Preoperative airway evaluation using multi-slice three-dimensional computed tomography for a patient with severe tracheal stenosis

K. Toyota¹*, H. Uchida¹, H. Ozasa¹, A. Motooka¹, S. Sakura² and Y. Saito²

¹Department of Anaesthesia, Tottori Prefectural Central Hospital, 730 Ezu, Tottori City, 680-0901, Japan.
²Department of Anaesthesiology, Shimane University School of Medicine, 89-1 Enya-cho, Izumo City, 693-8501, Japan

*Corresponding author. E-mail: toyokou@smn.enjoy.ne.jp

A 71-yr-old female with a malignant thyroid tumour was to undergo thyroidectomy under general anaesthesia. Preoperative chest x-ray and plain computed tomography (CT) showed severe tracheal stenosis. Three-dimensional figures of the trachea and a virtual bronchoscopic movie were obtained from multi-slice CT to evaluate the stenotic region and to simulate fibroscopic tracheal intubation, respectively. After induction of general anaesthesia with propofol, a tracheal tube was successfully passed through the stenotic region under the guide of a fibroscope as simulated in the virtual movie. We conclude that multi-slice CT is useful for preoperative airway evaluation for patients with stenosis and distortion of the trachea.

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Preoperative airway assessment is essential especially in patients with abnormal airway. Chest x-ray and plain computed tomography (CT) have been used for preoperative airway assessment.¹ Recently, multi-slice CT, which can reconstitute three-dimensional (3D) images has become available. The quality of the 3D images created is significantly better than that of conventional helical scan CT.²

We were presented with a patient whose airway was severely narrowed by a thyroid tumour. Preoperative airway evaluation included a multi-slice CT scan from which we obtained a virtual bronchoscopic movie.

Case report

A 71-yr-old female (weight 58 kg, height 155 cm) was to undergo thyroidectomy for a malignant thyroid tumour. She had dyspnoea while lying in the left lateral decubitus position. She had no significant previous medical history and had no abnormal finding on preoperative biochemical testing, including thyroid function. Preoperative respiratory function testing was normal (vital capacity 86.7% of expected, FEV₁ 89.7%).

The tumour was firm, rubbery, and mobile. Preoperative chest x-ray and plain CT showed severe tracheal stenosis (Fig. 1). As the tumour covered the anterior tracheal wall, tracheostomy under infiltration anaesthesia did not seem feasible and general anaesthesia with tracheal intubation was planned. Further airway evaluation was performed with multi-slice CT to obtain 3D figures of the trachea (Fig. 2).

The multi-slice CT data were obtained using Halfsecond Realtime CT Scanner Aquilion 16 (Toshiba Industry, Tokyo, Japan). Scanning parameters consisted of 16 slices with 1-mm x-ray beam collimation, 0.5 s of rotation time, pitch factor \( P = 1.0 \), and table feed of 1 mm \( \cdot \) s⁻¹. Helical images were transferred from the scanner to a 3D workstation, Ziosoft M900 Quadra (Ziosoft Inc., Tokyo, Japan), and 3D figures were reconstructed with a volume-rendering technique. The long and short internal diameters of the narrowest region estimated by multi-slice CT were 10.1 and 2.2 mm, respectively, whereas those estimated by plain CT were 16.0 and 5.6 mm, respectively. The multi-slice CT image showed severe distortion of the trachea. However, as the findings of magnetic resonance imaging (MRI) also indicated, the internal surface looked smooth, and thus direct invasion of the tumour to the tracheal wall seemed unlikely or minimal. In addition, a virtual bronchoscopic movie was made to simulate fibroscopic tracheal intubation.

Based on those preoperative findings, we assessed that tracheal stenosis could be extended easily, and a tracheal tube with a built-in spiral wire with an inner diameter of

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5.5 mm and an outer diameter of 7.5 mm (Mallinckrodt Corp., Ireland) was selected. Anaesthesia was induced with propofol 80 mg. After mask ventilation was secured, vecuronium 8 mg, fentanyl 150 μg, and additional propofol 450 mg h⁻¹ were administered to perform laryngoscopy. The tracheal tube was inserted until the tip was just above the stenotic region. We then inserted a fibroscopic bronchoscope (3 mm in diameter) through the tube and the stenosis was observed directly. The bronchoscope was passed through the stenotic region as simulated in the virtual movie, and the tracheal tube was successfully passed through the stenotic region under the guidance of the bronchoscope. After tracheal intubation was completed, mechanical ventilation was started and maintained successfully. The thyroid tumour was removed with a small part of the tracheal wall that was suspected of having the tumour invasion, and a temporary tracheostomy was performed. Emergence from general anaesthesia was smooth. The histology of the tumour was well-differentiated papillary carcinoma. The patient was discharged from the hospital with a temporary tracheostomy tube 59 days after surgery but returned for reconstruction of the tracheal wall using a pedicle flap 5 months later.

Discussion

Anaesthetic management of a patient with airway stenosis is challenging, and it is essential to fully assess the airway preoperatively. Chest x-ray, plain CT and additional respiratory function tests are often used to assess airway condition.1

Compared with a conventional helical CT system, which has a line of detectors, the advanced multi-slice CT system is equipped with multiple parallel detectors to obtain thinner slices. Thus, higher resolution in the z-axis and quicker scanning of wide area of body has become possible.2 The quality of the resulting images is significantly better than that of conventional singleslice helical CT. Extracted data are sequential and these tomographs can be reconstructed by interpolated algorithms. In addition, a virtual bronchoscopic model can be made.3 This non-invasive procedure carries minimal risk and has been shown to be useful for evaluation of airway stenosis.4–6 The short examination time and non-invasive method offer advantages in a case where direct bronchoscopy for preoperative airway assessment can be harmful.

In the present case, there were significant differences between the long and short internal diameters of tracheal stenotic region estimated with plain CT and multi-slice CT. We suspected that the axis of the stenotic region of the trachea was diagonally twisted by the tumour and the diameter estimated by plain CT was incorrect. In contrast, 3D figures enabled us to detect and measure the cross section of the narrowest region of the trachea easily and correctly.

We chose a tracheal tube of a diameter larger than that measured in the figures, and intubated the trachea successfully. Preoperatively, the patient complained of dyspnoea only when she was lying in the left lateral decubitus position, despite the shortest diameter estimated with multi-slice CT being 2.2 mm. Respiratory function tests did not reveal any obstructive changes preoperatively suggesting the tumour was compressible. In addition, the CT and MRI findings showed that direct tumour invasion into the trachea was unlikely. These finding indicated that the stenotic region was not solid and fixed but flexible and mobile, and thus we considered that the stenotic region could be distended and chose a larger size of tracheal tube. The same reasoning led us to select i.v. rapid induction instead of a slower
gaseous induction, in which the effect on the tracheal stenosis seemed unpredictable.

We successfully managed a patient with severe airway obstruction, in whom preoperative evaluation included multi-slice CT. We conclude that multi-slice CT is a useful tool for preoperative airway evaluation in a patient with stenosis and distortion of trachea.

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References

Fig 2 3D images of the trachea obtained from multi-slice CT. Diagonal right frontal view (a), rear view (b). Image (c) has been reconstructed downwards from the region of maximal narrowing. Arrows indicate the narrowest region of the trachea.