15th International Symposium on Computer Methods in Biomechanics and Biomedical Engineering
and
3rd Conference on Imaging and Visualization
CMBBE 2018
P. R. Fernandes and J. M. Tavares (Editors)

Abstract ID-78

LIMB SPARING IN DOGS USING PATIENT-SPECIFIC ENDOPROSTHESES AND CUTTING GUIDES: DESIGN, MANUFACTURE AND PRELIMINARY VALIDATION

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Keywords: Additive manufacturing, Personalized implant, CT-scan reconstruction, Limb-sparing surgery

Summary: Osteosarcoma, the most common type of bone tumor, affects over 10 000 dogs each year in the USA. For appendicular skeleton cases, the two available treatments are amputation of the limb and limb sparing surgery. Although amputation remains the standard of care, some owners are opposed to this approach. Limb sparing consists in removing the tumorous segment of bone and using a fixation system such as a metallic spacer-plate construct screwed to the remaining bony structures. This technique results in a functionally good outcome, nevertheless, the surgery is time-consuming and the post-surgery complication rate remains significant.
This project focuses on the limb sparing treatment of dogs clinically afflicted with osteosarcoma of the distal radius using 3D-printed patient-specific (personalized) endoprostheses (PE) and cutting guides (CG).
CT-scan data of the patient's affected and contralateral limbs are sent by the veterinary surgeon to the engineering team. Specialized software is used to build the bone models of the radius, ulna, carpal and metacarpal bones on the affected limb and of the radius on the healthy limb. The PE and the CG are designed in a CAD environment using the bone models as scaffolding. The affected radius is used to define the implant contours and the healthy radius is mirrored and positioned to replace the osteotomized radius. The designs of PE and CG are validated with the surgeon prior to 3D printing. The PE is manufactured from Ti6Al4V powder using a commercial laser powder bed fusion system, while the CG is 3D printed from ABS plastic using a commercial fused deposition modeling system. Several post-processing steps are undertaken: a) PE: stress-relief heat treatment, part/build plate separation, support removal and surface finishing, b) CG: support removal. The PE/CG kit is shipped to the surgery site where sterilization is performed. A total turnover time ranges from 65 to 85 hours.
Preliminary biomechanical testing indicates similar post-operative stability of the PE and the standard spacer-plate construct. The ongoing clinical study shows that the patient specific implants allow at least a threefold reduction of surgery time and promises to decrease the risk of post-operative infection and implant failure.