Tracheal Constriction by Morphone
and by Fentanyl in Man

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The effects of morphone and fentanyl on tracheal smooth muscle tone were studied in 38 patients during induction of anesthesia. Endotracheal tube cuff pressure was used to measure tracheal tone. Anesthesia was maintained with nitrous oxide, 70% per cent in oxygen, and pancuronium and ventilation was controlled with a respirator. Morphone, 0.5 mg/kg, produced a biphasic response, initially causing tracheal dilatation and then tracheal constriction. Ten minutes after morphone injection, cuff pressure increased to significantly (21 ± 8 per cent) above control. Morphone-induced tracheal constriction could be completely blocked by the prior administration of atropine, 0.5 mg. Fentanyl, 0.006 mg/kg, also produced significant tracheal constriction, cuff pressures increasing to 44 ± 11 per cent above control at 10 min. Fentanyl-induced tracheal constriction could be blocked by pretreatment with droperidol, 0.25 mg/kg. At equianalgesic doses, morphone and fentanyl produced similar tracheal constriction. (Key words: Analgesics, narcotic: morphone; fentanyl. Airway: trachea. Lang: trachea.)

Recently, Himori and Taira reported a simple method using endotracheal tube cuff pressures to measure tracheal tone.1 In the dog they showed tracheal constriction by acetylcholine and tracheal dilatation by isoproterenol epinephrine, and norepinephrine. We used this method to measure tracheal tone in patients anesthetized with morphone or fentanyl.

Methods

Thirty-eight adult patients whose ages ranged from 21 to 67 years (mean 42) and whose weights ranged from 38 to 71 kg (mean 52), undergoing elective surgical procedures, were studied. Patients received atropine, 0.5 mg, intramuscularly, two hours before the scheduled time of operation. Anesthesia was induced with thiopental, 5 mg/kg, and maintained with nitrous oxide, 70 per cent, and pancuronium, 0.14 mg/kg. The trachea was intubated with a tube with a floppy rubber cuff (Igarashi B type) filled with sterilized water. The proximal end of the cuff catheter was connected to a pressure transducer (Statham P234BB) and recorded (San-ei Instrument 1410-6). Initial cuff pressure was adjusted to 10–20 cm H2O. Ventilation was controlled (Bird Mark 4 or 8) at a tidal volume sufficient to maintain arterial carbon dioxide partial pressure between 31 and 35 torr. After completion of these preparations, morphone, 0.5 mg/kg, was administered to 15 patients; fentanyl, 0.006 mg/kg, to 11 patients; morphone, 0.5 mg/kg, after atropine, 0.5 mg, pretreatment to six patients; fentanyl, 0.006 mg/kg, after droperidol, 0.25 mg/kg, to six patients. All drugs were given intravenously. Changes in cuff pressure were recorded continuously.

Changes in cuff pressures after administration of the drugs were analyzed statistically using Student's t test for paired data. Cuff pressures at equianalgesic doses of morphone and fentanyl were compared using Student's t test for unpaired data. Differences were considered significant when P values were less than 0.05.

Results

Control mean tracheal cuff pressure was 15.9 ± 1.2 cm H2O (mean ± SE). The effect of morphone on tracheal tone was biphasic, initially producing slight dilatation and then constriction (fig. 1). A minute after morphone administration cuff pressure had decreased significantly to 14.7 ± 1.2 cm H2O (fig. 2). Within 10 min cuff pressure had increased to 19.7 ± 1.5 cm H2O, a 27 ± 8 per cent increase above control. Tracheal constriction by morphone was completely blocked by pretreatment with atropine in six patients (fig. 2). The initial mean cuff pressure, 15.0 ± 1.0 cm H2O, decreased to 12.9 ± 1.3 cm H2O after atropine administration. Ten minutes after morphone administration, cuff pressures averaged 12.7 ± 2.1 cm H2O.

Fentanyl also induced tracheal constriction (fig. 3). Control mean cuff pressure, 12.7 ± 0.9 cm H2O, increased to 17.7 ± 1.0 cm H2O 10 min after fentanyl administration. This represented an increase of 44 ± 11 per cent above control. Pretreatment with droperidol prevented the increase in cuff pressure produced by fentanyl. The initial mean cuff pressure, 18.9 ± 1.5 cm H2O, decreased to 15.4 ± 2.3 cm H2O after administration of droperidol. Ten minutes after fentanyl administration, cuff pressures averaged 13.6 ± 1.0 cm H2O. At equianalgesic doses, no significant difference between the effects of morphone and fentanyl on cuff pressure was found.

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Discussion

The present study has shown that morphine and fentanyl increase water-filled tracheal cuff pressure in man. Equianalgesic doses of morphine (0.5 mg/kg) and fentanyl (0.006 mg/kg) produce similar tracheal constriction.

Recently, Crawley and Cross stated that high-volume cuff pressure represents airway pressure. Himori and Taira reported a simple method using endotracheal tube cuff pressures to measure tracheal tone. In the dog, they demonstrated tracheal constriction by acetylcholine and tracheal dilatation by isoproterenol, epinephrine, and norepinephrine. The two reports conclude that increase and decrease of cuff pressures are caused by tracheal constriction and dilatation, respectively.

Although the effects of narcotics on bronchial tone have been well elucidated, the actions of morphine and fentanyl on tracheal tone in man has not been established. Shemano and Wendel demonstrated by measuring lung capacity that both meperidine and morphine produce bronchoconstriction in the intact dog. Zauder and Nichols suggested that fentanyl decreases dynamic and static compliance in patients whose tracheas are intubated. The results of Shemano et al. and Zauder et al. may suggest the possibility of a decrease in the airway dimensions between the alveoli and the trachea.

Using bronchograms, Kilburn demonstrated tracheal dilatation by atropine, and Ingram et al. suggested that the major action of atropine on the airway is to produce dilatation of the trachea. Himori and Taira reported that acetylcholine-induced tracheal constriction is antagonized by atropine. In our study, atropine completely blocked morphine-induced tracheal constriction. Our results indicated that the increase in central vagal tone and the excitation of cho-
linergic receptors in tracheal smooth muscle might be major factors in morphine-induced tracheal constriction in man. However, Shemano and Wendel suggested that morphine-induced tracheal constriction in the dog may be due to an increase in central vagal tone and histamine release. 3

The mechanism of the initial phase of tracheal dilatation induced by morphine that we observed remains unclear. It may be direct depression of the medullary constrictor center by morphine, similar to the depression of the cough reflex center. 7

Droperidol in large doses is known to have an alpha-adrenergic receptor-blocking action. Cottrell et al. reported that droperidol decreases airway resistance, and suggested bronchodilatation. 8 Shephard concluded that droperidol had neither an atropine-like action nor an antihistaminic action. 9 The results of the present study indicate that the mechanism of fentanyl-induced tracheal constriction may be an alpha-adrenergic receptor stimulant effect. However, Shephard stated that fentanyl produced bronchoconstriction that was antagonized by atropine in the dog. 9 The possibility of cholinergic receptor stimulation as an important factor cannot be ruled out.

In summary, the present study showed: 1) tracheal smooth muscle tone is increased by morphine and by fentanyl in patients whose tracheas are intubated; 2) equianalgesic doses of morphine and fentanyl produce similar tracheal constriction; 3) atropine completely blocks morphine-induced tracheal constriction; 4) droperidol antagonizes fentanyl-induced tracheal constriction.

This method may be useful for qualitative evaluation of effects of drugs on tracheal smooth muscle tone.

References

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