

3D printing – the new revolution in veterinary medicine?

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look at 3D printing, and how it can aid veterinary professionals and improve patient care

3D printing has been revolutionising human medicine since the 1980s through advancements in prosthetics, implants and surgical planning. But how can veterinary professionals make the most of this technology to change the way we work and, ultimately, improve patient care and recovery?

What is 3D printing and how does it work?

There are a number of ways you can create 3D printed anatomical models. One is to use an image created with computer aided design (CAD) modelling software, while another is to use the CT scans performed on veterinary patients.

In the latter, once the CT scan is performed, the images obtained are exported into a suitable object file format. The object is then built up in layers of powder, where the cross sections are melted by a laser. These layers of melted powder then harden to form the finished model. A detailed video of the entire process can be found on the VetCT website (www.vet-ct.com/gb/services/3d-printing).

The process involves large and specialist 3D printers, which are very different from the desktop 3D printers advertised on the general market.

Various materials can be used for the models. The most commonly used technology is called Nylon SLS (selective laser

sintering) as it can print complex and detailed orthopaedic models that can be drilled, screwed, plated and sterilised – this is ideal for surgical planning.

How can I use the 3D printed model? Will it just sit on a shelf?

As prices become more affordable, the use of 3D printing in veterinary medicine is becoming extremely popular.

For example, veterinary surgeons are using 3D printing for orthopaedic diagnosis and surgical planning, while the technology can be applied to treat disorders such as angular limb deformities, femoral/tibial torsions, patellar luxation or complex fracture assessment. This is because 3D models allow surgeons to measure the deformity directly, perform preoperative morphologic assessments and communicate more effectively with the owners of the patient. Implants can then be directly matched to the bone, without the need of special templating software for diagnostic images.

The models can also be used to practice a surgical repair, as to determine the proper location for placements of implants. 3D printing can also be used to plan surgical approaches in case of an osteotomy.

Elsewhere, 3D prints of vascular structures can also be obtained, based on CT angiographic studies. These can be used for planning surgical and interventional

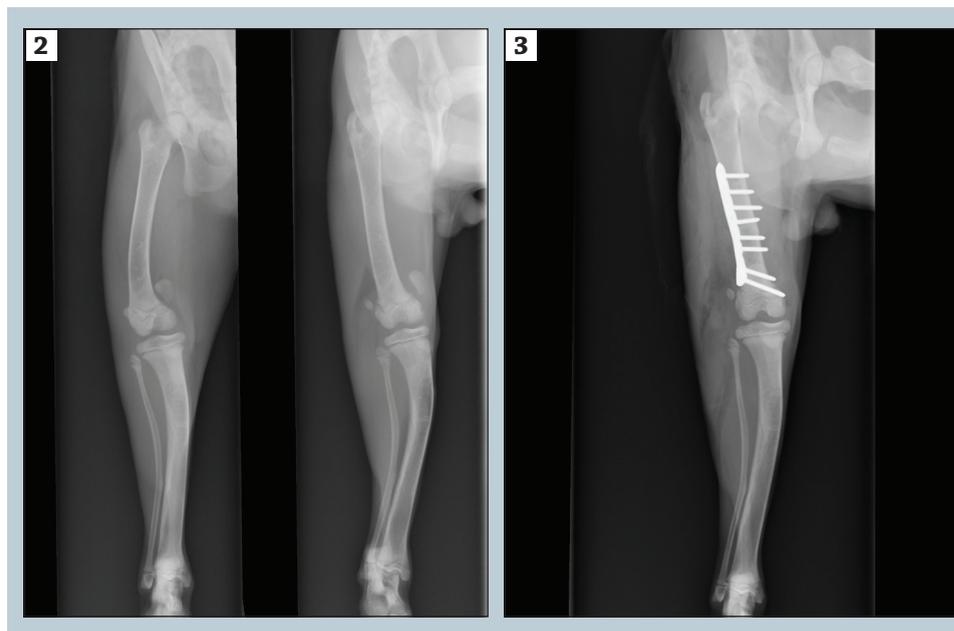


Figure 2. Preoperative radiographs showing Zuko's patellar luxation. **Figure 3:** Postoperative radiograph.

radiology approaches to portosystemic shunts, vascular ring anomalies, and other vascular malformations.

In oncology, meanwhile, 3D models can be used to assess the extension of oncologic masses, as well as treatment planning.

3D prints generally improve understanding of complex anatomical structures, so there is no doubt the technology will find its place in teaching and education.

Case study: Ridge Referrals

Ridge Referrals is a small animal orthopaedic referral service in south Devon, with a particular expertise in arthroscopy.

The service is led by Mr Patrick Ridge, who has been pioneering 3D printed technology through VetCT, and realising the benefits for some time.

When asked what interested him about the use of 3D printing in the veterinary profession, Patrick said there are certain situations where being able to rehearse a procedure in advance of surgery makes it a lot more "predictable, safe and precise".

"We see a number of cases where some form of osteotomy will be required and the smaller the patient, the smaller the margin for error," he said. "Being able to plan the surgery before performing the osteotomy, and then being able to contour the implants before even anaesthetising the patient, provides enormous benefits."

An example of Patrick finding value in using the 3D printed models was with Zuko, a juvenile Savannah cat with grade 4 medial patellar luxation.

Zuko was presented six weeks after a fall from height. It was apparent from plain radiographs he had damaged the distal

femoral physis, which had led to a femoral deformity. A CT scan was performed, and a 3D model printed with VetCT for surgical planning (Figure 1).

From volume rendered images of the CT scan, a distal femoral osteotomy was planned, including a lateral closing wedge osteotomy and derotation. This was first planned using the 3D model and performed with a 2mm locking compression plate contoured, and applied. Care was taken to make specific measurements from landmarks on the model that would be readily palpable on the patient, for both the osteotomy and the placement of the plate laterally. Optimal screw size was measured, too. This way, any variation from the model would be easily noted at the time of surgery and rectified smoothly so a near perfect osteotomy and reduction could be performed. Screw placement in particular was such as to avoid the distal femoral physis, which may have still had some growth potential.

Under anaesthesia, and via a standard lateral approach, the femur was exposed and an identical osteotomy performed. The femoral varus and torsional deformity were corrected and the osteotomy stabilised with the precontoured 2mm locking compression plate and screws. The femoral sulcus was deepened and closure was routine. Following the procedure, radiographs showed excellent femoral alignment, with the patella remaining in the femoral sulcus through a full range of movement.

Zuko was confined to a cage for four weeks, and further radiographs taken after this time contained good signs of bony healing (Figures 2 and 3). The patella still remained in place through a full range of movement, with Zuko returning

to a normal active lifestyle without restrictions or lameness.

According to Patrick, the use of 3D models had no negative impact on surgery time – in fact, it was the opposite.

"This is clearly one of the most amazing things," he said. "It doesn't just mean we get to go home on time, but more importantly, the models reduce surgical time, thereby decreasing complications. With postoperative infections in orthopaedics being shown to be related to anaesthetic time, among other things, reducing this will hopefully allow us to better control this aspect of surgery."

Discussing the impact on clients, he said the models help with explanation of cases and surgery.

"They are great to show clients the end result, as this helps them better understand the problem as well as appreciate the solution," he said. "I am a control freak when it comes to operating, especially postoperative management, so if we can get clients to understand why it is so important their dog not be allowed to run around uncontrollably immediately after surgery – that's a good thing."

Asked where he thought 3D printing would go in the future,

considering how quickly the technology has developed in the past few decades, Patrick called it "one of the most exciting areas" to get into.

"We are on the edge of customised orthopaedic surgery while nearing the edge of customised biologic treatments," he said. "If we can combine digital printing of biologic scaffolds with stem cell treatments or cellular processes, for example, we have the potential to do things we have only dreamed of."

● 3D printing can now be used by vets to improve diagnostic accuracy, plan complex interventions, and aid in both teaching and client communication. Future applications could include printing of soft tissue structures such as tendons, ligaments and skin grafts. Meanwhile, in human medicine, bespoke surgical and dental implants are becoming commonplace. The possibilities, as they say, are endless.

More information

If you'd like to know more about the benefits of combining diagnostic reporting with 3D printing technology, please get in touch with VetCT and quote "Veterinary Times".

Figure 1. Volume rendered image (below) and corresponding 3D printed model (right). Zuko, a juvenile Savannah cat with grade 4 medial patellar luxation.



VETCT

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