

Effect of Lidocaine on ICP Response to Endotracheal Suctioning

MASAMI YANO, M.D.,* HIROAKI NISHIYAMA, M.D.,† HIROYUKI YOKOTA, M.D.,† KAZUYOSHI KATO, M.D.,† YASUHIRO YAMAMOTO, M.D.,‡ TOSHIBUMI OTSUKA, M.D.§

Control of intracranial pressure (ICP) is important in the treatment of patients with severe head injury.^{1,2} Increases in ICP due to endotracheal suctioning, postural drainage, or moving the patient may aggravate brain damage. Intravenous (iv) injection of lidocaine lowers ICP and, at the same time, controls the stimulation caused by endotracheal suctioning.³ The effectiveness of iv lidocaine is controversial.^{4,5} We compared the effects of iv and intratracheal (IT) application of lidocaine on the increased ICP caused by endotracheal suctioning.

SUBJECTS AND METHODS

Nine adolescent and adult patients with severe head injury (Glasgow Coma Scale \leq 8) were studied. Informed consent was obtained from the next of kin. Their ages ranged from 16 to 71 yr with an average of 34.6 yr. All patients underwent endotracheal intubation during mechanical ventilation (PaCO₂ 25–30 mmHg, PaO₂ 80–120 mmHg). Continuous ICP monitoring was performed with a subarachnoid catheter⁶ and recorded by a polygraph. We selected patients with mild intracranial hypertension whose baseline ICP had decreased to about 20 mmHg or less from initial values of 25–40 mmHg. After the baseline ICP was determined, the peak ICP induced by endotracheal suctioning was measured. Delta ICP was calculated by subtracting the peak ICP from the baseline values; the measurements before injection of lidocaine were used as control.

Lidocaine (1.5 mg/kg) was administered iv 1, 3, 5, 10, and 15 min before endotracheal suctioning was performed, which was carried out by the same physician who determined the ICP. Endotracheal suctioning was performed by the same physician who was determining the ICP. Six hours after iv lidocaine injection, 2 ml of 4% lidocaine was injected IT through a 4 French fine tube (Atom[®]) inserted near the carina, and the same protocol

was performed. Serial plasma concentrations of lidocaine after injection were measured by gas chromatography. The reliable lower limit of detection was 0.01 μ g/ml.

RESULTS

There were no hemodynamic changes or differences between the two groups during or after lidocaine administration. There were no differences between the two treatments with respect to endotracheal suctioning.

The mean baseline ICPs in the iv and IT groups were 17.6 ± 2.8 (mean \pm SE) and 17.4 ± 3.0 mmHg, respectively, similar to the control baseline values throughout the study (fig. 1). Neither iv nor IT lidocaine lowered the baseline ICP. However, both treatments suppressed the increased ICP caused by endotracheal suctioning (fig. 2). There were significant differences between the peak ICP of the control and the ICP at 1 and 10 min after iv injection of lidocaine ($P < 0.05$). Furthermore, the peak ICP after IT injection of lidocaine was significantly lower, and the decrease continued throughout the study ($P < 0.01$). There was also a significant difference between the peak ICP in the two groups after 5 min (fig. 2). The mean delta ICP was below 10 mmHg for 10 min after application of IT lidocaine (fig. 3).

Plasma levels of lidocaine were 5.03 ± 0.60 μ g/ml 1 min after iv injection, 2.10 ± 0.40 μ g/ml and 1.02 ± 0.25 μ g/ml 15 and 30 min after injection, respectively. No lidocaine was detected in the blood 6 h after iv injection. The plasma level of lidocaine after IT injection was 0.35 ± 0.05 μ g/ml 1 min after injection (0.70 ± 0.16 μ g/ml peak) and 0.68 ± 0.15 μ g/ml 15 min after injection, respectively.

DISCUSSION

Cough is suppressed by iv injection of lidocaine.^{3,7} ICP responses to laryngoscopy and endotracheal intubation were significantly prevented by iv lidocaine, compared with the administration of laryngotracheal (LTA) lidocaine.⁸ Furthermore, direct instillation of lidocaine into the trachea caused a significant increase in ICP.⁸ In contrast, it lidocaine was more effective in preventing the cough reflex and attenuating the increase in ICP.⁴ In this study, both iv and it lidocaine suppressed the ICP elevation caused by endotracheal suctioning, but it lidocaine was significantly more effective than iv lidocaine.

However, neither iv nor it injection of lidocaine could

* Assistant Professor.

† Resident.

‡ Associate Professor.

§ Professor and Chairman.

Received from the Department of Emergency and Critical Care Medicine, Nippon Medical School, 1-1-5, Bunkyo-ku, Tokyo 113, Japan. Accepted for publication December 18, 1985.

Address reprint requests to Dr. Yano.

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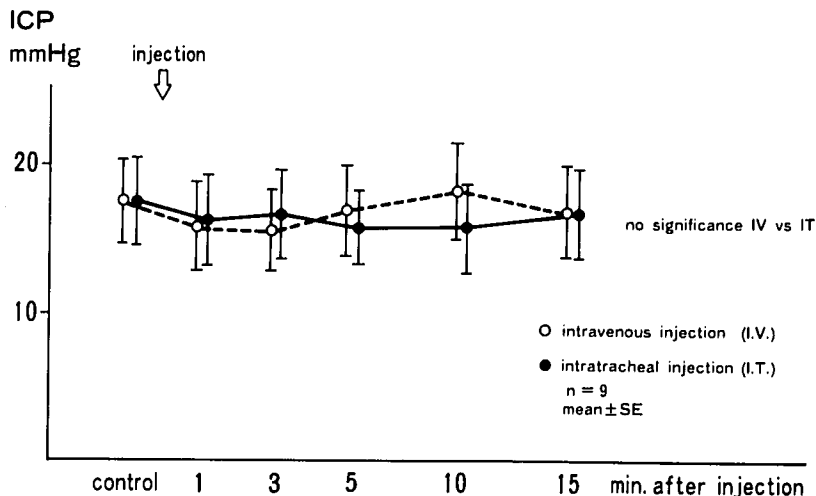


FIG. 1. Comparison of baseline ICP (*i.e.*, before suctioning) before and after lidocaine injection. The baseline ICPs that were determined as control before iv and IT lidocaine injection were 17.6 ± 2.7 and 17.4 ± 3.0 mmHg, respectively. Serial baseline ICPs that were obtained just before every suctioning did not change significantly from the control values throughout the study.

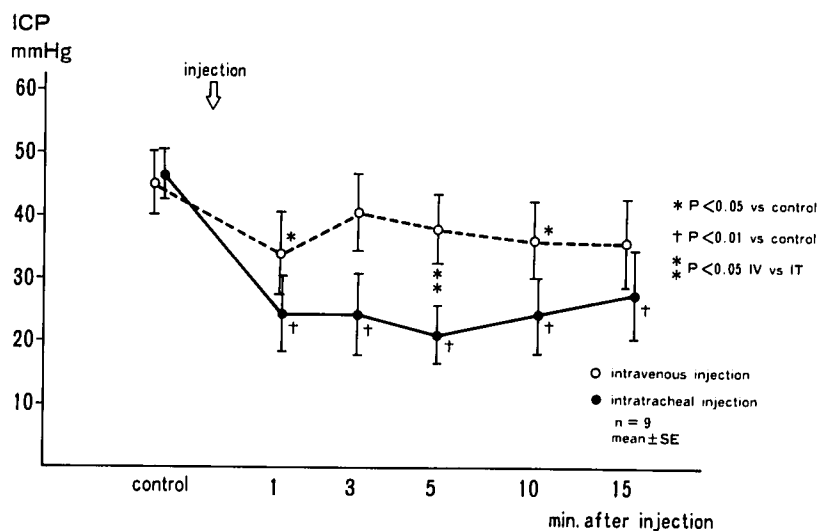


FIG. 2. Change in peak ICP caused by suctioning before and after lidocaine injection. The peak ICPs of both iv and IT lidocaine were suppressed significantly, compared with those of control. IT lidocaine clearly depressed the peak ICPs throughout the course.

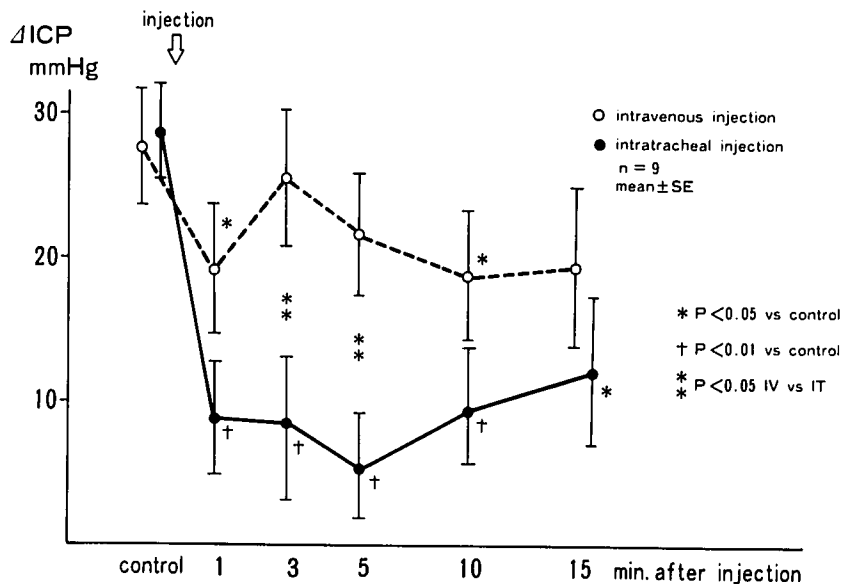


FIG. 3. Change in delta ICP. Delta ICPs of both iv and IT lidocaine were significantly lower than those of control. Delta ICPs of IT especially were kept below 10 mmHg for 10 min after injection.

reduce the baseline ICP, although Bedford *et al.*³ mentioned that iv injection appeared to reduce the ICP.

Lidocaine blood levels of 3–6 $\mu\text{g}/\text{ml}$ are effective in suppressing coughing.⁹ Although in this study mean blood levels of 3.2 $\mu\text{g}/\text{ml}$ or more were maintained for 10 min after iv bolus injection, the ICP elevation induced by suctioning was not suppressed sufficiently. On the other hand, Viegas and Stoelting¹⁰ showed that lidocaine levels are low 1 min after laryngotracheal lidocaine spray but gradually increase to 1.0–2.7 $\mu\text{g}/\text{ml}$ between 4 and 15 min after application. Their values were much higher than those in our study.

The effectiveness of IT lidocaine is not attributed to the plasma concentration but to the anesthetic effect on the tracheobroncheal mucosa. Because IT lidocaine injection with the use of a syringe from the top of the endotracheal tube stimulates the trachea and bronchus, causing bucking, we injected lidocaine through a fine tube to avoid expulsion of the lidocaine fluid from the endotracheal tube. When this tube was inserted or lidocaine was injected, bucking was induced, but the response was not as strong as that caused by suctioning.

Our findings demonstrate that IT lidocaine is significantly more effective in suppressing ICP elevation caused by suctioning than iv lidocaine, although neither iv nor IT 1.5 mg/kg of lidocaine lowered the baseline ICP.

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