PATIENT SPECIFIC MEDICAL
DEVICES AND SOLUTIONS
AT THE POINT OF CARE

3DLIFE Prints

3D SOLUTIONS FOR PAEDIATRIC ORTHOPAEDICS

3D PRINTED ANATOMICAL MODELS
PATIENT SPECIFIC IMPLANT
PLANNING CUSTOMISED SURGICAL
GUIDES

3D LIFEPRINTS

PAEDIATRIC ORTHOPAEDIC SOLUTIONS

PAEDIATRIC ORTHOPAEDIC PRODUCTS

- Patient-specific anatomical models
- Surgical guides
- Medical phantoms

PAEDIATRIC ORTHOPAEDIC APPLICATIONS

- Pre-surgical planning
- Patient/patient family communication
- Intra-operative surgical guidance
- Medical research
- Colleague education and training

Case Summary

In this case involving a young patient, anterior cruciate ligament (ACL) reconstruction in the knee was a complex procedure where the surgeon needed to navigate into the distal femur whilst avoiding the patient's growth plate. It was essential that the tunnel placement did not breach the growth plate as this can cause abnormal growth and future joint issues.

The surgeon requested a model of the distal femur to show the complex 3D geometry of the growth plate; the growth plate curves in all three planes which is difficult to appreciate without a 3D model.

Description

3D LifePrints produced a model from MRI, allowing visualisation of the growth plate in relation to good femoral bone, suitable for drilling. The model was printed in bone-like material with the growth plate highlighted in a different colour (red). Having the model printed in two halves gave the surgeon a unique appreciation of the geometry of the growth plate inside the femoral head.

Additionally, once a proposed tunnel was drilled, the model could be separated to confirm the growth plate hadn't been damaged.

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CASE STUDY

PAEDIATRIC ORTHOPAEDIC PRE-SURGICAL PLANNING AND SURGICAL SIMULATION

SPECIALITY: ORTHOPAEDIC
PROCEDURE: RECONSTRUCTION OF ACL
DEVICE: 3D PRINTED PATIENT SPECIFIC ANATOMICAL MODEL

OUTCOME / BENEFITS

Visualising ideal cutting and drilling planes from 2D imagery can be difficult. With an operable 3D model it became much easier to determine the best position and angle for the drill to enter the distal femur, through which the ligament could be properly anchored.

Pre-rehearsing the surgery meant the team was able to successfully locate the tunnel placement for the ACL reconstruction and not compromise the development of the femur.

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..

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CASE STUDY

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.

Case Summary

A paediatric patient at a childrens hospital required a pelvic osteotomy and relocation of the hips to correct their hip dysplasia.

The surgical team requested models of the patient's pelvis, femora and accompanying cartilage for use in their pre-surgical planning and simulation.

Description

3D LifePrints segmented the patient's data from their CT scans and produced multicolour multi-material models to aid the surgical team in their visual and manual assessment of the patient's condition.

The hemipelvis and proximal femora were printed in woodfill, a bone like material, to allow for realistic surgical simulation. The acetabular and femoral cartilage, calculated by defining the space between the external surface of bony anatomy and the boundaries of the contrast agent, was printed in clear PLA. The contrast agent was also printed in red TPU for reference.

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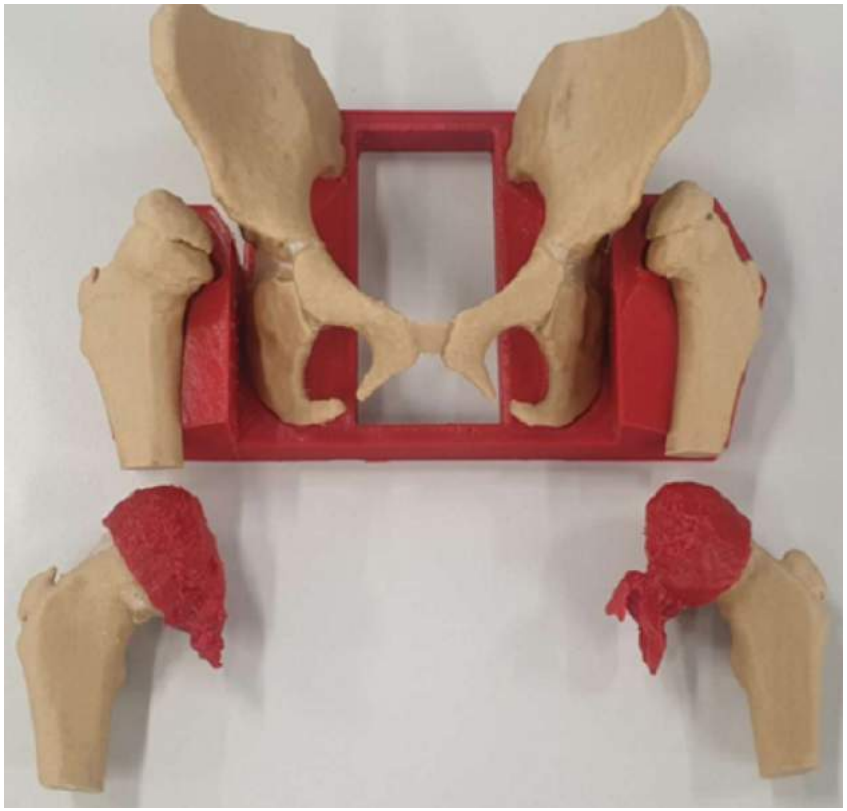
CASE STUDY

PAEDIATRIC ORTHOPAEDIC PRE-SURGICAL PLANNING AND SURGICAL SIMULATION

SPECIALITY: ORTHOPAEDIC
PROCEDURE: PELVIC OSTEOTOMY AND RELOCATION OF HIPS
DEVICE: 3D PRINTED PATIENT SPECIFIC ANATOMICAL MODELS



OUTCOME / BENEFITS

Besides the pre-surgical assessment and planning, the model was also used to effectively communicate the condition and the treatment choice to the patient and their family, a unique benefit to 3D printing as it provides a highly visual, tactile representation of the anatomy and pathology which might otherwise remain too abstract in people's minds.

This makes agreement on things like surgical approaches easier in paediatric cases where families make decisions on behalf of the patient.

Case Summary

The orthopaedic team at at a children's hospital were presented with an eight-year-old patient suffering from congenital spinal kyphoscoliosis. A complex procedure to rectify the curvature was required.

The lead surgeon requested a patient-specific anatomical model to assist the team in their pre-operative planning.

Description

Using segmentation software, 3D LifePrints' biomedical engineer segmented the patient's CT scan data to build 3D model of the spine. The model was then 3D printed in rigid, sterilisable polyamide filament.

The printed model was subsequently sterilised using an autoclave container so that it could be safely brought into the operating theatre.

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CASE STUDY

PAEDIATRIC ORTHOPAEDIC PRE-SURGICAL PLANNING AND INTRA-OPERATIVE REFERENCE

SPECIALITY: ORTHOPAEDIC
PROCEDURE: CORRECTION OF CONGENITAL SPINAL KYPHOSCOLIOSIS
DEVICE: 3D PRINTED PATIENT SPECIFIC ANATOMICAL MODEL

OUTCOME / BENEFITS

The surgeon remarked: *"The model was invaluable for use by the surgical team to undertake this complex procedure. It was useful both pre-operatively and intra-operatively – the surgery would have been much more complicated and difficult without the model in theatre. Without the model, the surgical team would have had a higher chance of needing to carry out an interior approach to the spine which would have increased time in theatre and the surgical risks of complications to the patient."*

Case Summary

A paediatric patient at a children's hospital presented with arthritic cysts in their midfoot alongside a condition which had caused gross malformations of the foot. Both problems were causing the patient discomfort and affected their plantar pressure distributions during gait.

The lead surgeon requested a patient-specific anatomical model of the foot to assess the need for surgery and be used for pre-surgical planning of the cyst removal if necessary.

Description

3D LifePrints segmented the patient's CT scan data and printed a model in a material that was both rigid, in order for any surgical simulation, and transparent, so that the location and severity of the cysts could be more easily identified.

The surgeons decided against surgery after seeing the model.

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CASE STUDY

PAEDIATRIC ORTHOPAEDIC PRE-SURGICAL ASSESSMENT

SPECIALITY: ORTHOPAEDIC
PROCEDURE: ARTHRITIC CYST REMOVAL
DEVICE: 3D PRINTED PATIENT SPECIFIC ANATOMICAL MODEL

OUTCOME / BENEFITS

Using the model, the surgeon was able to assess the level of need for surgery and choose a different approach to treatment. The model in this case becomes a good example of how 3D printed models can act as decision-making support in more ways than one; in this instance invasive surgery was avoided for the patient and the hospital resource costs avoided.

While the model had been manufactured in sterilisable material in anticipation of its intra-operative use as a point of reference, the decision to forego surgery in favour of alternative treatment has seen the model become and orthopaedic teaching aid in the department.

Case Summary

Treating paediatric scoliosis patients was common at a childrens hospital, however, there remains no universally established CT scanning protocol for the condition. As a result, the orthopaedic department wanted to work toward establishing a protocol that maximised image quality, while minimising radiation exposure, for paediatric patients with scoliosis with and without accompanying metalwork.

As a result, they reached out to 3D LifePrints for assistance in creating a series of patient specific spinal phantoms which imaged with correct Hounsfield Unit (HU) ranges for skeletal tissue, soft tissues and metalwork, and which could therefore be used to optimise their scanning protocol and help overcome issues such as metal artefact in the scans.

Description

Using patient scans, 3D LifePrints segmented the patient's spine and 3D printed the model in FibreTough, a material which offered a similar HU range to paediatric spinal bone when scanned. The external surface of the torso was also modelled and then printed in PLA to establish housing for a special gelatine mix which was poured and set to encompass the spinal model. The gelatine mix mimicked the HU range for soft tissues.

Two scans were taken, one with metalwork included in the spine and one without, allowing the team to explore the parameters for what makes the best imaging protocol.

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CASE STUDY

PAEDIATRIC RADIOLOGICAL RESEARCH

SPECIALITY: ORTHOPAEDIC
PROCEDURE: SCOLIOTIC SPINAL CT IMAGING
DEVICE: 3D PRINTED ANATOMICAL PHANTOMS

OUTCOME / BENEFITS

With the research ongoing, the phantom models continue to be a repeatable source of support for experimentation as the department seeks to minimise radiation dosage for their patients while maximising the image's data potential.

Case Summary

Reconstructive surgery is frequently employed to improve the congruency of the hip, to prolong or obviate the time-to-arthroplasty. Surgical decisions regarding reconstructive surgery can be challenging, and an arthrogram is the most dynamic investigation available to inform the decision-making process. However, arthrograms only offer two-dimensional imaging and necessitates both a general anaesthetic and time in the operating theatre.

Surgeons at a children's hospital asked for a series of 3D printed anatomical models to investigate the question – “Can 3D printing replace an arthrogram for hip imaging?”

Description

3D LifePrints received and segmented a variety of patient CT scans of paediatric hips displaying a range of dysplasia.

These models were then 3D printed in rigid, bone-like material for more realistic haptic experimentation and surgical simulation.

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CASE STUDY

ORTHOPAEDIC MEDICAL RESEARCH AND EDUCATION

SPECIALITY: ORTHOPAEDIC
PROCEDURE: HIP DYSPLASIA INVESTIGATION
DEVICE: 3D PRINTED PATIENT SPECIFIC ANATOMICAL MODELS

OUTCOME / BENEFITS

3D printing offered and opportunity to produce bespoke dynamic models of diseased hips, which enabled the surgeon to gain greater insight into the surgery required. By testing different materials, the models allowed surgeons to test optimal osteotomy positions and reliably template the materials required for the procedure.

It was also useful in the process of obtaining patient consent, enabling surgeons to perform ‘surgery’ on the printed model pre-operatively as a ‘trial-run’ or when training trainee surgeons.

Case Summary

The Orthopaedic department at a children's hospital conducted a series of workshops for clinicians.

A number of 3D models demonstrating a variety of complex tri-planar ankle fractures were commissioned so that participating clinicians could examine the exact topography of the breaks and understand how each could be treated.

Description

Using segmentation software, 3D LifePrints' biomedical engineer segmented the patients' CT scan data to build 3D models of the ankle bones and feet. The models were then 3D printed in rigid material for rigorous handling by workshop attendees.

The models could be separated along the fracture line to allow attendees to fully investigate the nature of the fractures and anticipate the effects of different treatment options.

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CASE STUDY

ORTHOPAEDIC MEDICAL RESEARCH AND EDUCATION

SPECIALITY: ORTHOPAEDIC
PROCEDURE: ANKLE FRACTURES
DEVICE: 3D PRINTED PATIENT SPECIFIC ANATOMICAL MODELS

OUTCOME / BENEFITS

The results of the workshops were reported as incredibly positive with clinicians confirming that the models improved their understanding of the issues, as well as greatly improving their ability to describe the 3D configuration of the break for teaching purposes.

A Surgeon commented; “I believe the use of a 3D model could improve pre-operative planning and produce novel operative strategies for new cases.”

PAEDIATRIC ORTHOPAEDIC SOLUTIONS

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

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