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Delayed and Prolonged Rigidity Greater than 24 h following High-dose Fentanyl Anesthesia

JOSEPH MIRENDA, M.D.,* MAHMOOD TABATABAI, M.D.,† KARL WONG, M.D.†

Problems with muscular rigidity associated with the administration of narcotics during anesthesia were first reported by Hamilton and Cullen in 1953.[1] Although it may vary, an incidence of rigidity during induction of anesthesia of up to 80% has been seen by some investigators.[2] More recently, reports of chest wall rigidity have appeared during the recovery period, 5–7 h following induction of anesthesia, from both fentanyl[3,4] and sufentanil.[5]

We report a patient who experienced chest wall, truncal, and extremity rigidity more than 24 h after the induction of anesthesia with a high-dose fentanyl technique. Our patient's clinical appearance and response to naloxone supports the fact that rigidity may be observed later than previously thought after induction with narcotics.

CASE REPORT

A 68-yr-old, 65-kg man with coronary artery disease was scheduled for coronary artery bypass grafting (CABG). Premedication consisted of 7 mg morphine, im, 0.2 mg scopolamine, im, and 60 mg diltiazem, po. Prior to induction of anesthesia, electrocardiographic monitoring was attached and vascular access was established with both pulmonary and systemic arterial catheters in addition to peripheral venous lines.

Induction of anesthesia consisted of 40 μg/kg fentanyl, 0.3 mg/kg vecuronium, and 15 μg/kg midazolam, iv. Neither rigidity nor difficulty with ventilation were noticed prior to the loss of the last twitch of the train-of-four on the neuromuscular monitor. Endotracheal intubation took place without difficulty and arterial blood gases consistently revealed a Pa_{CO_2} between 32 and 43 mmHg with 99–100% oxygen saturation.

The anesthetic and surgical course remained uneventful. Intermittent doses of pancuronum were administered iv for paralysis and additional doses of fentanyl (45 μg/kg) were given iv during the case for a total dose of 95 μg/kg (6.48 mg). The patient remained paralyzed at the end of the anesthetic course, as evidenced by absence of all twitches on the train-of-four. The paralysis was not reversed, and the patient was transported to the intensive care unit (ICU) requiring controlled ventilation.

The initial ICU course was notable for gradual hypotension, unresponsive to iv colloid administration, which accompanied rewarming (39.0° C core) and eventually necessitated a phenylephrine infusion. Cardiac index was 5.10 $l \cdot min^{-1} \cdot m^{-2}$, pulmonary artery occlusion pressure was 12 mmHg, central venous pressure was 10 mmHg, and systemic vascular resistance index was calculated to be 640 $dynes \cdot sec \cdot cm^{-5} \cdot m^2$ prior to initiation of the infusion. Pa_{CO_2} values ranged between 36 and 41 mmHg on a volume set ventilator.

The majority of the ICU course, however, was marked by extreme somnolence, despite the lack of any narcotic or other sedative administration. By morning rounds on postoperative day one, 24 h after induction of anesthesia, the patient would arouse to painful stimuli only and the pupils were constricted bilaterally at 2 mm, although he was initiating spontaneous breaths above the set intermittent mandatory ventilator (IMV) rate. Ventilator adjustment consisted of lowering the set IMV rate to allow the patient more spontaneous ventilation, which did not raise the Pa_{CO_2} above 40 mmHg.

Over the ensuing 6 h, however, the patient became progressively less responsive to stimuli, was not consistently ventilating above the set IMV rate, and was noticed by the nursing and house staff to have become gradually more "stiff." By 1400 (6 h after rounds, 30 h after induction of anesthesia) he appeared rigid in the chest, abdomen, neck, and extremities and was completely unresponsive and without spontaneous ventilation. Peak inspiratory pressure (PIP) had increased from a baseline pressure of 35 cm H_2O to 57 cm H_2O at that time (triggering the respective ventilator alarm) and arterial blood gas analysis revealed a ph_a of 7.27, a Pa_{CO_2} of 58 mmHg, and a Pa_{CO_2} of 80 mmHg on 0.5 FI_{O_2}. Core temperature was 37.0° C. Systemic arterial blood pressure had not changed significantly; however, greater amounts of phenylephrine were required to sustain arterial blood pressure. Cardiac index was 3.05 $l \cdot min^{-1} \cdot m^{-2}$, systemic vascular resistance index was 1575 $dynes \cdot sec \cdot cm^{-5} \cdot m^2$, and pulmonary artery occlusion and central venous pressures had risen to 18 and 15 mmHg, respectively. Pulmonary artery pressures were elevated as well from initial systolic/diastolic values of 30 mmHg/18 mmHg to 47 mmHg/28 mmHg.

Naloxone 40 μg, iv, was injected with subsequent ablation of rigidity, appearance of spontaneous movement of all extremities, and initiation of spontaneous ventilation, all seen within 45 seconds of administration. Due to accompanied agitation and ventilator "bucking," diazepam 2.5 mg iv was given with good effect. After readjustment of the ventilator, analysis of blood gases revealed a ph_a of 7.42, a Pa_{CO_2} of 37 mmHg, and a Pa_{O_2} of 98 mmHg on 0.5 FI_{O_2}. Peak inspiratory pressure was reduced to 27 cm H_2O and filling pressures and pulmonary artery pressures had lowered as well. The phenylephrine infusion was tapered soon thereafter. Three hours later (then, 33 h following induction of anesthesia), similar findings of rigidity, unresponsiveness, and hypoventilation with a similar hemodynamic profile were again observed and amenable to 40 μg naloxone, iv.

The patient's ICU course was subsequently without incident. Due to persistent somnolence, his trachea remained intubated throughout the evening. His trachea was extubated by morning rounds the following day, approximately 50 h after the induction of anesthesia.

DISCUSSION

Reports of narcotic-induced rigidity are not unusual. To date, however, cases have described the phenomenon

* Fellow, Division of Critical Care Medicine, Department of Anesthesiology, University of Pittsburgh School of Medicine.

† Assistant Professor, Department of Anesthesiology, VA Medical Center—Oakland, University of Pittsburgh School of Medicine.

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Address reprint requests to Dr. Mirenda: Division of Critical Care Medicine, Presbyterian-University Hospital, DeSoto at O'Hara Streets, Pittsburgh, Pennsylvania 15213.

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to have occurred during either the induction period or the immediate postoperative period,[3-5] although not as late as the first postoperative day.

We feel that the delayed and prolonged rigidity we observed more than 24 h following induction of anesthesia in our patient was due to fentanyl. Although fentanyl levels were not measured, the patient's clinical appearance of unresponsiveness, pupillary constriction, and hypoventilation prior to and during the rigidity were consistent with exacerbated narcosis. Moreover, the large amount of fentanyl administered intraoperatively, although within accepted clinical practice,[6] most likely accounted for our patient's prolonged somnolence postoperatively given the lack of any narcotic or sedative administration during that time.

Most evidence suggests that rigidity is the result of stimulation at a single central nervous system site, possibly the caudate nucleus,[7] and is related to enhanced dopamine biosynthesis.[8] The exact mechanism underlying a 30-h delay in this phenomenon remains unclear to us at this time. In any event, naloxone, well known to effectively antagonize opioid rigidity,[9] reversed it promptly in both instances and adds further support to our claim.

The rise in pulmonary artery occlusion and central venous pressures are consistent with the physiological findings of narcotic-induced rigidity as well.[10] Although the rise may be in part attributed to the mechanical effect of rigidity, we suspect that hypercarbia resulted in the impressive elevation in pulmonary artery pressures that eventually lowered with normocarbia. Furthermore, despite evidence that the initial systemic vasodilation and hypotension in our patient may have been due to overaggressive rewarming or even the presence of a calcium entry blocker,[11] we likewise suspect that the hemodynamic instability seen during the rigidity necessitating a higher phenylephrine infusion rate may have been hypercarbia-induced as well. We can attribute this to the direct systemic vasodilating effect of CO_2 in the presence of opioids.[12] As with the pulmonary artery pressures, the hemodynamic instability resolved and the phenylephrine infusion was tapered with the reestablishment of normocarbia.

In conclusion, we have evidence that narcotic-induced rigidity after high-dose fentanyl may occur much later than previously described. This may result not only in respiratory, but also hemodynamic, compromise in the setting of significant hypercarbia. Our patient responded well to naloxone iv. We suspect that such delayed rigidity could be especially worrisome in the postoperative cardiac surgical patient whose trachea has been extubated relatively early after surgery.

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