diograph, and 10 ml of bupivacaine 0.5% was injected on each side. This resulted in no untoward sequelae and was associated with good pain relief. The test dose was followed with 10 ml of a 6% aqueous phenol solution on each side. Temperatures of both great toes increased 5°C over the next 2 h; capillary refill improved again to less than 15 s.

Mild, transient orthostatic hypotension was the only side effect from the procedure. The symptoms of pain and cold sensitivity have abated. In addition, the ischemic ulcers have shown complete healing within 8 months following the blocks.

**DISCUSSION**

Microvascular abnormalities probably are caused by endothelial cell injury in small arteries of patients with scleroderma. Similarly, Raynaud’s phenomenon is the result of structural abnormalities of the arteriolar vessel wall that predispose the digits to the exaggerated vasoconstriction and subsequent vasodilation. Several pathologic studies were unable to distinguish between the lesions of scleroderma and Raynaud’s. Myointimal cell migration in response to endothelial cell injury with resultant vasoconstrictive instability probably is the common pathophysiologic pathway of Raynaud’s in the periphery and scleroderma systemically.

This case demonstrates a good response to the use of lumbar sympathetic block for the treatment of Raynaud’s phenomenon of the lower extremity. The response to diagnostic sympathetic block was atypical in that the beneficial effects of sympathectomy were not realized for several hours but then lasted for a time period longer than the duration of the anesthetic. The reason for the delay in vasoconstrictor blockade is not known, but is possibly related to the variable response of patients to cervical sympathetic block for upper-extremity Raynaud’s. The success of sympathetic block in this case suggests a role for reversible vasospasm in the pathogenesis of Raynaud’s. Raynaud’s phenomenon may involve a continuum of vascular disease ranging from vasoconstriction hyperactivity, which would respond to chemical sympathectomy, to complete obliterator occlusion, which would not respond. Diagnostic blocks may aid in differentiation of these entities, while predicting the response to neurolytic sympathetic block.

As of this writing, beneficial effect from lumbar sympathetic block has lasted 8 months. Because the mechanism leading to vasospasm is not known, with disease progression the current perfusion improvement may not last, and long-term results are indeterminate. However, if vasospasm results in eventual obliterator changes, early permanent sympathetic block may represent optimal therapy.

This case suggests that neurolytic sympathetic blockade should be considered in the treatment of Raynaud’s phenomenon of the lower extremity.

**REFERENCES**


**Anesthesiology**

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**Laser Perforation of a Main Stem Bronchus**

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Airway perforation is a rare but potentially fatal complication following laser surgery. Perforation of a main stem bronchus by a laser is described below.

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**REPORT OF A CASE**

A 3-yr-old girl was admitted for excision of recurrent granulation tissue in her tracheobronchial tree. She had undergone 34 prior anesthetics for similar surgery, the most recent was 2 weeks before admission.

The child had nonspecific congenital granulation tissue on multiple areas of her trachea as well as a circumferential lesion of the left main stem bronchus 1 cm distal to the carina. On multiple previous occasions, bronchoscopy had led to spasm and swelling of the left bronchus with loss of breath sounds over the left chest. Breath sounds usually improved over the left chest within 45 min following completion of bronchoscopy. She received dexamethasone 1 mg every other day to diminish swelling in her tracheobronchial tree. No other medications or drug allergies...
were reported. A review of systems was noncontributory. Physical ex-
amination revealed a small 13-kg girl in no distress. Respiratory rate
was 24 breaths/min with a heart rate of 100 beats/min. Examination
of the chest revealed decreased breath sounds on the left with minimal
biphasic stridor and late expiratory wheezes.

Atropine 0.1 mg im was given 1 h before induction. Anesthesia was
induced by inhalation of halothane, nitrous oxide, and oxygen. Bron-
choscopy was initiated using a 4.0 ventilating bronchoscope and con-
trolled ventilation. Breath sounds diminished over the left chest after
5 min. She received dexamethasone 4 mg iv. Laser excision of extensive
granulation tissue in the distal trachea and left main stem bronchus
continued for 90 min. The extent of granulation tissue made identi-
fication of normal anatomy more difficult. Anesthesia was maintained
with 2-4% inspired halothane. One brief run of ventricular bigeminy
30 min after induction quickly resolved with repositioning of the bron-
choscope, improved ventilation, and lidocaine 10 mg iv. Even though
there were no manifestations of an accidental bronchial perforation,
a chest film and bronchogram were performed during the procedure.
There was no evidence of a bronchial tear or leak.

At the conclusion of bronchoscopy, the trachea was intubated with
a soft 4.0 uncuffed oral preformed endotracheal tube. The tube passed
easily and was secured to the lower lip. Breath sounds were good on
the right but reduced on the left side. The trachea was extubated after
the return of normal spontaneous ventilation. The patient was observed
for several minutes before transport to the recovery room. She had
good tidal volumes, maintained her airway without assistance, and was
responding appropriately to stimulation.

Shortly after her arrival in the recovery room, peripheral cyanosis
was evident. She appeared to have adequate tidal volumes with minimal
airway obstruction. Breath sounds were minimal on the left and present
but coarse on the right. A jaw lift was performed to clear her airway,
which initiated a cough. Immediately, her neck began to swell. Oxygen
was administered by mask with prompt resolution of the cyanosis. Sub-
cutaneous emphysema developed in her neck and agitation increased.
Her trachea was intubated with a 4.0 oral tracheal tube. A chest film
was taken. Subcutaneous emphysema with marked swelling progressed
to involve the entire head, chest, abdomen, and extended to the prox-
imal portion of all limbs. Bilateral needle thoracentesis using 14-gauge
cannulae was performed in the second intercostal space at the mid-
clavicular line. A soft whine was noted with each needle placement.
Initially, $\text{pH} = 7.15; P_{\text{CO}_2} = 67 \text{ mmHg}; P_{\text{O}_2} = 69 \text{ mmHg}$, and base
excess $= -6.9 \text{ mEq/l}$ while breathing 100% oxygen. Dramatic clinical
improvement occurred following placement of thoracostomy tubes.
Repeat arterial blood gas values showed a $\text{pH} = 7.21; P_{\text{CO}_2} = 44 \text{ mmHg},
P_{\text{O}_2} = 75 \text{ mmHg}$, and base excess $= -9.2 \text{ mEq/l}$.

The child was returned to the operating room, and anesthesia was
induced using spontaneous ventilation with halothane and oxygen. Fi-
erotic bronchoscopy revealed a 1-2-mm hole in the left main stem
bronchus through which lung tissue could be seen. There also was a
flap tear extending from the perforation for several additional milli-
meters, but the decision was made not to attempt surgical repair.
The anesthetic proceeded without incident. The child was transported
to the intensive care unit, and her trachea was extubated a short time
later. Arterial blood gases before extubation were $\text{pH} = 7.30; P_{\text{CO}_2} = 42$
mmHg, $P_{\text{O}_2} = 145 \text{ mmHg}$, and base excess $=-4.8 \text{ mEq/l}$ with an $P_{\text{FIO}_2}$
of 0.3.

Postoperative management included dexamethasone: 1 mg iv daily
along with penicillin and gentamicin sulfate iv. Oral cephalidine was
began on day 2; the penicillin and gentamicin discontinued. Six days
following surgery a repeat bronchoscopy demonstrated healing of the
area of bronchial perforation. Areas of granulation tissue on the op-
posite side of the bronchi were excised using the CO$_2$ laser without
complications. The chest tubes were removed the following day. The
child was discharged a day later.

**DISCUSSION**

The CO$_2$ laser has become a frequently used surgical tool for lesions of the aerodigestive tract. Its use permits good hemostasis with minimal postoperative edema, and it has become the treatment of choice for many airway lesions. However, lasers are not without complications. Injury to operating personnel and patients, including air-
way fires$^{3,3}$ and damage caused by misdirected laser beams$^{6,5}$ have been reported. Reviews of anesthetic tech-
technique and special considerations during laser surgery have
been discussed elsewhere.$^{6,8}$ Healy et al., in a study of 4,416 cases, reported an incidence of complications
directly attributable to the laser of 0.2%.$^{9}$

Coupling of the CO$_2$ laser to a ventilating bronchoscope allows the
surgone to eradicate lesions of the trachea and bronchi. Unfortunately, the optics used with rigid bron-
choscopy are not as refined as those available with the operating
microscope. Additionally, pediatric bronchoscopes have narrow
 diameter tubes, limiting the field of vision. Smoke may obscure the
visual field. The line between lesion and normal tissue may be less distinct, making
the risk of injury to normal tissue higher.

A rare but serious complication of airway surgery in-
volve airway disruption. Ganfield and Chapin$^{1}$ reported a 1.5-cm linear perforation of the anterior trachea, which
lacerated two tracheal rings in a 4-yr-old patient. The
injury was presumably caused by laser overshoot while
working on laryngeal lesions. This type of injury is ex-
tremely unusual, since the laser generally is focused to a
high degree and regions beyond the focus point receive
a diffuse beam unlikely to result in significant damage. In
the case studied by Ganfield and Chapin, an attempt to
pass a 6.0 stylsted Norton tube with an attached cuff was
unsuccessful and may have contributed to injury.

Regardless of the cause of the injury, when airway disrup-
tion occurs, it can be a life-threatening event requiring
immediate intervention. In the lower airway, perforation
can lead to pneumomediastinum, bronchopulmonary fistulae,
tension pneumothorax, and potential violation of the aorta
or pulmonary vasculature, which lie in close proximity to
the main-stem bronchi.

In this case the airway perforation was not clinically
evident until the patient’s arrival in the recovery room.
The high airway pressures generated by coughing may
have created a flap tear in the left main stem bronchus
in areas weakened by the laser. Peritracheal and mediastin-
tial air with subcutaneous emphysema resulted. The
peritracheal air could dissect along the right bronchus,
creating bilateral tension pneumothoraces.

Airway perforation and tension pneumothorax result-
ing from laser surgery is an unusual complication. De-
compression of the tension pneumothorax must be ac-
complished promptly, initially with needle thoracentesis,
then chest tubes. Ideally, ventilation should be spontaneous before decompression of the tension pneumothorax. Positive airway pressure and controlled ventilation can increase the pneumothorax, resulting in cardiovascular collapse. Recovery room personnel must be alert and prepared to initiate immediate therapy.

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REFERENCES

Anesthesiology
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Postoperative Hepatic Dysfunction after Halothane or Enflurane
Anesthesia in Patients with Hyperthyroidism

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Increasing experimental evidence indicates that the hyperthyroid state enhances hepatotoxicity by volatile anesthetic agents in rodents.1–4 The incidence of liver lesion after exposure to halothane in hyperthyroid rats is approximately four times more than that after enflurane or isoflurane.5 Patients with hyperthyroidism usually come to anesthesia and surgery in an euthyroid state by taking antithyroid drugs. Perhaps the hypermetabolic state of the liver in such patients has not returned to normal by antithyroid drugs. In addition, antithyroid drugs can be hepatotoxic.5,6 Thus, patients with hyperthyroidism, even in an euthyroid state, could have a significant risk of developing postoperative hepatic dysfunction when they are anesthetized by inhaled anesthetics, especially halothane.7,8

We, therefore, retrospectively investigated whether there is a higher incidence of early postoperative hepatic dysfunction in patients with hyperthyroidism when compared with patients with nonfunctional thyroid tumors. Second, we sought to determine whether halothane is more likely to produce hepatic dysfunction in patients with hyperthyroidism when compared with enflurane following thyroid surgery.

MATERIALS AND METHODS

From September 1980 to August 1984, 183 patients underwent elective thyroid surgery for both hyperthyroidism and nonfunctional thyroid tumors. Of these, 66 patients had hyperthyroidism, and the remaining had nonfunctional thyroid tumor (simple or nodular goiter, carcinoma, adenoma). Halothane was used in 78 patients (31 with hyperthyroidism and 47 with normal thyroid function), and enflurane was used in 105 patients (55 with hyperthyroidism and 50 with normal thyroid function) (Table 1).

All patients with hyperthyroidism had been rendered euthyroid by use of antithyroid drugs (propylthiouracil or methimazole, Lugol's solution, or a combination of propylthiouracil and Lugol's solution). In some of these patients, a hyperkinetic circulatory status was controlled with oral propranolol in doses of 30–60 mg/day (12 pa-