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The commercialization of 3D printed animal skeletons

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1、Introduction

3D printing technology was developed since late 1970 however it became popular in these years. Until now, the technology has been applied in various ways: daily living items or applied for biomedicine. In order to apply 3D printing technology on animals and assist the veterinarian to treat, we establish the practical procedures to apply the 3D printing technology in NPUST animal hospital.

2、Design Concept

It is just the beginning for applying the 3D printing technology in human medicine, but many aspects have been trialed: tracheal stent, reconstruction of face, and cranial surgery. These clinical trails were listed below:

(1) A patient with narrowed airway received thoracic dynamic computed tomography (CT). The obtained images were applied to produce breathing trachea 3D models. The models could assist to simulate the placement of bronchial stent and explain the details to the patient's families.

(2) The 3D models could help to diagnose efficiently, make the surgical plan, and offer the related information for facial surgery. According to the literatures, applying 3D models could reduce the surgical duration. More, mirrored CT image could be used to produce the opposite ear when the ear was lost due to the trauma or tumor.

(3) In order to increase the safety and success rate, 3D models also could be used to simulate the unusual cranial tumor remove surgery. Therefore, applying the 3D models for pre-surgical checking could reduce the surgical duration and human errors.

(4) For cardiovascular diseases, 3D models could be used to make the heart and its related vascular structure models. It could help the surgical members to understand the area for catheter placement and the cardiac construction.

(5) For orthopedics diseases, some surgical teams have applied the 3D models to diagnose and make the surgical plan, including cranial bone reconstruction, spinal, pelvic joint, pelvic and scapula bone disease. For example, the 3D printing models could help to decide the proper bone plate for cranial bone reconstruction and the surgical and inpatient time could be reduced. The comfort and cosmetic level could also be elevated.

3、Technical Development

(1) CT scan

The 3D images of skeletal come from the dog which undergo the computed tomography. At first, the dog was anesthetized on examination table and it was removed to moving table of CT scan until it is stable. Then, the dog was positioned and processing the CT examination.

(2) Edit the CT image

The obtained CT DICOM files were imported to OsiriX. The essential area was selected and exported to STL files.

(3) Slicing the object

The STL files were imported to special slicing software of the 3D printer to process the computer assist making. The slicing was set automatically to place the supported material. When the slicing is finishing, the files could be exported to memory card which was inserted to 3D printer to control its' printing or by connecting the connecting port of printer directly. (Fig. 1)

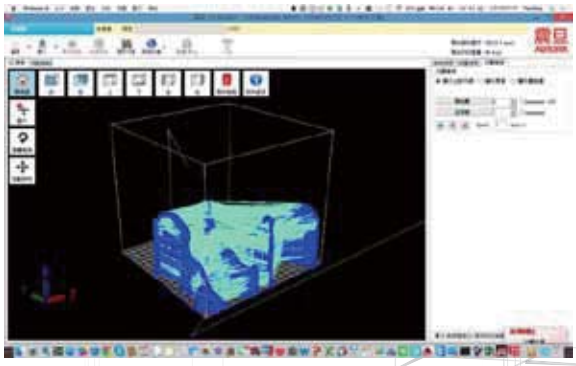

Fig 1. The special slicing software of 3D printer.

(4) 3D printing

The sliced files were sent to printer. The 3D printer will heat the printing head to the needed the temperature in order to melt the materials. Then the printer was starting to print according to setup.

(5) Remove the supported materials

When the printing was done, the slice was used to remove the final product. Then the supported materials were removed by pliérs and the sandpapers were used to polish the surface to obtain the final product.

Fig 2. Left: The printed object with supported materials.
Right: The final product after the supported materials were removed.

4、Technological Competitiveness

The 3D printing technology could be applied on various veterinary aspects: the canine cruciate ligament rupture repair, canine limbs deformity, broken avian/turtle beak repair, vertebrae reduction, prosthesis for dystrophic limbs, surgical planning for cranial surgery, and manikins for education.

5、R&D Result

An 8-year-old Chihuahua dog presented in NPUST animal hospital. The chief complaint was car accident. The physical examination results revealed the left hindlimb lameness and trauma at caudal trunk. Comminuted fracture was noted on pelvic region through radiography. (Fig. 3) In order to make and simulate the surgical plan, CT scan was performed.

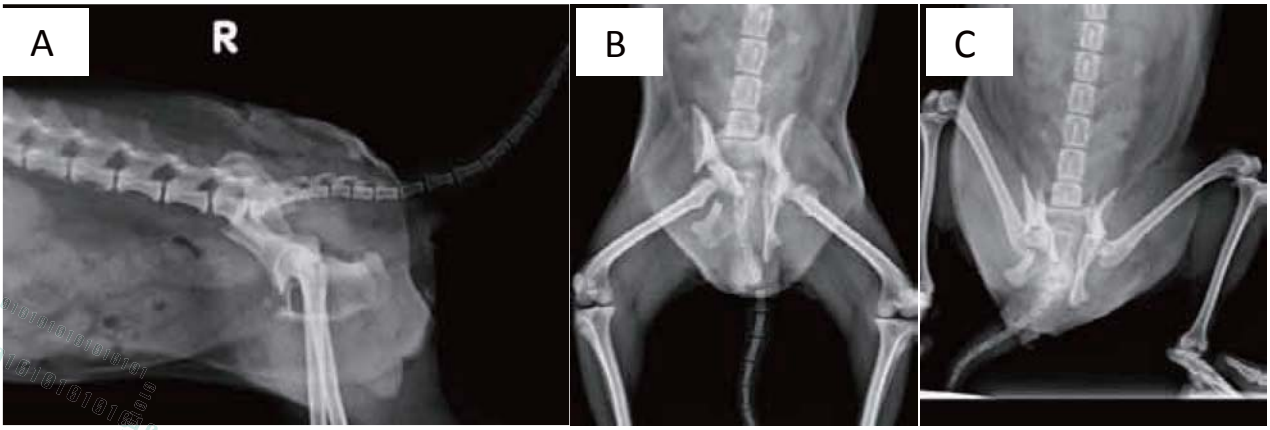

Fig 3. A: Lateral view, B: Dorsal-Ventral view, C: Dorsal-Ventral-Frog view.

The fractured pelvis and each piece of fractured bones and their related position were identified clearly through reconstructed 3D image. Further, the printed models were used to simulate the surgery procedures and served as materials for communication with owner. (Fig. 4)

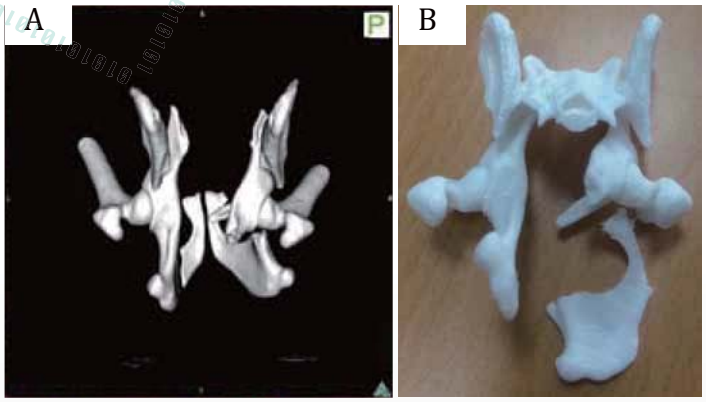

Fig 4. A: The reconstructed 3D CT images,
B: The printed models.

The surgery was done after the surgical plan was made and simulated. The post-surgery radiography revealed that the pelvic space was almost restored to normal and the reduction of compressed bone pieces were also revealed. The hematochezia was returned to normal after a few days.

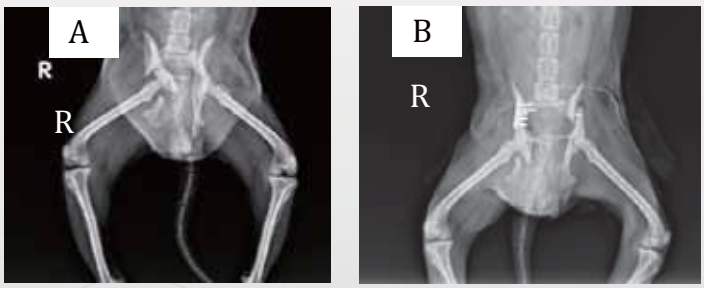

Fig 5. A: Radiograph before surgery. The narrowed pelvic cavity was noted.
B: Radiograph after surgery. The pelvic cavity almost returned to normal.

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