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Used of 3D printing technology in orthopedic oncology: Custom surgical guide and patient-matched prosthesis

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Abstract

Presenting the clinical outcome of patient-matched prosthesis and custom surgical guide via 3D printing technology. Total 11 cases of benign and malignant tumors applying 3D printing assisted surgery which are 6 anatomical models, 11 custom surgical guides, and 4 patient-matched prostheses. Image acquisition was derived from CT scan, 0.5-3 mm slices cut. The contralateral CT scan was used as a prototype for creating the patient-matched prosthesis while the ipsilateral CT scan was used in anatomical model and surgical cutting guide. Anatomical models, used as the preoperative planning tools, were printed by a fused deposition modeling (FDM) printer with acrylonitrile butadiene styrene (ABS) material and a Binder Jetting machine, 3D Systems ZPrinter 650 using VisiJet PXL materials. 11 custom surgical guides were printed by Envision TEC???s E-Guide Tint and E-Model. 4 of patient-matched prostheses, which are 2 fingers prostheses, 1 of total constrained proximal interphalangeal (PIP) joint prosthesis, and 1 of navicular 3D custom scaffold, were printed by selective laser-melted (SLM) printer with Ti6Al4V. The pore geometry selective laser-melted Ti6Al4V bone scaffolds was 200 µm, strut size and 500 µm, pore size.

Keywords: prosthesis; SLM; PIP

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Introduction

Time to produce was 3- 20 days. Preoperative planning via anatomical model showed better outcomes in term of decrease operative time and blood loss. Custom surgical guide demonstrated better outcomes comparing to navigation surgery in term of achieving same accuracy but less resection time. According to bone tumors can be found in the unusual locations which there is no off the shelf prosthesis, patientmatched prosthesis has gained popularity and played a major role in this area. Applying fabrication of 3D printing technology, via custom surgical guide and patient-match prosthesis in bone tumors surgery, has proved the advantages in limb sparing surgery.

Three Dimensional (3D) printed models can aid in effective preoperative planning by defining the geometry of tumor mass, bone loss, and nearby vessels to help determine the most accurate osteotomy site and the most appropriate prosthesis, especially in the case of complex acetabular deficiency, resulting in decreased operative time and decreased blood loss. Four complicated cases were selected, reconstructed and printed. These 4 cases were divided in 3 groups of 3D printed models. Group 1 consisted of anatomical models with major vascular considerations during surgery. Group 2 consisted of an anatomical model showing a bone defect, Tracheotomy was perfomed in 3/67 cases respiratory failures. A nasogastric tube was inserted at the end of the surgical procedure in 21 patients. The mean length of hospital stay was 10 days . Major complications included post-operative bleeding in 3 patients, 1 exitus for massive bleeding 20 days post-surgery and 1 respiratory failure treated with tracheotomy and monitoring in the Intensive Care Unit (ICU) for 3 days. Robotic surgery has been considered a valid alternative to traditional open treatment in many specializations with the advantages of an endoscopic procedure, with the same oncological and functional results and with fewer complications. The advantages of this type of surgical technique have been discussed, it is mandatory to focus on the indications and this series comprises all patients managed for head and neck cancer by TORS between February 2013 and February 2018 by the. Each case was discussed at a multidisciplinary consultation meeting during which it was decided to perform TORS. Unilateral or bilateral neck dissection of group I to V nodes, according to tumour site, was performed during the same operating time, when indicated.

Patients underwent general anesthesia via nasotracheal intubation. Transoral exposure was obtained with a Feyh–Kastenbauer (FK) retractor and three arms were used: a central endoscopic arm with a 0° integrated three-dimensional camera; a right robotic arm with a 5-mm monopolar cautery with a spatula tip; and a left robotic arm with a 5-mm DeBakey forceps. The surgeon was seated at the console and the assistant was seated at the patient's head to monitor the operative site, retract tissues, and facilitate dissection, to evacuate smoke released by the monopolar electrosurgery, and to perform suction in the case of intraoperative bleeding. Adjuvant therapy was discussed at the multidisciplinary consultation meetings, based on the pTNM classification. All charts were recorded with the following data: name and surname, age, gender, date of surgery, intra or post-operative hemorragia, tumor site, histology, pTNM stage, robot set-up time, tumor resection time, whether or not tracheotomy was performed, whether or not neck dissection was performed, insertion of a nasogastric tube or gastrostomy, time to resumption of oral feeding, surgical margins, mean length of hospital stay, adjuvant treatment .

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