Inability to Deflate the Distal Cuff of the Laser-Flex Tracheal Tube
Preventing Extubation after Laser Surgery of the Larynx

To the Editor—The Laser-Flex tracheal tube (Mallinckrodt, St. Louis, MO) is unique in its design, possessing a dual cuff system, each with its own pilot balloon and self-scaling valve. We describe below two cases in which we were unable to deflate the distal cuff at the conclusion of laser airway surgery, thus preventing extubation.

Case 1

A 64-yr-old man with a history of laryngeal carcinoma was scheduled for microsuspension laryngoscopy and carbon dioxide laser debulking of the tumor. After intravenous induction with propofol and succinylcholine, an unsutured Laser-Flex tracheal tube (5.0 ID, 7.5 OD; lot #ML02740) was advanced very slowly and gently through the narrowed glotic opening with mild resistance noted. The tracheal tube had been checked before use by injecting and then easily aspirating 5 ml of air from each of the two cuffs, according to the manufacturer’s instructions. The distal cuff was inflated with 15 ml of isotonic sterile saline, which was necessary to obliterate the air leak during manual ventilation. The proximal cuff then was inflated with approximately 12 ml of isotonic sterile saline. At no time was a suction catheter passed through the tracheal tube.

At the conclusion of surgery, when the patient was ready for tracheal extubation, we readily aspirated the full volume of saline from the proximal cuff. However, we were unable to aspirate more than 1 ml from the distal cuff. We attempted to slowly withdraw the tracheal tube past the vocal cords without success. Inspection of the pilot balloon and valve revealed no obvious damage or disruptions. Repeated attempts were made using very slow aspirations with 3- and 10-ml syringes. The pilot balloon and inflating valve were cut off, assuming they might have been malfunctioning. We were still unable to force the saline out of the cuff by direct or indirect pressure.

The ear, nose, and throat surgeon inserted a Dodo laser micro-laryngoscope, an anterior commissure scope, to a point just below the vocal cords. With cephalad traction on the tracheal tube and intensely bright fiberoptic lighting, the distal cuff was identified readily. The surgeon subsequently passed a Tucker mediastinoscopy aspirating needle through the laryngoscope and punctured the cuff. After aspiration of a few milliliters of saline, the tracheal tube was removed easily, and the patient was allowed to awaken. His emergence from anesthesia was uneventful.

Case 2

A 62-yr-old man with a history of laryngeal carcinoma requiring partial laryngectomy and tracheostomy was scheduled for microsuspension laryngoscopy, laryngeal biopsy, and carbon dioxide laser excision of subglottic granulation tissue. After intravenous induction with sodium thiopental and succinylcholine and ventilation via a 6.0 uncuffed tracheostomy tube, this tube was removed, and the trachea was reinserted easily via the stoma with an unsutured Laser-Flex tracheal tube (5.5 ID, 7.9 OD; lot number not available). This tracheal tube had been checked before use by injecting and then aspirating 10 ml of sterile saline from both the proximal and the distal cuffs. After tracheal intubation, each cuff was inflated with 6 ml of sterile isotonic saline. Anesthesia was maintained with isoflurane in an oxygen/helium mixture in addition to fentanyl and a succinylcholine infusion.

After emergence from anesthesia, while the patient was breathing spontaneously, the entire contents of the proximal cuff was aspirated easily using a 10-ml syringe. However, repeated attempts at aspiration of the distal cuff were unsuccessful. Finally, continuous gentle traction was applied to the tracheal tube for approximately 60 s, and simultaneously the tube was slowly rotated alternately 45 degrees clockwise and counterclockwise. The trachea ultimately was extubated, and the tracheostomy appliance was reinserted. No obvious trauma or bleeding at the stoma was noted. Subsequent repeated attempts at deflating the still partially inflated cuff were unsuccessful. The cause of the failure to deflate the distal cuff in either patient was never discovered.

Discussion

We present these cases because we are unaware of any prior reports of inability to deflate one cuff on a Laser-Flex tracheal tube. It is possible that contamination in the injectate created an obstruction or a check-valve-type mechanism, preventing aspiration of the saline after an uneventful injection. This contamination could have come from a small core of rubber obtained while aspirating our saline from a stoppered ampule. A manufacturer’s defect in the cuff-pilot balloon assembly or at the inflation tubing-cuff junction also may have led to an apparent check-valve mechanism. Although we cannot verify the lot number of the tracheal tube used in case 2, inflation and deflation with saline of the cuffs of a Laser-Flex tracheal tube from the same lot number as in the first case failed to reveal any difficulties. It also is conceivable that the inflation tubing for the distal cuff became kinked during the intubation or the procedure. Although there was no gross evidence of kinking or twisting of the tracheal tube at any time, it would require only a minute degree of kinking to embarrass the lumen of an inflation line, itself only 1 mm in diameter. Both inflation tubes run inside the steel lumen of the tube and, therefore, are not readily available for inspection. Regrettably, the tracheal tubes were discarded before they could be sent to the manufacturer for analysis.

It is conceivable that the laser beam used on a tumor resting against the metal tracheal tube generated sufficient heat to deform or melt.
the polyvinylchloride inflation tubing that runs along the inner wall of the tube. This could account for our inability to deflate a cuff postoperatively after an uneventful preoperative testing. The carbon dioxide laser settings that significantly increase the risk of polyvinylchloride deformity or melting include a continuous mode, a smaller spot size, and a higher power setting (≥20 W). On the other hand, Mallinckrodt has noted experimentally that deformity could occur with a power as low as 10 W using a 0.48-mm spot over 25 s. Clearly, more than a stray laser beam would be necessary to accomplish this. The laser used in our first patient was set to the continuous mode, a power of 11 W, 46 s, and a spot size of approximately 0.7 mm. Laser settings for the second patient were not recorded.

Although we do not know the cause for our difficulties, certain modifications in the Laser-Flex tracheal tube would address probable contributing factors. Enlarging the lumen of the inflation tubing, even slightly, would significantly reduce the resistance posed by the injection and aspiration of saline. Another improvement would be to enlarge the opening of the inflation tubing into the cuff itself, presently only a tiny slit.

The requirement that aspiration of saline from the cuffs of the cuffs of the Laser-Flex tracheal tube be done in a slow, gentle manner cannot be overemphasized. However, as we have described here, it may be impossible to deflate the cuff and extubate the trachea despite apparent satisfactory technique and no other obvious explanations.

* Nye D: Personal communication.

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In Reply:—The Mallinckrodt Laser-Flex tracheal tube is a safe and effective laser-resistant medical device. Studies show that the Laser-Flex tracheal tube is resistant to laser exposures typical in most clinical procedures.†

More than 100,000 Laser-Flex tracheal tubes have been used in surgical procedures worldwide over the past 5 yr. Patient injuries related to product misuse are rare. The only report of a fire involved misuse of the Laser-Flex tracheal tube: The cuffs apparently were not inflated with the prescribed protective saline solution.

Caution is advised in the use of lasers and tracheal tubes, because no material can claim to be completely laser proof. All materials melt, degrade, or burn when exposed to high laser power levels. This is most apparent when materials are exposed to high oxygen concentrations. The Laser-Flex tracheal tube is no exception. The stainless steel shaft becomes incandescent, perforates, and burns at power levels higher than 25 W when exposed to a single perpendicular 0.5-mm diameter carbon dioxide laser beam for more than 20 s in an environment of 98% O2.† The polyvinylchloride cuff inflation tubes inside the stainless steel tracheal tube may melt, occlude, or break upon exposure to lower energy levels. Indeed, precautions are necessary with all tracheal tubes in the presence of lasers.

Mallinckrodt is working closely with voluntary standards organizations to develop test methods and identify safeguards for use of lasers during airway surgery. The American Society for Testing and Materials (ASTM) Committee on Anesthetic and Respiratory Equipment recently drafted a new test method for determining the laser resistance of the shafts of tracheal tubes.‡ The committee members, chaired by Gerald Wolf, M.D., also developed a recent guide for use of tracheal tubes involving the use of lasers in airway surgery.§ Similar

† Mallinckrodt: Internal testing. 1993.