3D printing, motion-tracking technology create new treatment options for veterinary orthopedic patients

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Barnes removes a newly printed 3D model and its scaffolding (connecting the printed bone to the platform) from the printer's build platform (black). Once removed from the platform, the bone model is detached from the scaffolding. Credit: Texas A&M University School of Veterinary Medicine & Biomedical

When you walk into a veterinarian's office, you expect to see photos of furry friends, anatomy charts, and a computer upon which your doctor will make notes about your pet. When you walk into Dr. Kate Barnes' office, you see all of this with a futuristic touch of 3D printers.

A clinical associate professor at Texas A&M University's School of Veterinary Medicine and Biomedical Sciences (VMBS) who specializes in small animal orthopedics, Barnes devotes her research and clinical practice at the VMBS' Small Animal Teaching Hospital (SATH) to the cutting edge by defining 3D printing's role in health care and implementing mobility assessment technology into veterinary medicine as part of the Gait Lab.

Veterinary medicine in 3D

Using the 3D printers in Barnes' office to print biocompatible materials puts the VMBS on the cusp of further developing veterinary medicine. While 3D models are more common in human medicine to create custom-fit replacement parts and medical devices, Barnes said the practice of using 3D printed surgical guides is still in the developmental phases in veterinary medicine.

Of particular interest to Barnes is working to implement 3D models into her operative protocols, both in the planning phase of surgery and during the actual procedure.

"We can do a couple things with the 3D printers," she said. "One is that we can look at the bones with our 3D software and do some virtual surgical planning; it is a little easier to assess some of the limbs and

bones when you're looking at them in 3D. We also can actually print out the models so that we can assess deformities and fractures during the process of planning surgeries, and we can practice those surgeries using the models."

One of the most common issues Barnes and her team treat in dogs, and occasionally cats, using printed 3D models is angular limb deformities, a condition in which the limb is not straight. Angular limb deformities can be the result of trauma or improper growth and are commonly treated surgically by making cuts in the animal's bone, which allows the deformed limb to be accurately realigned.

To ensure the cut is accurate and efficient, SATH orthopedic surgeons can print 3D surgical guides, which are tailor-made templates developed using special software during the surgical planning stage. Once guides are printed, they are attached to a bone during surgery, showing the surgeon exactly where and at what angle to cut to correct a deformity.

Guides are beneficial because they are customized to the exact size and shape of each individual patient.

"If you have everything already mapped out, the use of surgical guides decreases the surgical time, which decreases the risk for things like infection," Barnes said. "If you're free handing the procedure (without a guide), there's also a little bit more of a tendency to be less accurate.

"So, guides help with the timing in surgery, help with the accuracy in surgery, and help shorten the time that a dog is under anesthesia," she said.

One of the current challenges of moving 3D printing more mainstream is the high price faced by veterinarians interested in developing their own models and guides, which includes the cost of the software, printers, and

the biocompatible materials that are safe to use on living organisms.

Fortunately, because the rewards outweigh the cost of the equipment, these resources are available at Texas A&M for use with veterinary patients and treatments are offered at a price that is accessible to owners, Barnes said.

Mobilizing the future of mobility

In addition to 3D printing, Barnes, along with other researchers at the SATH, are helping dogs improve their mobility in the new Gait Lab. Barnes' work in the Gait Lab is unique, both furthering research and putting the use of motion-tracking technology into medical practice.

The VMBS is one of the only veterinary schools and the SATH is one of the only veterinary practices with access to this technology, which performs two different kinds of assessments.

The first is called kinematic assessment, which allows VMBS researchers to examine joint and limb movement using small reflective balls. Barnes compares this technology, which they're currently only using for research purposes, to that used to create CGI effects in movies.

"It's the same type of technology," she said. "We can put small reflective balls on the dogs as they walk, and we have cameras that pick up their movement so we can analyze it."

The second type of assessment, called kinetic assessment, uses plates to determine how much weight a dog is bearing on each leg. VMBS clinicians have used this tool both with the SATH's orthopedic patients and in many research projects.

The results produced in the Gait Lab enable researchers to monitor a

dog's joint motion or even detect subtle lameness. If a dog is favoring one leg due to pain, the new technology allows Barnes and her team to see this in the data points.

The data gathered in the Gait Lab allows Barnes and her fellow researchers to quantitatively monitor a dog's mobility. Prior to using this technology, most postoperative mobility data was subjective, relying on the researcher and pet owner's perspective to monitor a dog's progress.

"During a dog's recovery, the placebo effect occurs in owners and veterinarians," Barnes shared. "When we do treatments on animals, people want to believe that they're getting better.

"The Gait Lab is great because it gives us an objective number for how much weight a dog is bearing on their leg, instead of having to rely on just, "I think it looks pretty good." It helps us track them over time and really be able to tell the impact of what we've done for them," she said.

Because the kinetic assessment technology used with patients in the Gait Lab is not typically available at private veterinary practices, Texas A&M is one of the only places in the state where patients can experience its benefit; as such, the SATH and the work being conducted in the Gait Lab have the potential to make a large impact on veterinary medicine.

The forefront of veterinary medicine

Texas A&M continues to move veterinary research into the future by empowering work like Barnes' research in 3D printing and the Gait Lab.

These technologies are still relatively new in terms of veterinary surgical technology, and Barnes is one of few practitioners dedicating her career to their advancement.

"They're a little bit more common in human medicine. It's something that is becoming more available in veterinary medicine, but it's often more time consuming," she said. "There are other universities that do it, but it's definitely something that's still up and coming."

Barnes is also helping ensure that these technologies will grow in the future by passing on her knowledge and experiences to students.

"I do a lecture on 3D printing in angular limb deformities," she said. "Students will usually look at the models together, look at the guides if we have them, and talk about the deformity and what things we're going to do to correct it."

Because of Barnes' work, as well as other innovations in research and patient care being explored at Texas A&M, the SATH will be home to many exciting breakthroughs in the coming years.

As Barnes continues to help pioneer this movement, she looks to the future with excitement.

"It's coming out more and more in veterinary medicine, so hopefully we'll get the opportunities to use it even more," she said. "If you know any cases, any dogs with crooked legs, send them over. We'd be happy to see them."

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