Frontiers in Veterinary Science, vol.9, pp.887676-1-887676-13, .

Biomechanical test of a new endoprosthesis for cylindrical medullary canals in dogs

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Abstract-

Exo-endoprosthesis is a limb salvage procedure for animals, although only expensive metal devices have been described. Now-a-days, new materials for this type of implant could be considered due to novel and affordable manufacturing techniques. However, a factor of safety (FoS) should be considered. There are kinetic and kinematic studies of canine natural gaits, which can be used to establish an FoS for mechanical tests for new non-metallic devices. Polyetheretherketone (PEEK) is used in different specialties in human medicine. Its mechanical properties (and its close mechanical stiffness to that of bone) make this polymer an alternative to metals in veterinary traumatology. PEEK could also be used in 3D printing. The suitability of a novel inner part of an exo-endoprosthesis manufactured by fuse deposition modeling (FDM) was presented in this study for long canine bones. Mechanical characterization of 3D-printed PEEK material and ex vivo mechanical tests of a customized endoprosthesis were performed to address it. Young's modulus of 3D-printed PEEK suffered a reduction of 30% in relation to bulk PEEK. Customized 3D-printed PEEK endoprostheses had promising outcomes for the tibiae of 20 kg dogs. Pure compression tests of the non-inserted endoprostheses showed a maximum force of 936 ± 199 N. In the bending tests of non-inserted endoprostheses, the PEEK part remained intact. Quasistatic mechanical tests of bone-inserted endoprostheses (compression-bending and pure compression tests) reached a maximum force of 785 ± 101 N and 1,642 ± 447 N, respectively. In fatigue tests, the samples reached 500,000 cycles without failure or detriment to their quasistatic results. These outcomes surpass the natural weight-bearing of dogs, even during a galloping pace. In conclusion, the 3D-printed PEEK part of the endoprosthesis for an exo-endoprosthesis can withstand loading, even during a galloping pace.

Index Terms- biomechanical test, patient-specific implant, FDM, PEEK, exo-endoprosthesis, ex vivo, tibia, canine

Citation:
Mendaza-DeCal, R.; Ballesteros, Y.; Peso-Fernández, S.; Paz, E.; del Real-Romero, J.C.; Rodríguez-Quirós, J. "Biomechanical test of a new endoprosthesis for cylindrical medullary canals in dogs", Frontiers in Veterinary Science, vol.9, pp.887676-1-887676-13, .