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

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Statement of the Problem: Presenting the clinical outcome of patient-matched prosthesis and custom surgical guide via 3D printing technology.

Methodology & Theoretical Orientation: 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. 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, patient-matched prosthesis has gained popularity and played a major role in this area.

Conclusion & Significance: 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.

Figure 1: Demonstrating the patient-matched prostheses of 5th proximal phalange. We have developed 2 designs which are no constrained and total constrained PIP joint.

Recent Publications

1. Punyaratabandhu T, Liacouras P C and Pairojboriboon S (2018) Using 3D models in orthopedic oncology: presenting personalized advantages in surgical planning and intraoperative outcomes. 3D Printing in Medicine 4(1):12.
2. Punyaratabandhu T, Lohwongwatana B, Puncreobutr C, Kosiyatrakul A, Veerapan P and Luenam S (2017) A patient-matched entire first metacarpal prosthesis in treatment of Giant cell tumor of bone. Case Reports in Orthopedics 2017(7):1-6.
3. Wong K C, Kumta S M, Geel N V and Demol J (2015) One-step reconstruction with a 3D- printed, biomechanically evaluated custom implant after complex pelvic tumor resection. Computer Aided Surgery 20(1):14-23.
4. Wong K C, Sze K Y, Wong I O, Wong C M and Kumta S M (2016) Patient-specific instrument can achieve same accuracy with less resection time than navigation assistance in periacetabular pelvic tumor surgery: a cadaveric study. International Journal for Computer Assisted Radiology and Surgery 11(2):307-16.

Biography

Sutipat Pairojboriboon is an Orthopaedic Surgeon, specialized in bone and soft tissue tumours. His research interest is the 3D printing technology, focusing on the printed models as an assisted tool for surgery and patient-matched prosthesis. He has experience in working with engineers who focus on the 3D printing technology from the Chulalongkorn University, Bangkok, Thailand, 3DMAC in Walter Reed Military Medical Center, USA and materialize medical company for three years. He has designed a lot of custom surgical guides and patient-matched prostheses in order to perform limb sparing surgery. By using the 3D printing technology, he has proved that his works will help many sarcoma patients from amputation.

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