

Title

The use of 3D printing in pre-operative surgical planning

Abstract

The additive manufacturing technologies are bringing about a new powerful revolution in terms of tools and production capabilities to sectors where they are applied. Three-dimensions (3D) printers are radically changing the way in which we produce things and, consequently, we think objects. 3D printing is the process of creating solid objects from a digital image file.

While this revolutionary technique has already applied in Human Medicine in the field of Veterinary Medicine medical applications of additive manufacturing technologies seem so far little investigated.

As far as Human Medicine is concerned, applications of additive manufacturing technologies are extremely wide-ranging in terms of fields of interests: additive manufacturing technologies are employed in the 3D printing of tissues and organs, a process known as "bio-printing", with a particularly relevant application in surgery. In fact these technologies are used to build anatomical models to help preoperative surgical planning. It is this latter specific field of application that is recently involving Veterinary Medicine. As in humans, 3D printing can improve the planning of surgical approaches in animal patients. However, 3D printing are far from being a routine procedure in Veterinary Medicine.

The aim of the present thesis is to evaluate the application of 3D printing in pre-operative surgical planning in veterinary patients. Currently, surgical planning is mainly based on bi-dimensional images, obtained with diagnostic imaging modalities such as radiology or computed tomography. Three-D printing technology provides surgeons with tri-dimensional true size anatomic models, allowing them to better understand pathological conditions and their treatment and to precisely simulate surgical approach before the actual surgery. Moreover, the application of 3D printers considerably reduces surgery risks.

In the first part of the thesis, the main four 3D printing technologies and how they work in different models of 3D printers are described. Subsequently, the process from the acquisition of digital images with computed tomography (CT) or magnetic resonance (MRI) is explained. Specific software then converts images from CT and MRI to digital models. Digital models are then converted in G-CODE to be printed by 3D printers. Lastly, the building of digital models is briefly described.

In the second part of the thesis, notions outlined in the first part are practically applied. In particular, the application is made step by step in treatment planning in clinical cases. Both applications are made using Free Open Source software, reducing costs. Real true size anatomic models are produced with a FDM 3D printer type by a private service within few days (1-2 weeks).

In conclusion, applying additive manufacturing technologies with 3D printing is feasible in veterinary surgery, may reduce risks for the patients and helps a precise preoperative surgical planning. The main limitation of this technique is the need of a CT or MRI scans, which are not currently widespread in veterinary practice.