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## REFERENCES

1. Leading Article (1977): Brit. med. J., **1**, 667.
2. Schrire, V. and Asherson, R. A. (1964): Quart. J. Med., **33**, 439.
3. Dunn, G. D., Hayes, P., Breen, K. J. *et al.* (1973): Amer. J. med. Sci., **265**, 174.
4. Sherlock, S. (1951): Brit. Heart J., **13**, 273.
5. White, T. J., Leevy, C. M., Brusca, A. M. *et al.* (1955): Amer. Heart J., **49**, 250.
6. Sherlock, S. (1975): *Diseases of Liver and Biliary System*, 5th ed., chapt. 21, pp. 490-505. Oxford: Blackwell Scientific Publications.
7. Seggie, J., Saunders, S. J., Kirsch, R. E. *et al.* (1979): S. Afr. med. J., **55**, 75.
8. Rossouw, J. E. and Saunders, S. J. (1975): Quart. J. Med. (NS XLIV), **173**, 1.
9. Litwack, K., Bohan, A. and Silverman, L. (1977): J. Rheum., **4**, 307.
10. Cairns, S. A. and Oleesky, S. (1977): Brit. med. J., **2**, 127.
11. Hamrin, B., Jonsson, N. and Landberg, T. (1965): Lancet, **1**, 1193.
12. Hall, G. H. (1973): Amer. Heart J., **85**, 835.

## The Anaesthetic Management of Distal (Thoracic) Tracheal Resection in a Quadriplegic Patient

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### SUMMARY

The anaesthetic management of distal tracheal resection in a quadriplegic patient is described. Ketamine, halothane, fentanyl and Entonox (50% N<sub>2</sub>O, 50% O<sub>2</sub>) were successfully employed. The major problems discussed include airway maintenance, cardiovascular instability and autonomic hyperreflexia, the dangers of depolarizers, and the need for monitoring temperature, blood pressure and fluid balance. The importance of teamwork is mentioned.

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### CASE REPORT

A 30-year-old man presented for resection of a distal stenotic lesion of the trachea. He had been involved in a motor vehicle accident 3 months previously, and had sustained a compression fracture of the 6th cervical vertebra with resulting complete distal quadriplegia. Emergency tracheostomy had been performed in a peripheral hospital as a life-saving measure, and the patient had then been transferred to the Spinal Unit at Conradie Hospital, Cape Town.

Three months later, soon after the tracheostomy tube

was removed, stridor developed. Two stenotic lesions in the trachea were diagnosed by means of tomography and confirmed at bronchoscopy; the proximal stenosis just below the cricoid cartilage could be dilated satisfactorily, but the distal stenosis could not. In order to maintain an airway and allow suction of secretions, a nasotracheal tube (Portex) 7,5 mm in diameter was introduced with difficulty and left *in situ* in preparation for an operation scheduled for 2 days later.

### Pre-operative Assessment and Premedication

When examined 1 day before surgery, the patient was breathing spontaneously through the nasal tube. Of note (apart from the flaccid paralysis below the 6th cervical vertebra) was a chest radiograph which revealed resolving pneumonia which had not been detected on clinical examination. The blood pressure was 115/75 mmHg and the pulse rate 76/min, and there were no signs of dehydration. Serum electrolyte values and the acid-base status were within normal limits. The haemoglobin concentration was 11,5 g/dl. A premedication dose of diazepam 10 mg intramuscularly was prescribed. Intravenous infusion was commenced 24 hours before the operation by the staff of the intensive care unit to ensure adequate hydration.

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### Anaesthesia

At induction the patient's blood pressure was stable at 110/70 mmHg. Entonox (50% N<sub>2</sub>O, 50% O<sub>2</sub>) 6 l/min

was administered through a rebreathing circuit including a warm H<sub>2</sub>O humidifier connected to the nasotracheal tube. Halothane 0,5% was added, and then ketamine 50 mg; fentanyl 0,1 mg was injected over a period of 5 minutes, the blood pressure being checked frequently.

The breathing was easily controlled, and no relaxants were given. Anaesthesia was maintained with Entonox, ketamine infusion at a rate of 0,25 - 0,5 mg/min, halothane 0,5%, and small increments of fentanyl. In total, 150 mg of ketamine and 0,3 mg of fentanyl were administered during the operation, which lasted 310 minutes. Plasmalyte B was infused at a rate of 5 ml/kg/h. Ventilation was checked by means of a stethoscope taped to the left axilla to monitor ventilation of the left lung. The blood pressure and pulse rate were stable during the operation.

After transection of the trachea below the distal stenosis, an attempt was made to ventilate both lungs through a No. 30 Foley catheter with a 30 ml bulb, a minor modification of the technique described by Abou-Madi *et al.*<sup>1</sup> However, this was abandoned owing to inability to evacuate secretions and the high resistance encountered on inflation. A latex armoured tube 7 mm in diameter was used instead, and although the cuff encroached upon the suture line a compromise was reached and both lungs were ventilated satisfactorily. For this part of the operation a separate sterile breathing circuit of four lengths of corrugated rubber tubing was used with an anaesthetic machine at the foot of the table (to keep the tubes clear of the surgical area). Ventilation by hand allowed early recognition of obstruction or secretions, which required suction at intervals of about 10 - 15 minutes.

At completion of the posterior anastomosis, the temporary latex tube was withdrawn and replaced by a new nasotracheal tube 7,5 mm in diameter, with the cuff positioned below the suture line. Ventilation was then recommenced from above and the operation completed with the patient's neck flexed. Adequate spontaneous ventilation resumed at the completion of the operation without recourse to naloxone. When the drapes were removed, sweating of the skin of the patient's face and forehead was noted, although the blood pressure had not changed at all either during or at the end of the operation. At this stage it was noted that the urinary catheter had become kinked, probably during the latter part of the operation, since urine output had been satisfactory until about 30 minutes before it ended. The blood loss was estimated to be about 400 ml; this was replaced during the operation, and 2 additional units of blood were ordered afterwards. The only additional monitoring aids at our disposal were an oscillometer, electrocardiography and measurement of urine output.

The patient's emergence from anaesthesia and the immediate postoperative period were uneventful. The nasotracheal tube was removed 2 days after the operation and the airway remained patent. There were no complications in the 3 weeks that followed the operation, but the patient died suddenly on the 21st day. No autopsy was performed and the immediate cause of death could not be ascertained.

## DISCUSSION

Although anaesthesia for quadriplegics is not common, usually being managed at special centres by staff experienced in the handling of these patients, paraplegia is a more common condition which an anaesthetist may have to manage in the course of his duties and which involves similar problems.

### The Airway

A word of warning on Abou-Madi's technique is appropriate. He modified a No. 28 Foley catheter with a 5 ml balloon and an internal diameter of approximately 6 mm by cutting off the catheter tip and shortening the length to 25 cm, and used it as an endotracheal tube in a patient similar to ours with an obstruction 4 cm from the carina. Its advantages, as quoted by him, include the short balloon, the lack of a protruding tip, and overall slenderness and resistance to kinking. We found it difficult to pass a suction catheter down the Foley catheter. The surgeon therefore had to remove the catheter from the distal stump so as to be able to suck up secretions. This meant interruption of ventilation and interference with the operation. Unacceptably high resistance to inflation was also experienced — inflation of the catheter after removal revealed the reasons for this. Firstly, the diameter of the catheter at the balloon area is somewhat narrower than the rest of the catheter, and secondly, although the catheter is quite firm and does not easily kink, it is not armoured and balloon inflation causes the internal diameter to narrow appreciably. We would rather ventilate only the left lung (the accepted technique, described fully by Geffin *et al.*<sup>2</sup>) and possibly clamp the right pulmonary artery partially if the balloon of an armoured tube interferes with the operation to an unacceptable extent. We are currently negotiating with the manufacturer of an armoured endotracheal tube to manufacture a longer tube with a shorter cuff and no protruding tip beyond, and hope to report on this at a later stage.

Ventilation by tracheal jet inflation<sup>3-5</sup> was considered. It offers ideal exposure to the surgeon, but does not protect the airway, which is of the utmost importance in a quadriplegic.

### Choice of Drugs

Diazepam was chosen as premedicant because of its minimal influence (at this dosage level) on cardiovascular stability and its excellent sedative and anxiolytic action.

Agents for the induction and maintenance of anaesthesia which would preserve cardiovascular stability and yet limit mass sympathetic hyperreflex actions were chosen. The latter are due to indiscriminate massive reflexes which occur after cord transection and are triggered by a full bladder or any other tactile or autonomic stimulant, e.g. surgical manipulation below the level of transection.<sup>6</sup> The modulating and inhibiting effect of the higher centres is lost and this results in a mass outpouring of efferent sympathetic and motor stimuli. These cause vasoconstriction of the vessels innervated by fibres issuing

below the level of transection, and reflex vasodilation, bradycardia (even ST-segment changes and heart block) and sweating of the areas innervated by fibres issuing above the level of transection. This syndrome is seen when the transection level is above T6. Transection above C5 completely dissociates the higher sympathetic centres from the spinal part of the sympathetic system, thereby limiting vasodilation and sweating to the skin of the face. This also means that the patient has very little inherent potential to compensate; tremendous hypertension may result, causing signs of cardiac ischaemia and resulting in cerebrovascular incidents. In our patient, sweating of the forehead was noted at the end of the operation. However, this was not associated with hypertension or bradycardia and could therefore not be described as sympathetic hyperreflexia. It is important to avoid urinary retention due to catheter obstruction, since this is the classic trigger for this potentially hazardous syndrome.

It is important to remember, however, that since these patients have lost all vasomotor control they are extremely sensitive to vasodilating or myocardial depressant drugs. Severe hypotension during the induction of anaesthesia followed by severe hypertension at the onset of the operation is common. We prevented this by using low dosages of ketamine combined with fentanyl and halothane. The dosage of ketamine administered roughly equalled the analgesic dose and was much less than the dose (0,1-0,125 mg/kg/h) described recently by Lilburn *et al.*<sup>7</sup> for total intravenous ketamine anaesthesia.

Constant infusion of etomidate<sup>8</sup> or alphaxolone plus alphadolone<sup>9</sup> would have been equally acceptable, but ketamine was chosen to maintain cardiovascular stability, in a dosage range that would make untoward cardiovascular stimulation unlikely. Drinker and Helrich<sup>10</sup> used halothane to treat a sympathetic storm in a paraplegic, and we added this to dampen possible sympathetic effects.

### Muscle Relaxants

There was no indication for the use of muscle relaxants. Depolarizers present a particular danger owing to the precipitous increases in serum K<sup>+</sup> levels released from denervated muscle when depolarized, with consequent electrocardiographic changes and possible cardiac arrest.<sup>11-13</sup> If this patient had not previously been intubated, a technique of liberal oral and transtracheal spray, blocking of the superior laryngeal nerves and intubation without the use of relaxants would have been chosen (with an assistant stabilizing the patient's head to prevent cord damage where this was not already complete).

### Monitoring

Ideally one should also monitor rectal temperature with a rectal thermistor probe and blood pressure by means of

an arterial line. Blood gases also require monitoring during periods of compromised ventilation or left lung ventilation.

### Temperature Control

Patients with spinal lesions are poikilothermic below the level of transection owing to loss of control of skin perfusion and of thermogenesis by means of shivering.<sup>14</sup> Careful adjustment of ambient temperature, careful under-body heating and a warm-water humidifier in the anaesthetic circuit are useful measures to prevent heat loss.

### Postoperative Ventilation

Patients who have high cord lesions and who undergo major abdominal surgery usually require assisted ventilation after the operation; however, tracheal anastomosis may be regarded as a contraindication because of the danger of surgical emphysema. If required, a technique of intermittent mandatory ventilation seems indicated.

### Fluid Balance

Quadriplegic patients are unable to take fluids as required and are at the mercy of attending staff to supply their needs; they are therefore particularly prone to dehydration, and require the administration of adequate intravenous fluids from 24 hours before the operation.

### The Anaesthetic Team

Two experienced anaesthetists and two assistants are required in order to perform the constant monitoring necessary and the ventilation by hand while tracheal suturing is being carried out. In addition, excellent rapport between surgeon and anaesthetist is a prerequisite of success.

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### REFERENCES

1. Abou-Madi, M. N., Cuadrado, L., Domb, B. *et al.* (1979): *Canad. Anaesth. Soc. J.*, **26**, 26.
2. Geffin, B., Bland, J. and Grillo, H. (1969): *Anesth. Analg. Curr. Res.*, **48**, 884.
3. Lee, P. and English, C. W. (1974): *Anaesthesia*, **29**, 305.
4. MacNaughton, F. I. (1975): *Brit. J. Anaesth.*, **47**, 1225.
5. Baraka, A. (1977): *Anesth. Analg. Curr. Res.*, **56**, 429.
6. Desmond, J. (1970): *Canad. Anaesth. Soc. J.*, **17**, 435.
7. Lilburn, J. K., Dundee, J. W. and Moore, J. (1978): *Anaesthesia*, **33**, 315.
8. Booi, L. H. D. J., Rutten, J. M. J. and Crul, J. F. (1978): *Acta anaesth. belg.*, **29**, 165.
9. Park, G. R. and Wilson, J. (1978): *Brit. J. Anaesth.*, **50**, 1219.
10. Drinker, A. S. and Helrich, M. (1963): *Anesthesiology*, **24**, 399.
11. Cooperman, L. H. (1970): *J. Amer. med. Ass.*, **213**, 1867.
12. Beach, T. P., Stone, W. A. and Hamelberg, W. (1971): *Anesth. Analg. Curr. Res.*, **50**, 431.
13. Tobey, R. E. (1970): *Anesthesiology*, **32**, 359.
14. Katz, J. and Kadis, L. B. (1973): *Anesthesia in Uncommon Diseases*, pp. 391-393. Philadelphia: W. B. Saunders.