



Service Priorities and Programmes Electronic Presentations

Convention ID: 261

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3D Printing of Kidney Model for Laparoscopic Donor Nephrectomy

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Keywords:

3D Printing

Kidney Model

Laparoscopic Donor Nephrectomy

Transplant

Introduction

3D printing technology has developed rapidly and is employed to improve medical care, particularly in orthopaedic, cardiac and vascular surgery. However, the use in enhancing the safety of living donation surgery has not been explored.

Objectives

- Production and utilisation of a patient-specific 3D kidney model to aid pre-operative planning of laparoscopic donor nephrectomy.
- Enhancement of donor safety and vascular length preservation of kidney graft during laparoscopic donor nephrectomy.

Methodology

Live donor kidney transplantation has become a widely sought after treatment by patients with end-stage renal failure. Our patient, a 39 year-old woman, had agreed to donate her kidney to her husband, who had end-stage renal failure. A laparoscopic left donor nephrectomy was planned following extensive pre-transplant donation workup. On reviewing the CT films, the patient appeared to have double left renal arteries. A 1mm fine cut contrast computed tomography DICOM file was retrieved from the donor. Segmentation was undertaken with Materialise Mimics v19.0, from which a single artery left kidney model was generated. The STL files were sent to the University Research Facility in 3D Printing, the Hong Kong Polytechnic University for medical data processing and 3D Printing.

Result

A model using a 1:1 ratio was printed for pre-operative discussion and planning. A laparoscopic left donor nephrectomy was performed on 7/9/2016. Intra-operatively, a single left renal artery was identified and it was possible to preserve sufficient length of the left renal vein. The operation was uneventful. Both further bench surgery of the graft and the renal transplant undertaken on the recipient were uneventful.

The 3D-printed model enabled surgeons to have a better understanding of the anatomical relationships than a traditional 2D image. Additionally, the experience of using 3D modelling has the benefit of relieving pressure on surgeons undertaking living donor transplants. In conclusion, the outcome suggests the use of 3D modelling plays a role in pre-operative planning of laparoscopic donor nephrectomies, and helps minimize the risk of surgical error.

Acknowledgments:

1. 3D Model Service Development & Strategic Planning Committee (QEH) for the professional support
2. Ir. Dr. Martin C.M. Wong and the University Research Facility in 3D Printing, The Hong Kong Polytechnic University for the professional support of medical data processing and 3D printing
3. Dr. Sheila Twinn for professional editing of the abstract