PATIENT SPECIFIC MEDICAL DEVICES AND SOLUTIONS AT THE POINT OF CARE

3D SOLUTIONS FOR ORTHOPAEDIC SURGERY

SUMMARY / INDEX

ORTHOPAEDIC AREAS

- Replacement
- Revision
- Reconstruction (lower and upper limb)
- Resection
- Implantation

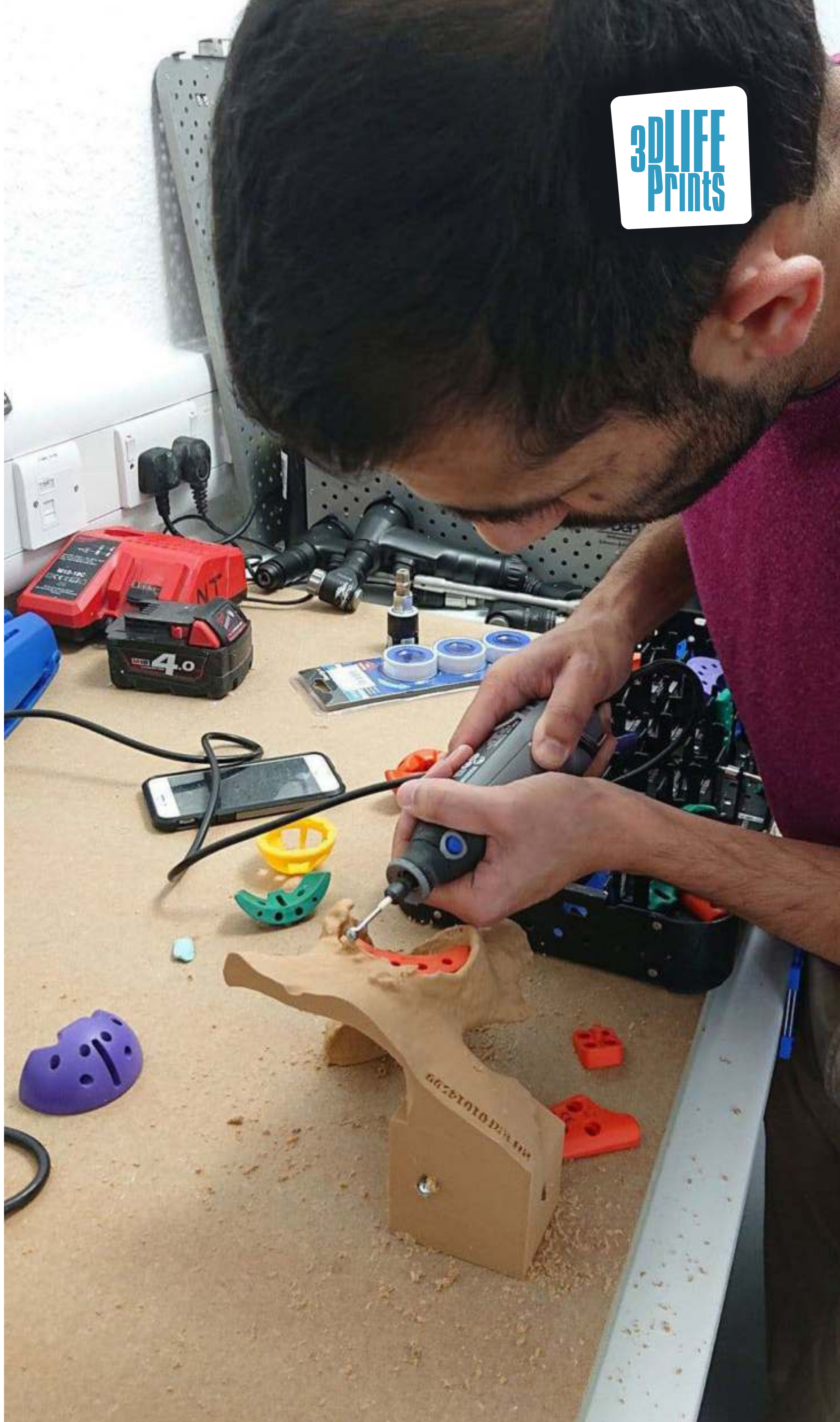
ORTHOPAEDIC PRODUCTS

1 3D PRINTED PATIENT SPECIFIC ANATOMICAL MODELS

1. Pre-surgical assessment, planning and simulation
2. Intra-surgical use
3. Patient communications
4. Device sizing

2 SURGICAL GUIDES

1. Cement removal
2. Femoral/Pelvic osteotomy
3. Osteosarcoma resection
4. Opening/closing wedge osteotomy



Case Summary

To manage the onset of osteomyelitis, this patient had undergone debridement of the distal femur. As a result, a large cavity was left for the surgeon to navigate in a subsequent ligement repair.

The surgeon requested a 3D model to gain full appreciation of the cavity in preparation for a tunneling procedure. The nature of the cavity meant drilling a tunnel that travelled through all three planes, which added to the complexity of the surgery.

Description

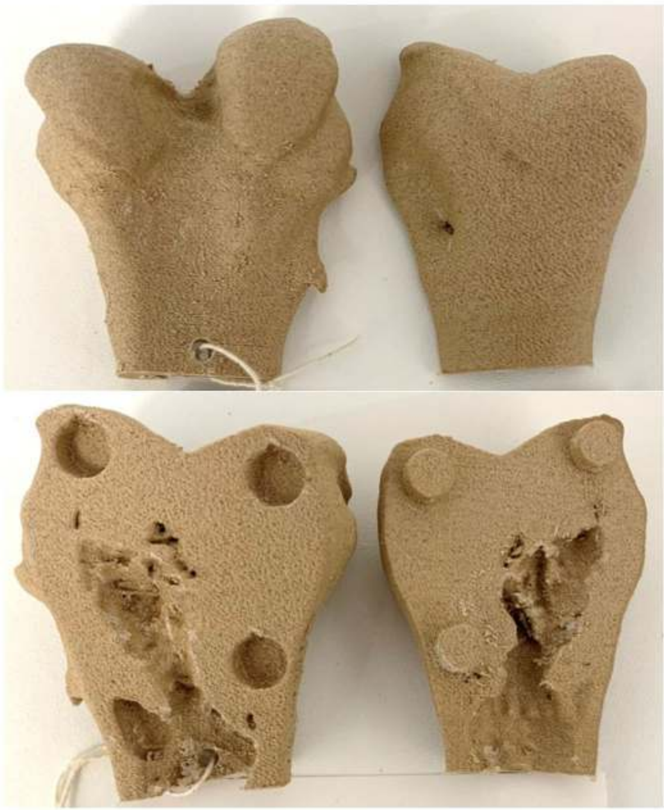
3D LifePrints segmented the patient's CT scan data to produce a virtual model of the femur and an accurate visualisation of the cavity.

This model was then 3D printed as two halves in bone-like material. Connectors were made so that the model could slot together in the correct orientation, without obstructing the surgeons drilling trajectory.

3D LIFEPRINTS
CASE STUDY

ORTHOPAEDIC PRE-SURGICAL PLANNING

SPECIALITY: ORTHOPAEDIC
PROCEDURE: DISTAL FEMUR WITH PREVIOUS OSTEOMYELITIS
DEVICE: 3D PRINTED PATIENT SPECIFIC ANATOMICAL MODEL



OUTCOME / BENEFITS

The model gave the surgeon the opportunity to measure and trial various angles and location of entry before getting into theatre.

The surgeon was left confident after simulating that he could successfully drill a suitable tunnel without breaching the cavity.

Case Summary

A patient suffering with ostearthritis required an excision of heterotopic ossification around the hip joint. A total hip replacement was advised and removal of previously implanted plating, which added to the complexity of the surgery.

The consulting clinician requested a patient-specific anatomical model to identify the severity of the chronic ossification and help plan the surgery.

The model was also be used as a communication tool to discuss the condition of the joint with the patient.

Description

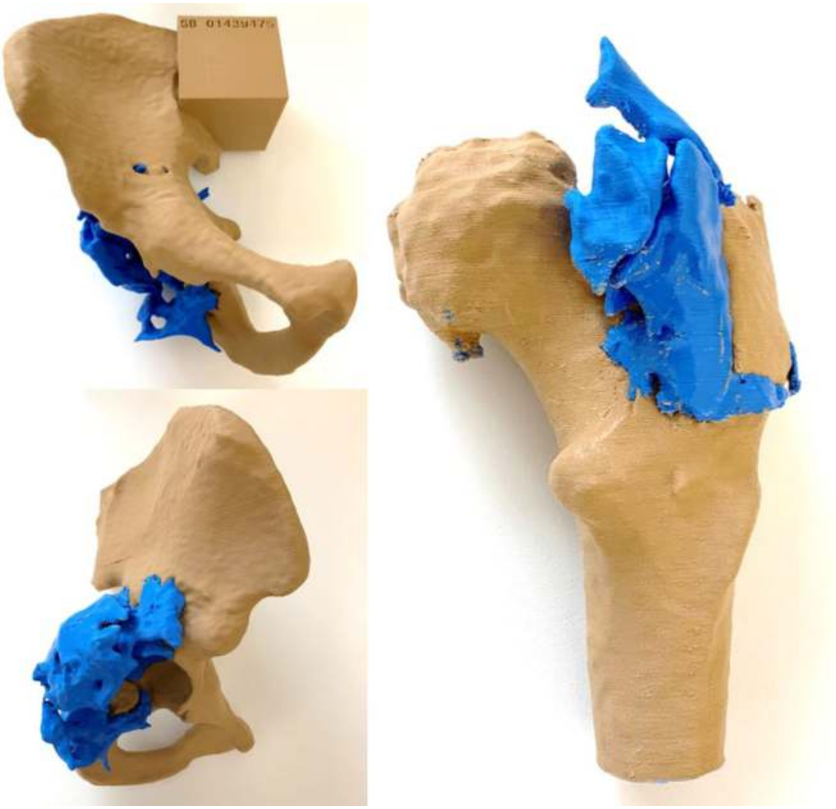
Using CT scan data, 3D LifePrints developed models of the right hemipelvis and proximal femur, paying particular attention to the segmentation of the heterotopic ossification for accurate representation.

The models were then printed in bone-like material.

3D LIFEPRINTS
CASE STUDY

ORTHOPAEDIC PRE-SURGICAL PLANNING AND PATIENT COMMUNICATION

SPECIALITY: ORTHOPAEDIC
PROCEDURE: EXCISION OF HETEROTOPIC OSSIFICATION IN HIP
DEVICE: 3D PRINTED PATIENT SPECIFIC ANATOMICAL MODELS



OUTCOME / BENEFITS

The model was able to highlight the areas for resecting the HO without compromising the integrity of the joint.

As an addition to the hard tissues, the clinician also requested that the on-site engineer liaise with the radiologist to identify and segment the sciatic nerve. This was then added to the model to help plan to avoid the nerovascular structures.

Case Summary

A neurosurgeon approached 3D LifePrints for help with an urgent case requiring pre-surgical planning and the use of a rehearsal model. The patient presented with cervical vertebrae instability due to deformity of the vertebral anatomy. This can lead to very severe complications such as compression of the spinal cord.

Due to the complexities involved in stabilising the vertebrae, the surgeon wanted to rehearse the surgical approach to find the optimum solution.

Description

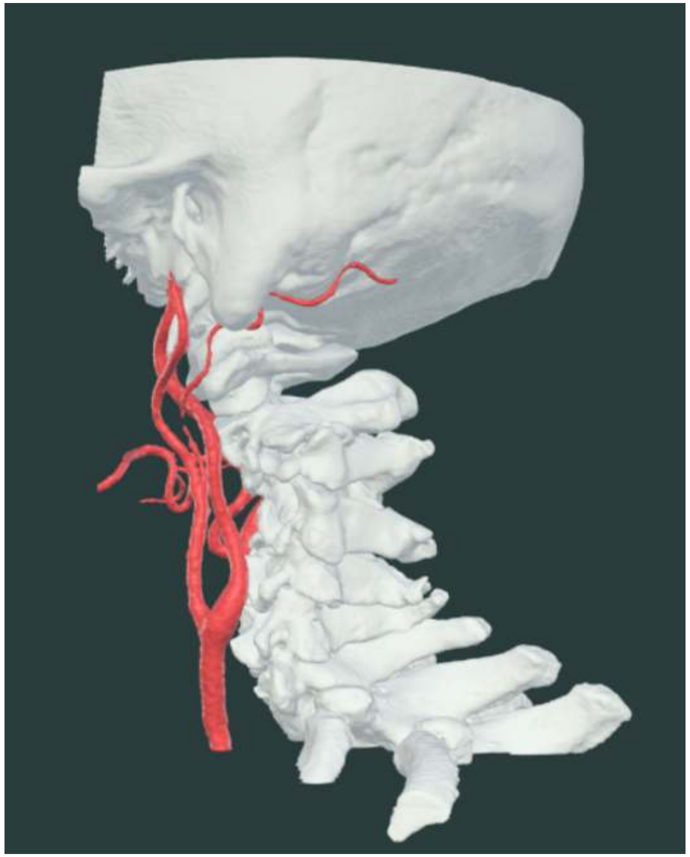
Segmentation software was used to create this model from a CT scan provided by the neurosurgeon. The carotid arteries were separted from the bone, however these were not included in the final 3D print as the surgeon decided these were not necessary for his pre-surgical planning and rehearsal.

The model was 3D printed using a bone mimicking material, which allowed the surgeon to simulate the surgery on a high fidelity model.

3D LIFEPRINTS
CASE STUDY

NEUROSURGICAL PRE-SURGICAL PLANNING AND SIMULATION

SPECIALITY: NEUROSURGERY
PROCEDURE: CORRECTION OF SPINAL DEFORMITY
DEVICE: 3D PRINTED PATIENT SPECIFIC ANATOMICAL MODEL



OUTCOME / BENEFITS

The neurosurgeon commented that *"the model contributed to a very successful outcome for the patient"*, and that the material the model was printed in was particularly good at mimicking the bone and was better than previous models he had used.

3D LIFEPRINTS
CASE STUDY

ORTHOPAEDIC PRE-SURGICAL PLANNING AND SIMULATION

SPECIALITY: ORTHOPAEDIC
PROCEDURE: OSTEOTOMY AND RECONSTRUCTION OF LEFT AND RIGHT MIDFEET
DEVICE: 3D PRINTED PATIENT SPECIFIC ANATOMICAL MODELS

Case Summary

To restore mobility to a patient with Charcot disease, a diabetes related condition, surgical intervention to correct the shape of the mid/fore foot of both feet was required.

The lead surgeon requested two anatomical models of the mid and forefeet to allow his team to assess the degree of the problem and the level of surgery required to address the malformation, reposition the bones and enable fusion between them.

Description

3D LifePrints provided the surgical team with two anatomical models, both the patient's left and right foot, in bone-like material on which they could realistically emulate surgery.

They were able to simulate the wedge-shape osteotomy necessary to bring both feet into their correct anatomical position through subsequent reconstruction.

OUTCOME / BENEFITS

3D, tactile models provided the team with anatomical insight and the opportunity to simulate surgery where 2D scan imagery could not. Without soft tissue distorting their interpretation, the ideal size, shape and angles of the upcoming osteotomy could be determined in advance, saving time.

When it came to live theatre, the surgical team were able to approach the resection and closing of the forefoot to midfoot with both accuracy and confidence, successfully realigning the patient's anatomy to alleviate their condition.

CASE SUMMARY

A patient had suffered a fracture of the wrist and forearm, requiring corrective surgery and the use of an implanted titanium plate to fix the bones in place for healing.

The surgical team requested assistance in the pre-surgical planning phase of the treatment pathway. In this case, it was important to be able to find the best positioning for a plate and subsequently make the right choice in the type of plate for the fracture type and the patient's individual anatomy.

A patient-specific anatomical model of the wrist and forearm was commissioned.

DESCRIPTION

3D LifePrints segmented the patient's CT scan and created a model demonstrating the radius, ulna, carpus, the fracture site and the existing metal plate in situ.

The model was then printed in bone-like material, to imitate the realistic properties of the limb while allowing the templating of a range of implants and devices on it.

3D LIFEPRINTS
CASE STUDY

ORTHOPAEDIC PRE-SURGICAL PLANNING

SPECIALITY: REVISION AND RECONSTRUCTION (UPPERLIMB)
PROCEDURE: WRIST FUSION AND FIXATION OF RADIAL NON-UNION
DEVICE: 3D PRINTED PATIENT SPECIFIC ANATOMICAL MODEL

OUTCOME / BENEFITS

The model proved useful in comparing plate models and sizes and the surgeon was able to make the best choice for their patient ahead of surgery. The correction and implantation of plate was successful, and the patient recovered well.

By ensuring that the correct size of implant was selected in advance, the surgeon was confident taking fewer implant and tooling options into the theatre. This clarity avoids not only the need for those extra devices, but also the extra sterilisation required of them.

After repeat usage at this specialist hospital the use of this Guide is becoming standard practice for this procedure.

CASE SUMMARY

A patient required an acetabular reconstruction due to a peri-acetabular defect and surrounding bone loss. The surgeon needed to assess the extent of the defect and plan the reconstructive surgery. Key to the assessment was determining whether a buttress and augment were required to achieve stability of an acetabular cup. The surgical team requested a model of the patient's hemi-pelvis in order to help their pre-surgical planning and simulate different reconstruction options.

DESCRIPTION

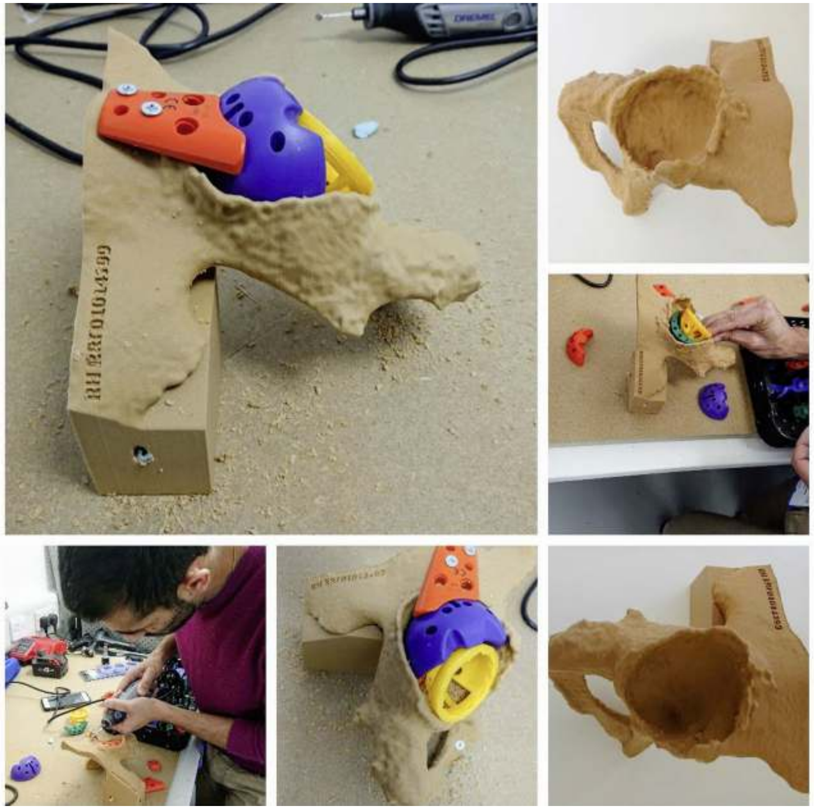
The patient specific model containing the acetabular defect and compromised bone stock was provided for use in the on-site simulation laboratory. Printed in bone-like material, the acetabulum could be safely reamed to a recorded diameter, whilst maintaining suitable anterior cup coverage - avoiding post-surgical issues with psoas impingement.

The surgical team were then able to trial implants with the model; augments (blue and green), buttress (orange), cup (yellow).

3D LIFEPRINTS
CASE STUDY

ORTHOPAEDIC PRE-SURGICAL PLANNING AND SIMULATION

SPECIALITY: REVISION AND RECONSTRUCTION (LOWER LIMB)
PROCEDURE: ACETABULAR RECONSTRUCTION AND PROXIMAL FEMORAL REPLACEMENT
DEVICE: 3D PRINTED PATIENT-SPECIFIC ANATOMICAL MODELS



OUTCOME / BENEFITS

Using the model, the surgical team could fully assess the defect and find the most effective implants for the reconstruction ahead of live theatre. This preoperative planning saved substantial intra-operative decision making time while the patient was under anaesthetic and resulted in a stable and bespoke solution.

The planning also confirmed the surgeons' belief that an optimal solution could be achieved without the need for an expensive bespoke implant.

Case Summary

This complex total hip replacement (THR) required correction of deformities in both the acetabulum and proximal femur. It was questioned whether surgery would be an appropriate solution as a surgical solution wasn't deemed possible and that physical therapies were a more suitable approach.

A 3D printed model of the pelvis and femur were created in a bone-like material in 3DLP's in-house simulation lab for surgeons to experiment with in their search for best patient treatment.

Description

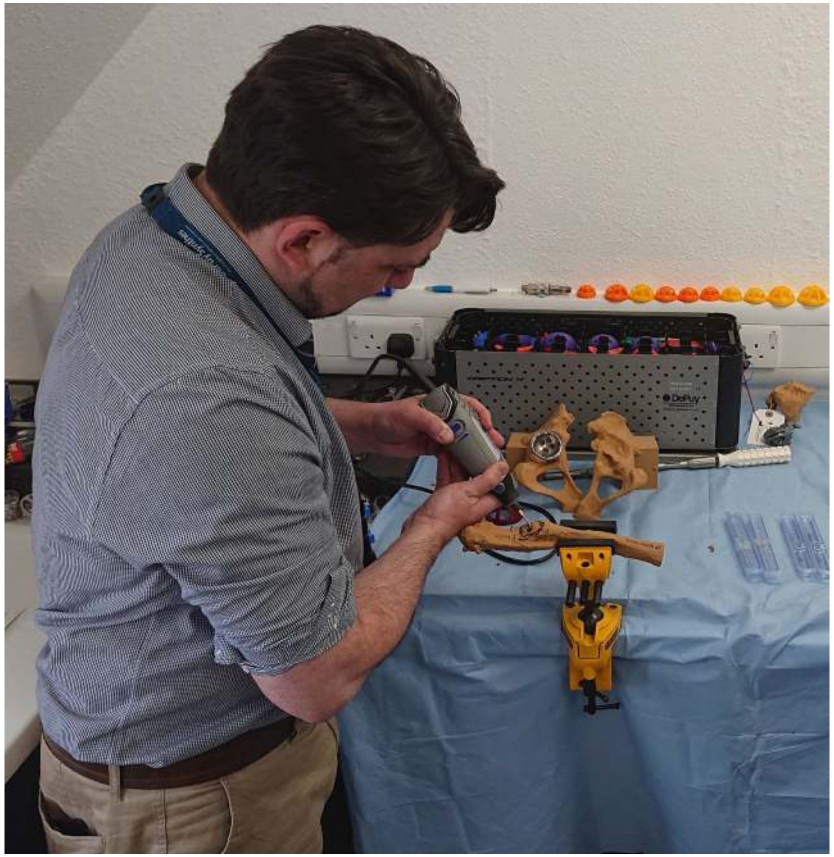
Simulation began by burring away the trochanteric cortex to open the medullary cavity for insertion of a standard femoral stem. It was realised during the simulation that a trochanteric osteotomy was necessary to allow for reaming in the appropriate trajectory, but which did not interfere with adductor muscle attachment sites.

The osteotomised bone fragment was then used as an autograft to build-up the superior lunate surface of the acetabulum to gain structural support for the implant of a cup.

3D LIFEPRINTS
CASE STUDY

ORTHOPAEDIC PRE-SURGICAL PLANNING AND SIMULATION

SPECIALITY: ORTHOPAEDIC
PROCEDURE: COMPLEX TOTAL HIP REPLACEMENT
DEVICE: 3D PRINTED PATIENT SPECIFIC ANATOMICAL MODEL



OUTCOME / BENEFITS

Simulation with the bone-like, Polywood model demonstrated that with the plate left in place during the osteotomy and burring, the risk of fracture could be reduced.

The simulation gave the clinicians a clear understanding of the deformity and a safe environment to carry out their intended procedures.

Case Summary

A paediatric patient presenting with multiple pathologies, including Mucopolysaccharidosis type I, required complex total hip replacement (THR) surgery.

Owing to the high-risk nature of the procedure, the surgeon requested the design and manufacture of a patient-specific anatomical model and accompanying surgical guide to be created in 3D LifePrints' in-house simulation lab.

Description

3D segmentation and modelling from the CT scan allowed the surgeon to plan, in a virtual space, the ideal cutting planes for the femoral neck osteotomy. At the same time, a bespoke surgical guide was designed for the custom stem. The patient-specific anatomical model was printed in bone-like material, while the guide was printed in sterilisable nylon.

Prior to surgery, the surgeon rehearsed the intended procedure in 3DLP's simulation lab on the 3D printed model of the proximal Femur and Acetabulum. The model is shown here with a copy of the surgical guide used during the simulation. A sterilised guide was employed during the live procedure..

PAEDIATRIC ORTHOPAEDIC PRE-SURGICAL PLANNING, SIMULATION AND SURGICAL GUIDE

SPECIALITY: ORTHOPAEDIC
PROCEDURE: COMPLEX TOTAL HIP REPLACEMENT
DEVICE: 3D PRINTED PATIENT SPECIFIC ANATOMICAL MODEL AND SURGICAL GUIDE

OUTCOME / BENEFITS

With the experience of the pre-operative simulation and by using the patient specific guide in theatre, the surgeon was able to accurately cut the femur in the pre-determined location and plane. As pre-planning, simulation and guide use negated the need for intra-operative anatomical measuring the overall surgery time was reduced in comparison to a traditional approach.

For the patient, quicker and more accurate surgery meant less time under general anaesthetic, lower risk of complications in an already high-risk procedure, and potentially a faster recovery.

3D LIFEPRINTS
CASE STUDY

ORTHOPAEDIC PRE-SURGICAL PLANNING, SIMULATION, AND SURGICAL GUIDE

SPECIALITY: ORTHOPAEDIC
PROCEDURE: IMPLANTATION OF PEDESTAL CUP
DEVICE: 3D PRINTED PATIENT SPECIFIC ANATOMICAL MODEL AND PROTOTYPE IMPLANT

Case Summary

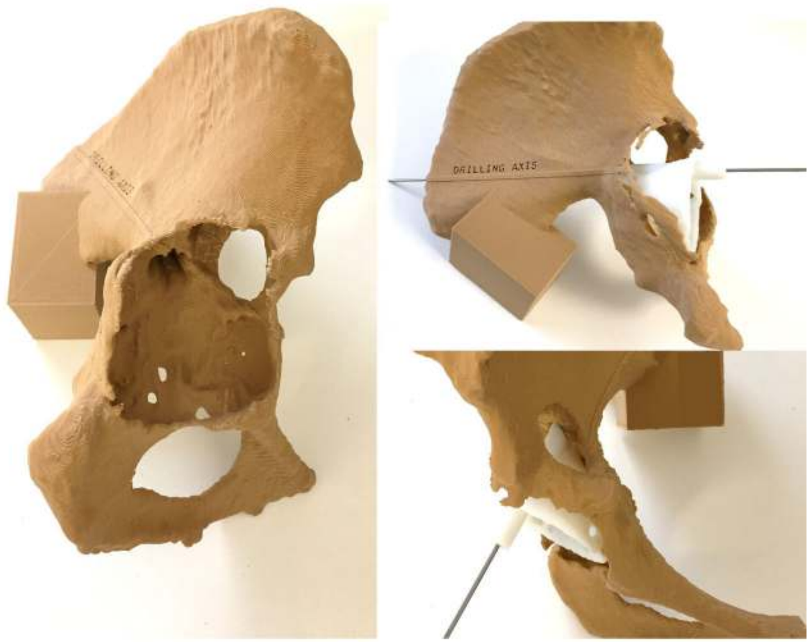
Virtual 3D planning and printing gave the surgeon for this complex revision case the opportunity to pre-plan a drilling axis for a pedestal cup before entering theatre. This case presented various complexities around reconstruction the acetabulum to regain mobility to the joint.

Description

3D LifePrints segemented the scan data to create a virtual model of the patients pelvis. This was then 3D printed in bone-like material to facilitate the surgical team's simulation of the implantation in the on-site simulation lab.

The proposed implant was brought into a digital space and used to generate a suitable trajectory for implantation into the illiac wing. The axis was then made into a channel that was then added to a digital model of the existing implant, creating the custom guide.

A line was added to the model showing the trajectory of the proposed drilling axis. Understanding the angle of insertion was essential to ensure the loading dynamics were appropriate for the patient, as well as considering any breaching of the implant through the bone.



OUTCOME / BENEFITS

Having the 3D model allowed the surgeon to appreciate the trajectory needed for implanting the pedestal cup into the illiac wing. This helped to avoid breaching of the cortex and potentially interferring with large neurovascular structures in the pelvic cavity.

Having the option of a pre-planned guide builds confidence for the clinician and saves overall procedural time for the patient. Both the model and guide help mitigate against the risks of drilling into an unknown space.

Case Summary

A patient's previous fracture had malunited, causing reduced range of motion in their wrist.

3D LifePrints were asked to provide a patient-specific open wedge osteotomy cutting guide to allow the surgeon to accurately realign articulating cartilage with the carpals of the hand in an effort to restore mobility in the wrist.

A standard plate would also be implanted using 3D LifePrints' predetermined drilling locations to secure realignment.

Description

3D LifePrints used Simpleware Medical ScanIP to segment CT scans of both the patient's left and right (affected) wrist anatomy. The left side was mirrored and the right side orientated to match the radiocarpal alignment present in the left side.

The optimum location of the cutting planes were identified by the surgeon and converted by the biomedical engineer into a surgical guide which would allow accurate recreation of the cuts in theater.

The guide was printed in Biomed Clear, a biocompatible, sterilisable material on a Formlabs 3B printer, and delivered to the surgical team. The guide was printed in 3D LifePrints' controlled environment facilities, located within its Nuffield Orthopaedic Centre Hub (UK).

3D LIFEPRINTS
CASE STUDY

ORTHOPAEDIC PRE-SURGICAL PLANNING, VIRTUAL SIMULATION, SURGICAL GUIDE

SPECIALITY: ORTHOPAEDIC
PROCEDURE: RADIOCARPAL REALIGNMENT VIA OPEN WEDGE OSTEOTOMY
DEVICES: 3D PRINTED PATIENT SPECIFIC ANATOMICAL MODEL AND SURGICAL GUIDE

OUTCOME / BENEFITS

Pre-surgical planning with the virtual model, and use of the patient-specific guide intra-operatively, resulted in time saved during theater. Accuracy in the cuts to the bone, and securing of the implant, also improved the procedural outcome.

Realignment surgery proved to be a success with post-op x-rays showing good placement of the plate and alignment of the radiocarpals.

Case Summary

A patient presented with an atypical impending fracture, potentially caused by bisphosphonate infusion. A closing wedge osteotomy for tri-planar correction was required to restore biomechanical function of the femur.

The orthopaedic surgeon requested patient-specific anatomical models for pre-surgical planning and simulation, as well as surgical cutting guides which would be used in theatre.

Description

3D LifePrints segmented the patient's CT scan to build a virtual model of the patient's femur. In collaboration with the surgeon, optimum cutting planes for the osteotomy were decided upon.

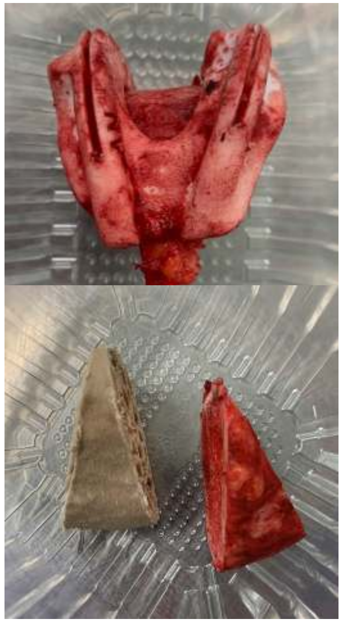
The biomedical engineer then designed a surgical cutting guide which would allow the surgeon to recreate these cuts accurately in theatre. The guide was printed in sterilisable material at 3D LifePrints' controlled environment and delivered to the hospital's team for sterilisation.

A replica of the femur was printed in wood-like material to allow the surgeon to practice the procedure with a dummy guide before live surgery.

3D LIFEPRINTS
CASE STUDY

ORTHOPAEDIC PRE-SURGICAL PLANNING, SIMULATION, SURGICAL GUIDE

SPECIALITY: ORTHOPAEDIC
PROCEDURE: CLOSING WEDGE OSTEOTOMY
DEVICES: 3D PRINTED PATIENT SPECIFIC ANATOMICAL MODEL AND SURGICAL GUIDE



OUTCOME / BENEFITS

The combination of advanced pre-surgical planning, active procedural simulation, and use of the custom surgical guides in theatre saved significant time during the actual procedure.

Post-op X-rays showed a tight fit between the proximal and distal sections of the femur, owing to guide use, with the large surface area of both halves lining up well for better osseointegration as the patient recovers.

A femoral stem was also put in place and a total hip replacement successfully carried out in a single staged surgery.

3D LIFEPRINTS
CASE STUDY

ORTHOPAEDIC PRE-SURGICAL PLANNING, SIMULATION AND SURGICAL GUIDE

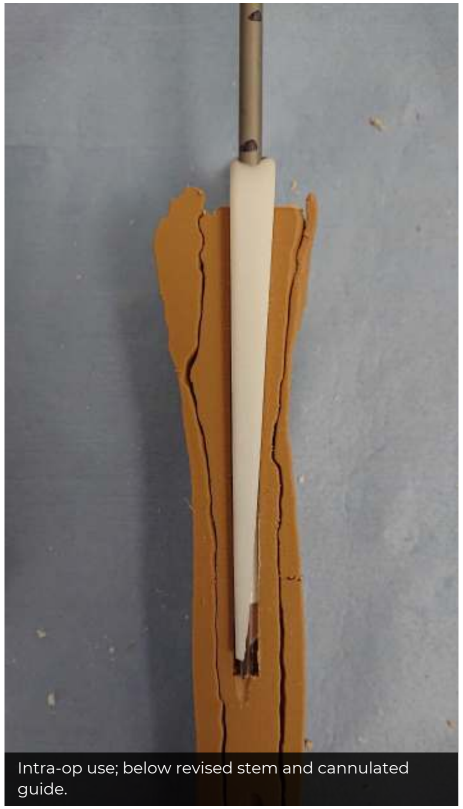
SPECIALITY: REVISION AND RECONSTRUCTION (LOWER LIMB)
PROCEDURE: INTRA-OPERATIVE REMOVAL OF DISTAL CEMENT PLUG DURING FEMORAL STEM REVISION
DEVICE: 3D PRINTED PATIENT SPECIFIC CEMENT REMOVAL DRILLING GUIDE

CASE SUMMARY

Conventional cement removal techniques for femoral stem revision can result in complications or prolonged surgical procedures. After removing a previously implanted femoral stem, it is necessary to clear the cement to achieve good fixation of a new stem. Proximally, this is achieved with an osteotome by breaking the cement into the space created by the removed implant; the cement found distally to the implant is released by drilling and inserting a drill tap that is reverse-hammered using a slap-hammer. Problems arise when the drill diverts from the cement, breaching the femoral cortex. The surgical team approached 3D LifePrints to plan and print a sterile guide that controlled the drilling direction and depth and reduced the risk of perforation of the patient's femur.

DESCRIPTION

3D LifePrints designed and 3D printed a novel drilling guide, in sterilisable material, using the geometry of the removed femoral stem and introducing a cannulation directed along a pre-determined axis. The axis is orientated in virtual space directly into the centre of the cement tail and removed from the implant mesh to create the specified cannulation. 3D LifePrints' simulation lab gave the surgeon the opportunity to 'test-run' the guide with a 3D printed model of the patient's femur. The bone and cement were segmented out from the patient's scans and printed in an operable 3D material for simulation.



Intra-op use; below revised stem and cannulated guide.

Tap used to remove large piece of distal cement.

OUTCOME / BENEFITS

Using the patient specific drilling guide allowed the surgeons to more effectively and efficiently remove the cement from the patient's femur.

Damage to the femur was kept to a minimum and no splitting occurred, which had been serious consideration prior to surgery.

Surgery was completed more quickly than anticipated which is a direct benefit to the patient and hospital.

Access to the simulation lab gave the surgeon the opportunity to consider the appropriate access, including any fouling of the greater trochanter, ensuring the guide could be used effectively on the day of surgery

CASE SUMMARY

A patient diagnosed with a sarcoma of the distal radius required surgery to remove it from the forearm. The surgical team were presented with the challenge of resecting the tumour with a safe margin in order to preserve as much of the distal radius and the radiocarpal joint as possible.

The surgeons requested that 3D LifePrints Virtually Simulates the surgical resection of the tumour in order to create a highly accurate surgical cutting guide to determine the exact location and angle of the incisions. An anatomical model was requested alongside the surgical guide to assist with the planning of the surgical approach.

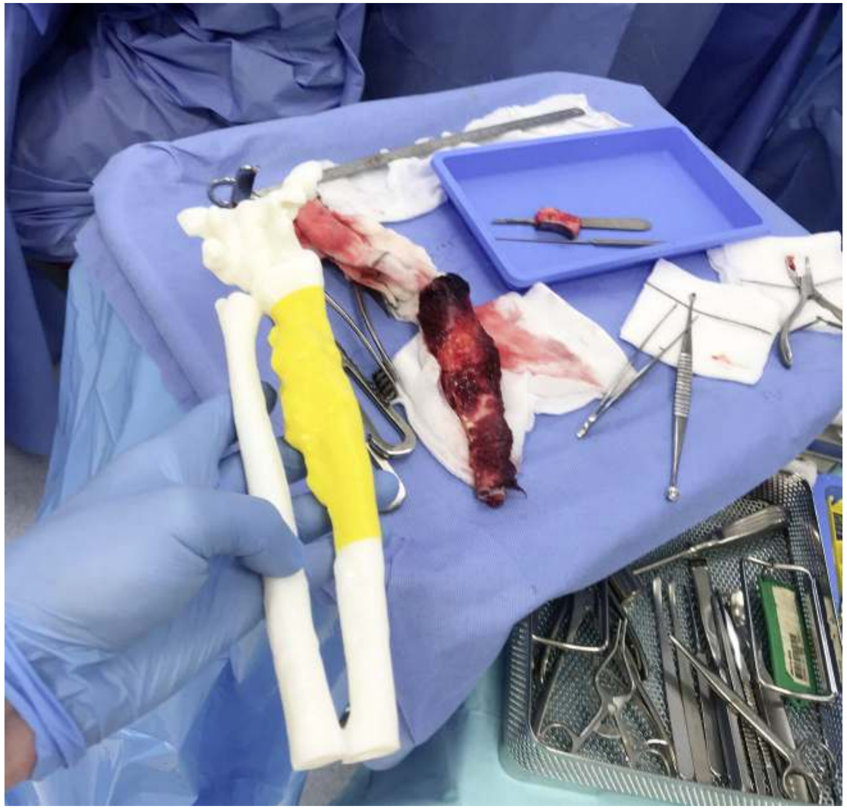
3D LifePrints developed a virtual model of the patient's anatomy, including the tumour, from the high-resolution CT scan. A 1cm margin was added at the surgeons' request to the extremities of the tumour in order to determine the ideal cutting planes for the patient specific surgical guide which would be used to resect the tumour.

An anatomical model was 3D printed in multi-colour to vividly show tumour boundaries while the surgical guide was 3D printed in sterilisable material for the surgery, shown in the picture adjacent to the model.

3D LIFEPRINTS
CASE STUDY

ONCOLOGICAL PRE-SURGICAL PLANNING, VIRTUAL SIMULATION, SURGICAL GUIDE

SPECIALITY: ORTHOPAEDIC ONCOLOGY
PROCEDURE: PARTIAL RADIAL OSTEOTOMY
DEVICE: 3D PRINTED PATIENT SPECIFIC ANATOMICAL MODEL AND SURGICAL GUIDE



OUTCOME / BENEFITS

The surgeon commented that is was *“Superb to have the design engineers embedded within the hospital. Very responsive and ended up with a model that really accurately reflected our patient's pathology which was of huge assistance both intra-operatively and for pre-operative consenting and discussion.”* And in respect of the guide *“The intra-operative guide hugely assisted the intra-operative resection and ensured we had an adequate margin around the tumour.”*

This time in theatre for this complex surgery was reduced by over an hour and 15 minutes by the use of the anatomical model and guide.

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)

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.

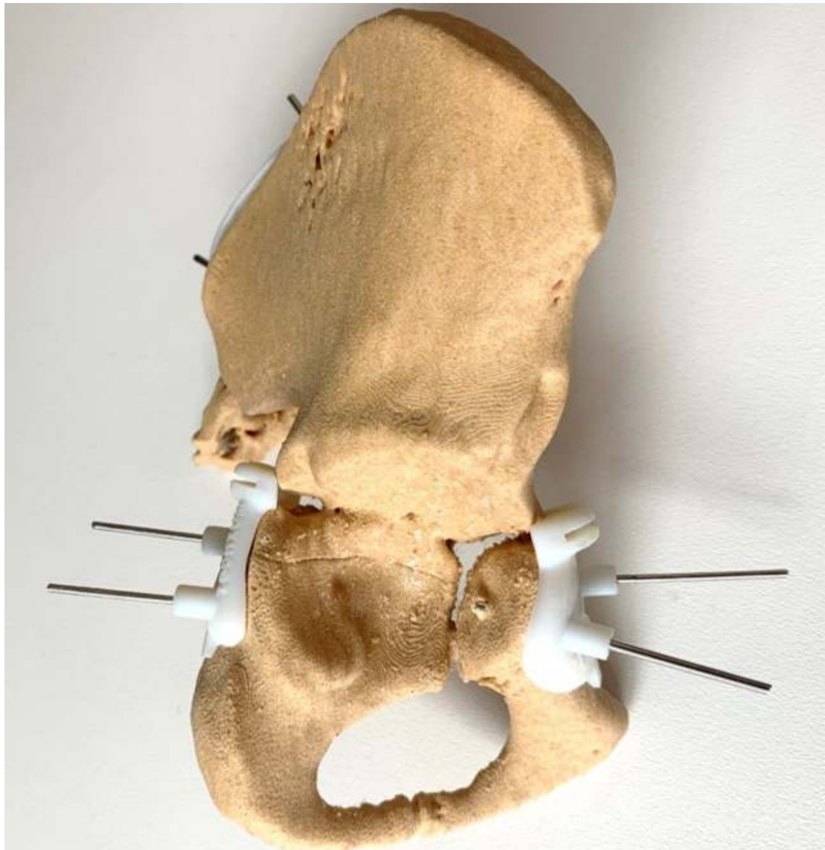
Description

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



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.

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

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.

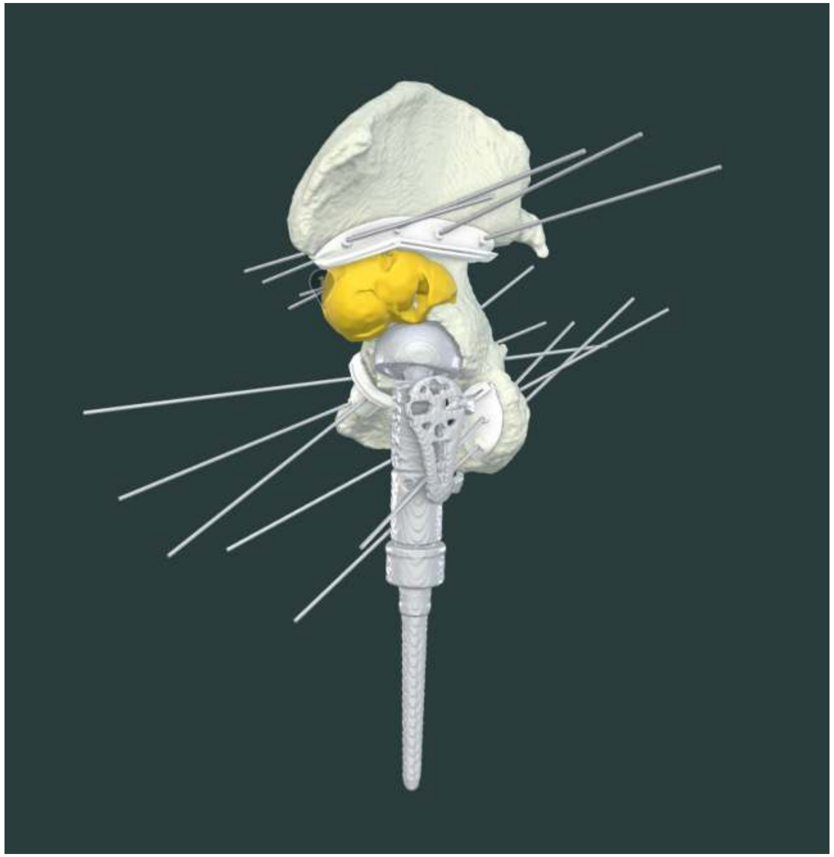
A fast-track service was required to meet the urgent surgery date for the resection of the sarcoma.

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).



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 chordoma, a rare type of sarcoma growing in the thoracic region (T2-T4) of their spine, required urgent surgery to remove it due to its proximity to the spinal cord and its affect on the structural integrity of the spinal column.

The surgical team were presented with the difficulty of resecting the tumour and affected tissue in an extremely challenging location in the body. Additionally, artificial support would need to be implanted to maintain the patient's structural mobility and strength. A request was made for (i) an anatomical model to be used for pre-surgical planning and (ii) a virtual surgical simulation ahead of the live procedure.

DESCRIPTION

3D LifePrints developed a virtual model of the patient's spine, spinal cord, oesophagus, airway, blood volume and tumour.

As the accurate boundaries of the tumour were only visible on the MRI, the imagery was overlain onto the CT data to define its location and severity.

3D LIFEPRINTS
CASE STUDY

ONCOLOGICAL PRE-SURGICAL PLANNING AND VIRTUAL SURGICAL SIMULATION

SPECIALITY: SPINAL
PROCEDURE: CHORDOMA RESECTION AND SPINAL CAGE INSERTION
DEVICE: 3D VIRTUAL AND PRINTED PATIENT SPECIFIC ANATOMICAL MODEL

CHANGING THE ENTRY POINT

Using the model in pre-surgical planning brought immediate benefit to the team as assessment made it clear how close the tumour was to the patient's oesophagus.

An oesophageal surgeon was brought in and the location of the surgical entry site altered to address this concern. This insight improved the accuracy of the team's plan, which can have a direct affect on outcomes and therefore the patient's chances of survival.

The surgeons confirmed that time taken in theatre was significantly reduced having had use of the 3D technologies.

DESIGNING THE CAGE

Virtual planning of the surgery by 3D LifePrints allowed for the precise design of a set of custom-made patient-specific implants, consisting of a carbon fiber spinal cage, bespoke rods, and screws which would fixate onto the remaining bony anatomy post-osteotomy.

3DLP's embedded biomedical engineer, under direction from the surgical team, individually positioned and designed the implants to fit the patient's anatomy while taking into account the anatomical situation once the vertebrae and tumour were surgically removed.

RESECTION CHALLENGE

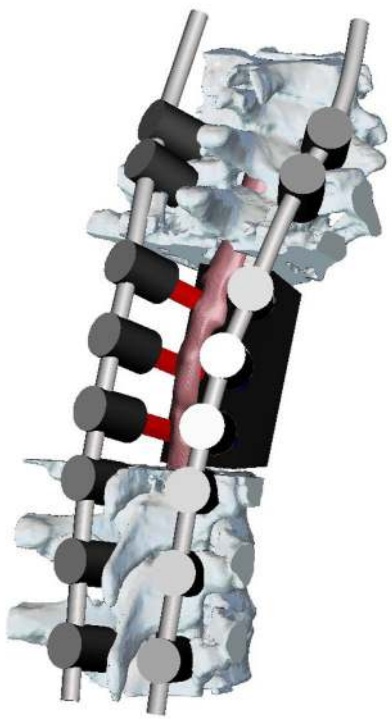
Accuracy of resection was crucial. The surgeons had realized that it would be impossible to remove a safe margin of tissue around the tumour site without resulting in paraplegia for the patient as the growth was sitting on the spinal cord. Inevitably, cancer cells would be left behind.

The use of CarboFix rod, screws and cage made targeted post-surgery proton therapy possible. To further add to the complexity, in surgery the aggressive nature of the tumour became clear, having grown an additional 1.5cm in the interim month between virtual surgery and live theatre.

3D LIFEPRINTS
CASE STUDY

ONCOLOGICAL PRE-SURGICAL PLANNING AND VIRTUAL SURGICAL SIMULATION

SPECIALITY: SPINAL
PROCEDURE: CHORDOMA RESECTION AND SPINAL CAGE INSERTION
DEVICE: 3D VIRTUAL AND PRINTED PATIENT SPECIFIC ANATOMICAL MODEL



CUSTOM ROD IMPLANTATION

Carbo-Fix carbon fiber rods were chosen to fix the cage in place owing to their level of fatigue strength and suitability for follow up radiation therapy; producing no backscattering or attenuation under CT. The rods fitted the patient "absolutely perfectly" as a result of 3D LifePrints' planning and the surgical team was able to finish the surgery in the second session, without the need to operate for a third straight day. Virtual planning of the screw lengths resulted in accurate recreation of the plan during live surgery with no deviation from the predetermined lengths. The only change from the virtual plan was a decision to alter the carbon cage as a result of the growth of the tumour.

OUTCOME

After a total operation time of 31 hours, spread over two days, the surgery was considered a complete success and the patient has begun recovery.

ORTHOPAEDIC SOLUTIONS

WE PRIDE OURSELVES ON PROVIDING OUTSTANDING CLIENT SERVICE, AND ARE ALWAYS AVAILABLE FOR A DISCUSSION

EMAIL US

info@3dlifeprints.com

CALL US
+44 (0) 151 528 6830 (Liverpool / Manchester office)
+44 (0) 1865 52 2767 (Oxford office)
+44 (0) 207 193 5630 (London office)
+44 (0) 113 328 1487 (Leeds Office)

FIND US

Alder Hey Children's Hospital
Eaton Road, Liverpool L12 2AP, UK
Nuffield Orthopaedic Centre
Old Road, Oxford OX3 7LD, UK
Wrightington Hospital
Hall Lane, Appley Bridge, Wigan WN6 9EP, UK
Leeds General Infirmary
Great George Street, Leeds, LS1 3EX