

Virtual endoscopy of the upper airway – a diagnostic tool

A 78-year-old man underwent open heart surgery complicated by prolonged intubation and requiring a tracheotomy. Three months after decannulation he presented with progressive difficulty in breathing due to laryngotracheal stenosis. Laryngotracheal reconstruction with insertion of a T-tube were performed. At surgery, thyroid goitre was found and the trachea was slightly deviated to the left. Six months after surgery, the patient complained about progressive difficulty in breathing while recumbent and could not manage with a plugged T-tube. Fiberoptic laryngoscopy did not reveal any significant pathology. It was not possible to pass the scope through the glottis. Three-dimensional spiral computed tomography (CT) including virtual endoscopy (VE) was then performed. A large multinodular appearing goitre was found. VE demonstrated severe deviation of the tracheal segment containing the T-tube from the more superior airway. A shelf-like soft tissue was hanging over the upper margin of the T-tube, leaving only a small opening of approximately 4 mm in diameter (figure 1). Three-dimensional reconstruction of the airway confirmed these findings (figure 2).

We speculate that, subsequent to the laryngotracheal reconstruction, gradual enlargement of the thyroid gland had caused the trachea to deviate not only from right to left, but also from the anterior to posterior direction. This was especially significant while the patient was recumbent, the enlarged thyroid gland being affected by gravity, pushing the segment of trachea containing the T-tube backwards, thereby causing almost complete obstruction of the airway. When questioned, the patient admitted that his symptoms occurred primarily while lying on his back. The



Figure 1 Virtual endoscopy. The trachea above the upper margin of the T-tube is visualised as though it is seen through an endoscope. *: the 'cul de sac' in upper trachea caused by deviation of the tracheal segment containing the T-tube; arrow: remaining upper opening of T-tube



Figure 2 Three-dimensional reconstruction of the airway demonstrates severe deviation of the T-tube from the upper tracheal segment. The asterisk and arrow correspond to those in figure 1

patient's short, heavily scarred and wide neck, did not afford accurate assessment of thyroid size, even in retrospect. Fiberoptic endoscopy, which is usually performed in the sitting position, did not suggest airway obstruction. Fiberoptic endoscopy while the patient was recumbent might have detected a problem earlier, however, it is often technically difficult in this position and therefore rarely performed. It is also often impossible to inspect the subglottic and tracheal regions during fiberoptic laryngoscopy.

Three-dimensional VE (also called 'virtual bronchoscopy') is a modern technique for performing a simulated endoscopy in order to view endoluminal structures similarly to a real endoscopic examination. In this method, thin-section CT helical data are reformulated to produce realistic surface rendering of the inner walls of the airway. These surfaces can then be visualised as though seen through an endoscope.¹⁻⁵

VE may be useful for medical education and training.¹ It may aid in the understanding of

complex tracheobronchial anatomy and demonstrate the relationship of the airway to surrounding tissue.² Clinical applications include assisting with diagnoses, replacing invasive examinations such as bronchoscopy in selected cases, and helping in surgical planning or endobronchial treatments such as trans-bronchial biopsies.²

Regular endoscopy is still the 'gold standard' in evaluating upper airway diseases.³⁻⁵ However, it can be misleading in cases such as our patient. Three-dimensional VE is an emerging new method suitable for various indications, especially when the structures in question are complex or tortuous, or when endoscopically non-passable stenoses, tumours, stents or tubes are encountered. An advantage of VE over regular axial and coronal CTscans, is its ability to illustrate complex anatomy in a manner that can be easily comprehended by surgeons familiar with the view through a real broncho-

scope. Regular endoscopy and VE should be considered as complementary modalities in difficult cases, the latter improving the diagnostic approach to these patients.

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