and the other open to atmosphere. Careful inspection of the proximal end of the catheter introducer after removal of the pulmonary artery catheter could detect either absence or incompetence of the valve.

The relatively high average air flow through the USCI Hemaquoter valve immediately and two hours after removal of the PA catheter was the result of one valve leaflet in one sample folding upon itself as the catheter was withdrawn. Airflows of 1.36 ml/s were measured immediately after catheter removal. The defect in the valve was obvious to the naked eye, and the valve assumed its normal configuration spontaneously.

The valve mechanism of valved percutaneous catheter introducer sheaths has been accused of tearing the balloon on flow-directed catheters. We did not test balloon integrity and are unaware of any data supporting that contention. Even if it were true, the potential danger of air embolism from any misadventure with a non-valved catheter introducer would seem to outweigh the occasional need to discard a damaged flow-directed catheter. We agree with Doblar et al. in suggesting that if percutaneous catheter introducer sets with sidearms are to be used without catheters, only those introducers which have competent valve mechanisms should be inserted.

REFERENCES

Anesthetic Management and Gas Scavenging for Laser Surgery of Infant Subglottic Stenosis

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The CO₂ laser has been used recently to excise severe subglottic stenosis in infants, thus avoiding tracheotomy.1 Anesthesia in these cases is difficult because the surgeon needs an unobstructed view and access to the subglottic larynx. In the last eight months, four infants with severe subglottic stenosis presented in our hospital and were treated with CO₂ laser as an alternative to tracheotomy. We describe the anesthetic management and scavenging of anesthetic gases and vapors that escape into the operating room.

REPORT OF A CASE

A 3.9-kg, 7-week-old girl, whose trachea had been intubated orally and was receiving continuous positive airway pressure (CPAP), was admitted to our intensive care unit. She had a history of “noisy breathing” since birth which had become progressively worse. Laryngoscopy at another hospital had yielded the diagnosis of congenital subglottic stenosis; within several hours of the endoscopic procedure, the infant had developed marked respiratory difficulty necessitating intubation of the trachea. A 2.5 endotracheal tube was inserted and she was transferred to our hospital. On admission, coarse rhonchi were present in both lung fields. On CPAP, with a FIO₂ of 0.4, pH₉₆ was 7.37, PACO₂ 45 mmHg, and Pao₂ 88 mmHg.

She was scheduled for endoscopic evaluation. Atropine, 0.1 mg, im, was given 30 min before inducing anesthesia with halothane and 50% nitrous oxide through the endotraheal tube. When adequate anesthetic depth was obtained, the trachea was extubated and the epiglottis, arytenoids, vocal cords, and trachea were sprayed with 1% lidocaine. A #8 catheter attached to the anesthetic machine was introduced into the nasopharynx through the right nostril. Direct observation confirmed placement immediately above the laryngeal opening. Anesthetic gases were insufflated with the infant breathing spontaneously.
A suction catheter connected to suction was taped to the proximal opening of the laryngoscope close to the patient's mouth to scavange anesthetic vapors.

Atmospheric \( \text{N}_2\text{O} \) was measured at the head of the patient using the Forreger 410 \( \text{N}_2\text{O} \) monitor. With the trachea intubated, atmospheric nitrous oxide was 5–7 ppm. When the endotracheal tube was removed for the insufflation technique, the concentration rose to 75 ppm without scavenging. When suction was placed close to the infant's mouth for close scavenging, the concentration dropped to 7–10 ppm and remained steady throughout the procedure.

During laryngoscopy, a small band between the arytenoids and an anterior subglottic narrowing were seen. The surgeon could not pass a 3-mm Storz bronchoscope. The \( \text{CO}_2 \) laser was used to excise the posterior commissure band and the subglottic soft tissue. Dexamethasone, 4 mg, was given iv and the infant was transferred to the recovery room awake, with trachea extubated, but with some stridor. She was placed in a high humidity environment and after observation for 60 min, discharged to the ward in satisfactory condition.

On the first postoperative day progressive respiratory distress occurred with subternal and intercostal retraction. With a \( \text{FiO}_2 \) of 0.4, \( \text{pH} \) was 7.44, \( \text{Paco}_2 \), 50 mm Hg, and \( \text{pO}_2 \) 80 mm Hg. Dexamethasone, 4 mg, was again given iv and racemic epinephrine (0.2 ml of 2.25% solution diluted in 2.5 ml saline nebulized with 100% \( \text{O}_2 \)) was given through a face mask. The infant's condition improved and she was discharged from the hospital two days later. A normal airway was observed at bronchoscopy three months later. She has remained asymptomatic.

**DISCUSSION**

Three other infants with severe subglottic stenosis also have been treated endoscopically with the \( \text{CO}_2 \) laser to excise subglottic tissue. One child had acquired subglottic stenosis for prolonged intubation at birth, the other two had congenital stenosis. In the acquired case, the laser was used twice; in the congenital cases, it was used three and seven times, respectively. To date, all infants are doing well without tracheotomy. Endoscopic laser excision is done for localized or circumferential stenosis. If the stenosis is circumferential, only one side is treated with the laser at each procedure.

In adults, Lines has used pharyngeal insufflation of anesthetic gases for microlaryngeal surgery. Brunnett et al., advocated the use of methoxyflurane-halothane for insufflation when the laser is used for laryngeal surgery. For our anesthetic management, we selected the nasopharyngeal insufflation technique in infants and children for microlaryngeal surgery including \( \text{CO}_2 \) laser removal of laryngeal papillomas, and have utilized this method for ten years. Endotracheal tubes of any size will obstruct the laryngeal operative field of an infant or small child. This is especially true in the infant with subglottic stenosis, where a 2.5-mm endotracheal tube is a tight fit.

The anesthetic management of these patients using the insufflation technique is not without problems. The anesthesiologist does not have complete control of the airway and must therefore rely on complete cooperation with the surgeon. The plane of anesthesia may be too deep causing cardiac arrhythmias and apnea, or too light causing cough and even laryngospasm. Close observation of respiratory effort is important. If respirations become shallow, the concentration of halothane is decreased. If respirations are rapid and deep, the halothane concentration is increased. In our cases, random analysis of arterial blood gases performed during the procedures indicated a range of 46–52 mm Hg for the \( \text{PaCO}_2 \). These results are similar to those of Kennedy et al.5

The position of the nasopharyngeal catheter tip is always carefully checked to confirm its position close to the laryngeal opening. If the catheter is unintentionally passed too far, it may enter the esophagus and marked gastric distention result. The stomach should be immediately suctioned to decompress it.

Insufflation of oxygen is a potential fire hazard with use of the \( \text{CO}_2 \) laser. We therefore administer \( \text{FiO}_2 \) no higher than 0.5. According to Burgess and LeJeune, when using the \( \text{CO}_2 \) laser, the \( \text{FiO}_2 \) should be between 0.3 and 0.5. We have observed a bigger spark produced by the laser on charred tissue with \( \text{FiO}_2 \) higher than 0.5. The possibility of tracheal burn therefore seems to be a real one.

Another disadvantage of the technique is the exposure of the operating room personnel to anesthetic gases. Krapetz et al. found that endoscopic surgeons have blood concentrations of \( \text{N}_2\text{O} \) significantly higher than general surgeons, anesthetists, and operating room nurses. Brunnett et al. recommended using activated charcoal masks for the operating room personnel during the insufflation period. However, in addition to the inconvenience, charcoal adsorbs halogenated agents only—not nitrous oxide. We prefer to place high suction close to the infant's mouth to scavange anesthetic gases. Random readings of atmospheric nitrous oxide have shown much lower values when suction is used. The National Institute for Occupational Safety and Health Standard (NIOSH) has recommended the measurement of \( \text{N}_2\text{O} \) as the basis for monitoring the atmospheric operating room pollution since \( \text{N}_2\text{O} \) is used in most anesthetic techniques. The recommended maximum permissible level is 25 ppm.

With spontaneous respiration during the insufflation technique, vocal cord motion is slight or absent—unless the plane of anesthesia becomes too light. This has not been a serious problem.

Dexamethasone was given iv at the end of the procedure. In the recovery room, the infants are watched closely and placed in high humidity environment. If there is significant respiratory obstruction, racemic epinephrine (0.2 ml of 2.25% solution diluted in 2.5 ml saline nebulized with 100% oxygen) is given through
a face mask. The infants are discharged from the recovery room by an anesthesiologist and high humidity is continued on the ward.

Although the insufflation technique is not innocuous, we feel it is appropriate for endoscopic surgery in the infant larynx. Having used this technique for many years for microlaryngeal and CO₂ laser surgery of the larynx, it is safe and efficient in our hands, and anesthetic gases and vapors in the operating room can be scavenged with suction.

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