secure Cloud-based Platform** accessible over a wide variety of technologies.
- Clinicians can **easily order new medical devices** such as Anatomical Models or Surgical Guides.
- Advanced visualization capabilities for the surgeon to **review and approve** segmented patient data.
- Case by case **feedback functionality**, capturing the benefits of the device used during the procedure including time saved and improved outcomes.



PELVIC ONCOLOGY

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