Thoracic | Focus Session | Video & Case Study 1

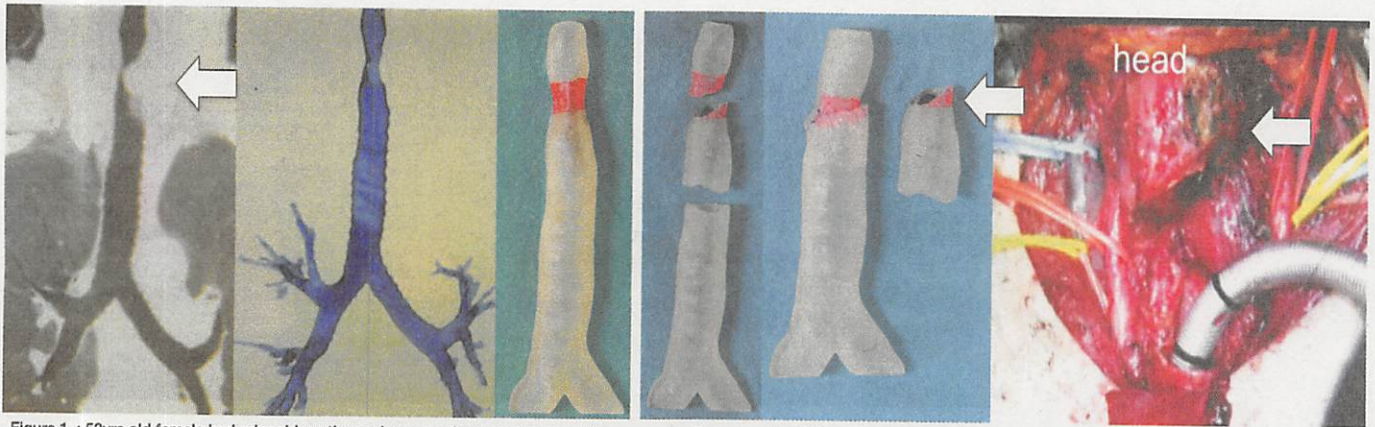# Tracheal resection simulation using a 3D printed trachea

Figure 1. ; 53yrs old female had adenoid cystic carcinoma at the upper trachea. Arrow indicates tumor and red part of the 3D model is cricoid cartilage.

Figure 2. ; Simulation using 3D model and surgical field during operation. In the simulation, left cricoid cartilage and left recurrent laryngeal nerve were expected to be resected. Arrows indicate cricoid cartilage

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Recently, 3D printers are increasingly being used for a wide variety of applications. In the medical field the 3D printer has revolutionary potential. The medical application of 3D printers is expected to include the creation of, for example, artificial organs, customised prosthetics, implants, patient specific anatomical models, and customised drug delivery systems. With regard to surgery, this technology is ideally suited to the creation of anatomical models for surgical training in general. Furthermore the ability to create patient specific models will facilitate simulation, practice and preparation for patient specific complex procedures, thus significantly increasing their efficacy.

Currently, resident surgeons use 3D anatomical models to gain an understanding of the human body. 3D digital software can be used to some degree, but it tends to be limited to providing only an introductory level of understanding. Regarding 3D printing, while most 3D printers are very limited in the material that they can print, some have been used to produce customised prostheses and implants. Some researchers have, for example, successfully 3D printed patient specific prostheses and implants from titanium and polyetherketoneketone for mandibular and skull sections.

In the field of thoracic surgery, 3D printing is most useful for the simulation of surgical procedures, particularly surgery that involves anatomical or technical complexity. Currently we use 3D models for tracheal, carinal resection, lung segmentectomy, funnel chest and bronchial stenting procedures. In our presentation today, we explain the use of 3D models for tracheal resection.

Tracheal resection is one of the most technically challenging operations for thoracic surgeons. Furthermore, the decrease of proximal airway malignancy has reduced the frequency of such resections, and as such the need to be able to share procedural techniques and data is important.

There are three key points critical to the success of tracheal resection using patient specific 3D models, which are: (I) Ventilation during and after the operation; (II) Preservation of recurrent laryngeal nerves; and (III) Mobilisation and release of residual trachea. We simulated each patient's resection on a 3D model prior to the actual operation. This facilitated an understanding of aspects to be cautious of.

The use of 3D printed models for simulation of surgical procedures potentially increases procedural safety, reduces operating time and increases surgical precision. In the near future, in the field of surgery, procedural simulation using patient specific 3D printed models may become standard practice for technically complex and/or infrequent operations.