Service Priorities and Programmes

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Novel Application of 3D-Printing for Personalised Anaesthesia in Difficult Airway

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Introduction

Patients with craniofacial deformities prove an anaesthetic challenge during airway management. Apart from predisposition to difficult intubation, conventional bag mask ventilation (BMV) techniques are prone to failure in these patients leading to potential airway crises, respiratory failure, morbidity and mortality. We evaluated the efficacy of an innovative approach, utilising a 3D-printed facial prosthesis for mask ventilation to ensure safe airway management in a patient with severe facial deformity.

Objectives

• To incorporate novel 3D-printing technology in safe perioperative airway management in patients with craniofacial deformities • To evaluate clinical efficacy and cost effectiveness of 3D-printed facial prostheses

Methodology

A 73-year-old man with facial depression caused by prior mandibulectomy and neck radiotherapy planned for elective open descending thoracic aorta replacement was recruited. Due to predicted difficult airway, surgical indication for double lumen tube insertion and background of Type B aortic dissection, a comprehensive airway plan was vital. 3D-scanning of the patient's face extracted contour data. A personalised facial prosthesis was produced to nullify leakage during mask ventilation. The device was 3D-printed, fit-tested, and used to facilitate pre-oxygenation and BMV during induction. Air leakage was assessed quantitatively and data collected was compared to a control scenario - BMV without prosthesis.

Result

The 3D prosthesis cost around HKD$400, and was produced within 5 days. Rigorous pre-operative fit-testing on both the phantom face model and patient revealed minimal leak at 1L/min fresh gas flow (FGF) – much lower than required for conventional BMV. The success of the personalized prosthesis was evident during anaesthesia induction,

where minimal leak allowed adequate pre-oxygenation and positive pressure BMV at 6L/min FGF, which facilitated gentle airway manipulation with stable haemodynamics. The prosthesis provided a reliable backup plan during intubation and tube exchanges, which are otherwise with great inherent risks in difficult airway. It also enabled meticulous extubation in the intensive care unit. We have demonstrated a cost-efficient, timely, reproducible and robust innovation that conformed with patient safety principles. Such approach using 3D-printing should be extended to benefit other practical areas of patient safety initiatives.