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CASE REPORT

Methoxyflurane for Procedural Analgesia at 4470 m Altitude

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Methoxyflurane is a volatile, fluorinated anesthetic agent with analgesic properties. Although no longer used as an anesthetic due to concerns regarding renal toxicity in high doses, it has enjoyed a resurgence as an inhaled analgesic in prehospital care and in the emergency department. The agent is nonflammable and leads to rapid, titratable analgesia without intravenous access. The Penthrox inhaler device is light, robust, and straightforward to administer. Consequently, it has been proposed as an ideal analgesic for the remote high altitude setting. We report its use for procedural analgesia during suprapubic aspiration for acute urinary retention at a remote rescue post at night, in cold winter conditions, at 4470 m altitude in Machermo, Nepal. We found that methoxyflurane provided rapid, effective analgesia for our patient's visceral and procedural pain. The inhaler was easy to administer, and the patient remained responsive to voice, with satisfactory oxygen saturation and respiratory rate throughout. We also briefly review the administration, dosing, efficacy, and safety of methoxyflurane and its role in remote medical care.

Keywords: analgesia, patient controlled, anesthesia, conscious sedation, nebulizers and vaporizers, wilderness, extreme environments

Introduction

Methoxyflurane (Penthrox, Penthrane) is a volatile fluorinated hydrocarbon, historically used as an anesthetic and still widely employed in Australasia as an inhaled analgesic.[1] It fell out of favor for anesthesia after reports of nephrotoxicity and was formally withdrawn from the United States by the Federal Drug Administration in 2005. In 2015, methoxyflurane regained its license in the United Kingdom for use as an emergency analgesic in adult trauma patients and is presently available in 11 countries and under review in 22 more (Table 1). It has been argued that methoxyflurane would be an ideal agent for remote high-altitude analgesia, but the authors noted there were no published reports of its performance in that setting.[2] In that light, we present a case of emergency suprapubic aspiration for acute urinary retention, using methoxyflurane for procedural analgesia, at a remote rescue facility at 4470 m.

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Case presentation

A 61-year-old Australian trekker presented at 0230 to the Community Action Nepal - International Porter Protection group rescue post at Machermo, Nepal, in acute urinary retention. He had experienced no problems voiding during the previous day, but on getting out of bed at 2200 he was only able to pass a small dribble of urine. By the time of his presentation, he was in considerable pain.

He had no symptoms of urinary tract infection or constipation, and his lower limb neurology was normal. Although this was his first presentation with retention, he recounted a 10-year course of gradually worsening lower urinary tract symptoms, including nocturia, poor flow, intermittent stream, hesitancy, and terminal dribbling. He had not sought treatment for these symptoms, and his only other medical history was hypertension, treated with lercanidipine. He was on day 6 of a trek from Lukla, had no symptoms of acute mountain sickness, was not taking acetazolamide, and had been to an equivalent altitude twice before.

His observations on admission were heart rate 101 beats·min^{-1}, blood pressure 150/110 mm Hg, respiratory frequency 32 breaths·min^{-1}, finger oxygen saturations 90% standing and 86% supine, and tympanic

temperature 35°C. His bladder was palpable to 4 cm inferior to the umbilicus, and there were no signs of peritonism. He described his pain as "severe."

With no access to urethral catheters, we elected to perform suprapubic bladder aspiration. However, with only a 10 mL syringe and 21G needle available at the post, it was to be a time-consuming and potentially painful process, necessitating procedural analgesia. We gave him 1 g of oral paracetamol (acetaminophen) and injected 4 mL of 1% lidocaine around the intended aspiration site, but he remained very uncomfortable secondary to visceral pain from his bladder and struggled to lie still. Our parenteral analgesic options were diclofenac, tramadol, or inhaled methoxyflurane. We were reluctant to give diclofenac for fear of renal dysfunction associated with the urinary retention, and we judged that the ability to titrate methoxyflurane inhalation made it safer than parenteral tramadol for this procedure. Our primary concern was that the ambient temperature, not measured but certainly below 0°C, would render the methoxyflurane less effective (see Discussion).

The patient held a Penthrox inhaler (Medical Developments International, Victoria, Australia), primed with 3 mL of methoxyflurane (Figure 1). Breathing the vapor, he described a rapid, significant reduction in his bladder pain and a feeling of being "blissed out." Although aware of the sensation of the needle aspiration, he did not report pain during the procedure. His oxygen saturation fell to 86% on air after lying supine. It then remained between 83 and 86% while breathing the vapor. (For context, the mean oxygen saturation at our post in well trekkers standing upright was 87% [SD ±4.1%].) His respiratory rate fell to 18 breaths·min^{-1} on breathing the vapor, likely due to the reduction in pain, and vocal contact was maintained throughout. Our oxygen supplies were limited at night, so we elected not to use supplementary oxygen unless demanded by his clinical condition.

After the successful aspiration of 400 mL of straw-colored urine and the cessation of methoxyflurane inhalation, he was almost immediately able to stand unaided. Although conscious of a recurring mild urge to pass urine, he remained free from pain until his helicopter evacuation to Kathmandu the following morning. There, he was catheterized and investigations confirmed a normal renal tract and renal function. The cause of the retention was benign prostatic hypertrophy, and the patient was discharged from the hospital the next day.

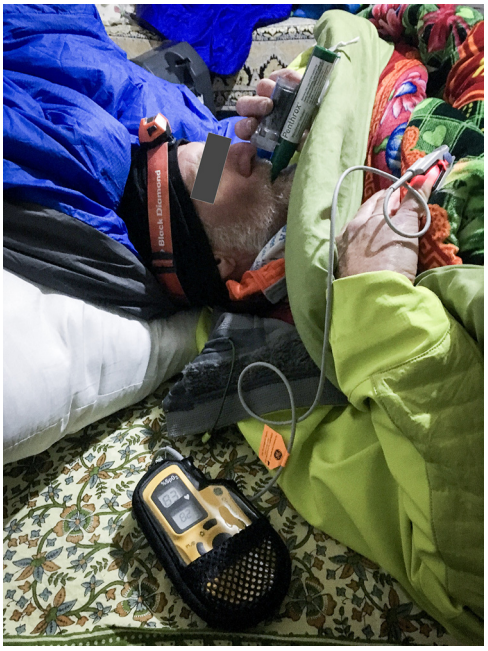

Figure 1. The patient using the methoxyflurane (Penthrox) inhaler during the procedure. He was covered by several blankets due to the low ambient temperature and had continuous oxygen saturation and heart rate monitoring. The inhaler was fitted with the activated charcoal filter to scavenge waste gases.

Discussion

We report the successful use of methoxyflurane for procedural analgesia during suprapubic aspiration for acute urinary retention at a remote, high-altitude Himalayan rescue post. Methoxyflurane is supplied in 3 mL (4.12 g) screw-top vials and administered via a disposable inhaler (nicknamed the "green whistle" in Australasia).[3] The clinician opens the vial and pours the liquid into the base of the inhaler, saturating a polypropylene wick inside. The patient is asked to breathe in and out through the unidirectional mouthpiece (gently at first) until analgesia is achieved. They then breathe intermittently on the inhaler as required to maintain pain relief. The inhaler has a dilutor hole; at sea level, the inhaler delivers 0.1 to 0.2% methoxyflurane, but covering the hole will increase the concentration to 0.2 to 0.4%.[4] An activated charcoal filter, included with the inhaler, can be fitted to the dilutor hole to scavenge waste gas and reduce the cumulative occupational exposure of rescue personnel.[5] Supplementary oxygen can also be given via a distal port.

Onset of analgesia typically occurs within 10 breaths, and one 3 mL ampoule lasts 30 to 60 min.[3] The maximum recommended dose is 6 mL (2 ampoules) per day to a total of 15 mL (5 ampoules) per week.[3] Methoxyflurane at analgesic doses was thought to be safe and effective in the emergency department and prehospital setting in a 2009 narrative review.[5] In a 2014 multicenter randomized controlled trial of 300 patients with minor trauma in the emergency department, methoxyflurane significantly