Difficult Intubation Assisted by Three-dimensional Computed Tomography Imaging of the Pharynx and the Larynx

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SURGERY for malignant tumors of the neck or mandible frequently results in severe postoperative anatomic distortion of the pharynx and the larynx. When these patients undergo reoperation for recurrent tumors or reconstructive surgery, laryngoscopy and intubation may be difficult. Although numerous reports describe how to predict difficult intubation,1-4 there is little mention of the preoperative evaluation of surgically distorted airways. Recently, helical scan computed tomography (CT) has become available to provide a three-dimensional imaging (3D-CT) of the skull,5 vessels,6 and tumors.7 We have used this new technique to evaluate the airway of patients in whom distortion of airway was evident.

Case Reports

Case 1

A 59-yr-old woman was scheduled for reconstruction of the mandible, half of which had been resected 6 yr earlier because of carcinoma of the oral floor and lower gum. The hard and soft palates, but not the uvula, were visible with mouth-opening (Mallampati classification III). The patient received 2 mg midazolam 1 h before induction of anesthesia. Awake nasoarachal intubation was attempted after sedation with 200 μg fentanyl and 5 mg midazolam intravenously and topically applied 4% lidocaine. The epiglottis could not be visualized with direct laryngoscopy because of restricted tongue movement and a narrow pharyngeal space. Fiberoptic laryngoscopy via the tracheal tube was unsuccessful in identifying the epiglottis and vocal cords again, because of the narrow pharyngeal space, and surgery was postponed. The next week, a 3D-CT of the neck was obtained (SOMATOM PLUS-S, Siemens, Germany). During scanning, the patient was asked to open her mouth and extend her tongue as much as possible. 3D-CT of a healthy volunteer was taken to compare with this patient (fig. 1). Major findings of this case were (1) left pyriform fossa and left vallecula epiglottica almost nonexistent, (2) posterior displacement of the tongue, (3) narrow space between the epiglottis and posterior pharyngeal wall, and (4) anterior shift of the larynx (fig. 2). The following week, fiberoptic-assisted nasoarachal intubation was attempted again. Although the epiglottis was not seen, we noted two orifice-like structures. The first orifice was located in the upper right of the second one. The 3D-CT image suggested that the upper right orifice was a part of the vallecula epiglottica. Thus, we proceeded with fiberoptic intubation via the left orifice and found the larynx. Thereafter, the trachea was intubated without difficulty.

Case 2

A 54-yr-old man was scheduled for resection of the tongue and neck because of recurrent carcinoma of the oral floor. He had undergone hemimandibulectomy and neck resection 8 months earlier, followed by radiation therapy for several weeks. The patient could open his mouth about 2 cm. The tongue was distorted and could be extended only just beyond the lower teeth. The hard palate, but not the soft palate nor the uvula, was seen (Mallampati classification IV). Preoperative 3D-CT revealed (1) narrow air space between the base of the tongue and posterior pharyngeal wall, (2) relatively wide space behind the epiglottis, (3) normally shaped epiglottis, and (4) no distortion of the larynx (fig. 3). After premedication with 5 mg midazolam and 0.5 mg atropine, nasoarachal intubation was attempted under sedation with 200 μg fentanyl and topically applied 4% lidocaine. Although the epiglottis could not be recognized using direct laryngoscopy, based on the CT scan showing that the pharynx was normally aligned with the larynx, which in turn was located in the middle of neck and was not distorted, we successfully intubated the trachea without further instrumentation.

Discussion

Factors used to predict difficult tracheal intubation include increased body weight; decreased head, neck, and jaw movement; receding mandible; and protruding

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Fig. 1. Normal three-dimensional computed tomography images of the pharynx and the larynx of a healthy volunteer. (A) The frontal outline is almost symmetric, and pyriform fossae are well developed on both sides (1). The uvula is shown as an incisura of frontal view (2). (B) In the sagittal view, curvature of the tongue base is less and the space behind the epiglottis is wider than those in case 1 (1). (C) The epiglottis is shown clearly, and the vallecula epiglottica (1) and pyriform fossae (2) are recognized on both sides.

Incisors.\(^1\) Radiologic measurements have been attempted to predict difficult intubation.\(^4,5\) Few reports have evaluated intubation of patients with the pharynx or larynx distorted by surgery. Methods for preoperative evaluation of these patients are limited. Although preoperative fiberoptic examination provides some information, it is difficult to obtain clear views to reveal the distorted structures in the narrowed pharynx. Frontal and lateral x-ray views of the neck show the larynx as an air space. Once distorted, however, overlapping shadows make it difficult to obtain accurate detailed information. Conventional CT scan of the neck provides a clearer anatomic image than that provided by plain x-rays. However, such images are two-dimensional, and no sagittal view can be obtained. 3D-CT overcomes these limitations.

For predicting difficult laryngoscopy according to Mallampati classification,\(^7\) Tham et al.\(^9\) reported that phonation while sitting improves the view of pharyngeal structures. However, it is difficult to continuously

Fig. 2. Case 1. Three-dimensional computed tomography images of the frontal out view (A), sagittal view (B), and the orifice of larynx (C). (A) The air space is asymmetric, and the deformity appears greater on the left (1), the main region of the previous surgery. (B) The base of tongue is pushed backward (1), and the space behind the epiglottis is narrow (2). The larynx is shifted forward (3). (C) The epiglottis is small and distorted to the left. An air space is recognized on the right upper of the epiglottis (1).
could be drawn from the nasopharynx toward the larynx. For that reason, we selected the blind nasal approach without fiberoscopy. In contrast, the anterior larynx in case 1 made it difficult to intubate via either an oral or a nasal approach.

Helical scanning, a newly developed method, can scan a wide area of body quickly (30 s) compared with a conventional CT scan. Helical scan data are sequential, and a large number of tomographs can be reconstructed by interpolated algorithms. High-resolution 3D-CT images are drawn from those volume data. Selecting the endoscopic mode, an air space is reconstructed as a cast with a certain wall width. Internal structures are also clearly shown. Once a three-dimensional image is available, the objects can be tilted, rotated, and cut freely and repeatedly. In the latest model, images of the pharynx and the larynx can be superimposed over translucent images of bones, such as the mandible, vertebra, and hyoid, which will enable us to evaluate difficult airways more precisely.

In summary, we had experiences dealing with two cases of difficult tracheal intubation with direct laryngoscopy because of previous surgery for carcinoma of the oropharynx and the tongue. After evaluation with 3D-CT images of the pharynx and larynx, the trachea was intubated successfully in both cases. These results suggest that 3D-CT of surgically distorted pharynx and larynx may be helpful for tracheal intubation with or without fiberoptics.

References

The Optimal Breathing Tube for Tracheal Resection and Reconstruction

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TRACHEAL resection and reconstruction involve major disruption of the trachea and result in a fresh tracheal scar. The following case reports illustrate the limitations of currently available breathing tubes during and after these procedures.

Case Reports

Case 1

A 19-yr-old woman sustained facial trauma, which was complicated with orbital cellulitis, generalized sepsis, and acute respiratory distress syndrome. She required prolonged ventilatory support through a cuffed tracheostomy tube. The patient was transferred to Georgetown University Medical Center, 3 months after the initial trauma, for repair of a tracheoesophageal fistula that developed at the site of the tracheostomy tube cuff.

Tracheoesophageal fistula repair was performed via a right thoracotomy. The fistula site was reinforced by a latissimus dorsi pedicle flap, which was wrapped around the proximal esophagus. During the initial phases of the procedure, the lungs were ventilated using a 7.0 mm-ID cuffed reinforced endotracheal tube (Mallinckrodt, St. Louis, MO) placed through the tracheostomy to the maximum depth compatible with bilateral lung ventilation. On exposure of the trachea, the tube cuff was seen bulging at the site of the fistula, whose distal limit was approximately 4 cm from the carina. Leaving the cuff at that level of the trachea would have interfered with the fistula repair and would have compromised the chances of successful healing.

Postoperatively, it was obvious that a breathing tube with a short cuff and a short tube segment beyond the cuff was needed. A tracheostomy tube fulfilled this characteristic (fig. 1); however, regular tracheostomy tubes were too short to be advanced far enough into this patient’s trachea via the existing tracheostomy. An oral RAE cuffed tube was modified and used instead. The oral RAE tube was chosen because of its relatively small cuff length compared to regular or reinforced tubes (fig. 1). The tube was cut proximally at the 18-cm mark. The part of the tube distal to the cuff also was cut to prevent endobronchial intubation when the cuff was advanced beyond the fistula site. However, the cuff lost its seal because the pilot tube extended beyond the cuff to the tip of the tube (fig. 1). To regain the cuff seal, the open distal end of the pilot tube was blocked using a short segment of an appropriate size surgical needle tip. The cuff was tested several times and was found to maintain its seal. The distance between the tip of the modified tube and the proximal end of the cuff was approximately 3 cm.

The modified tube functioned well intraoperatively and postoperatively, allowing bilateral lung ventilation without the cuff encroaching on the fistula site. Postoperatively, when it was clear that prolonged tracheal intubation would be required, a customized tracheostomy tube (Bivona Medical Technologies, Gary, IN) with the appropriate length and cuff characteristics was ordered and used for ventilating the lungs until extubation of the trachea was possible several weeks later.

Case 2

An obese 47-yr-old woman presented with tracheal stenosis as a complication of prolonged intubation after abdominal surgery. She was experiencing progressively worsening dyspnea, deteriorating exercise tolerance, and episodes of severe airway obstruction as a result of sputum accumulation at the stenotic site. A computed tomography scan of the neck and upper mediastinum showed the stenotic segment to be located at mid-trachea. It measured approximately 2 cm in length and 5 mm in diameter at its narrowest part. After considering all options, general anesthesia was induced using propofol. After confirmation of the ability to ventilate the lungs via mask, succinylcholine was given, and the trachea was orally intubated using a 7.5 mm-ID nasal RAE tube cut proximally at the 26-cm mark.