

Efficacy of an Epidural Test Dose in Children Anesthetized with Halothane

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The effect of an intravenous (iv) injection of lidocaine with epinephrine was studied to determine if such a test dose would cause a reliably detectable increase in heart rate and systemic blood pressure in children anesthetized with halothane and nitrous oxide. The effect of the injection of atropine before the test dose on these parameters was also determined. Sixty-five children 1 month to 11 yr of age and weighing 3.9–35 kg were studied. The children were assigned to one of four groups, each of which was anesthetized with 1% halothane and 50% nitrous oxide. Group 1 ($n = 20$) received 10 $\mu\text{g}/\text{kg}$ atropine followed 5 min later by an iv dose of 0.1 ml/kg 1% lidocaine with 1/200,000 epinephrine (0.5 $\mu\text{g}/\text{kg}$) to simulate an intravascularly administered epidural test dose. Group 2 ($n = 21$) was identical to group 1 but did not receive atropine prior to the simulated intravascular test dose. Groups 3 ($n = 12$) and 4 ($n = 11$) were identical to groups 1 and 2, but the simulated intravascular test dose did not contain epinephrine: group 3 received atropine prior to the test dose and group 4 did not. The simulated intravascular test dose increased heart rate in group 1 (with atropine) at each time period from 15 to 120 s, but only at 45 and 60 s in group 2 (without atropine). Following the iv test dose, 6 of 21 children in group 2 had an increase in heart rate of less than 10 beats/min, while only one child in group 1 had an increase in heart rate of less than 10 beats/min. Intravenous test doses that did not contain epinephrine (groups 3 and 4) had no effect on heart rate or blood pressure. Atropine, 10 $\mu\text{g}/\text{kg}$, improves the reliability of an epidural test dose in children anesthetized with halothane and nitrous oxide but does not ensure total reliability in detecting an intravascular injection. (Key words: Anesthesia; pediatric. Anesthesia technique: epidural; test dose. Anesthetics, local: lidocaine. Complications: intravascular injection. Parasympathetic nervous system: atropine. Sympathetic nervous system: epinephrine.)

WHEN EPIDURAL ANESTHESIA is performed an epidural test dose with epinephrine may be given to detect an intravascular injection of local anesthetic. In the event that the test dose is injected intravascularly, it is assumed that epinephrine would cause an immediate and detectable increase in heart rate and blood pressure as was shown in adults.¹ There are no available data on the effect of such a test dose in children. Moreover, children, especially younger ones, are often given a general anesthetic prior to the epidural block, and there are no data on the efficacy of a test dose in this circumstance. The purpose of this

study was to determine whether the intravenous (iv) injection of an epidural test dose of lidocaine with epinephrine would reliably cause a detectable increase in heart rate and systemic blood pressure in children anesthetized with halothane, and the effect of previously given iv atropine on the cardiovascular response of an intravenously administered epidural test dose.

Materials and Methods

Sixty-five ASA Physical Status 1 children were included in the study. Their age ranged from 1 month to 11 yr (mean \pm SD, 3.9 ± 3.3 yr), and they weighed from 3.9 to 35 kg (15.9 ± 9.7 kg). Approval by the Committee on Human Research and parental consent were obtained. All children were scheduled for minor surgery for which the anesthetic was to be 1% halothane administered by mask with oxygen and nitrous oxide in equal parts. No child had received medication of any type for at least 1 month prior to the procedure, and they did not receive preanesthetic medication. Following induction of anesthesia, a peripheral vein was cannulated and an iv infusion was started with 5% dextrose in water at a rate of 10 $\text{ml} \cdot \text{kg}^{-1} \cdot \text{h}^{-1}$. The study was conducted in two parts. For part I 41 children were randomly assigned to two groups (groups 1 and 2); for part II 24 children were randomly assigned to two other groups (groups 3 and 4). Investigators were not blinded to the drugs being injected. When all vital signs were stable for at least 5 min and with the child breathing 1% end-tidal halothane, a bolus dose of one of the four following drug regimens was administered intravenously. Group 1 ($n = 20$) received 10 $\mu\text{g}/\text{kg}$ atropine followed 5 min later by 0.1 ml/kg 1% lidocaine with 1/200,000 epinephrine (0.5 $\mu\text{g}/\text{kg}$). Group 2 ($n = 21$) did not receive atropine prior to the same test dose as in group 1; group 3 ($n = 12$) received 10 $\mu\text{g}/\text{kg}$ atropine followed 5 min later by 0.1 ml/kg 1% lidocaine without epinephrine; group 4 ($n = 12$) did not receive atropine prior to the same test dose as in group 3.

Lead II of the ECG was continuously recorded in all patients, and heart rate was computed using the mean values of RR intervals from the ECG recorder (Roche-Kontron). Blood pressure was determined with a sphygmomanometer cuff. Measurements of heart rate were made when anesthesia with 1% end-tidal concentration of halothane was stable (T1); 5 min after administration of atropine in groups 1 and 3 or 5 min after T1 in groups 2 and 4 (T2); and 15, 30, 45, 60, 90, 120, and 180 s after

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administration of the test dose. Systolic blood pressure was measured at T1, T2, and 45, 90, 120, and 180 s after the test dose. Two-way analysis of variance (ANOVA) followed by a Student's *t* test for paired data was used to compare the intragroup and intergroup differences in change in heart rate and systolic blood pressure at T2 versus T1. Repeated measures ANOVA followed by a Newman-Keuls test was performed to test the intragroup and intergroup differences in changes in heart rate and systolic blood pressure versus T2 after test dose injection. Then each group was divided into two subgroups: those who had a maximum increase in heart rate less than or equal to 10 beats/min and those who had a maximum increase more than 10 beats/min. We chose a change in heart rate of 10 beats/min as the threshold value because a greater increase in heart rate would have resulted in an unacceptable percentage of false-negative responses and because an increase in heart rate as little as 10 beats/min is still easily detectable clinically. A Woolf G test was used to compare the differences in frequency distribution between the groups. All results are expressed as the mean \pm SD; $P < 0.05$ was considered statistically significant.

Results

There were no significant differences in mean age and weight between the groups. The age distribution was the same in all groups, and there were as many children younger than 2 yr old as there were children older than 2 yr: 10 versus 10 in group 1, 10 versus 11 in group 2. After injection of the test dose none of the children had an untoward response, such as circumoral pallor, and no dysrhythmias were observed. Atropine significantly increased heart rate in group 1 from 100 ± 17 to 129 ± 21 beats/min and in group 3 from 90 ± 20 to 132 ± 24 beats/min, whereas in groups 2 and 4 heart rate remained stable at T2 compared with T1.

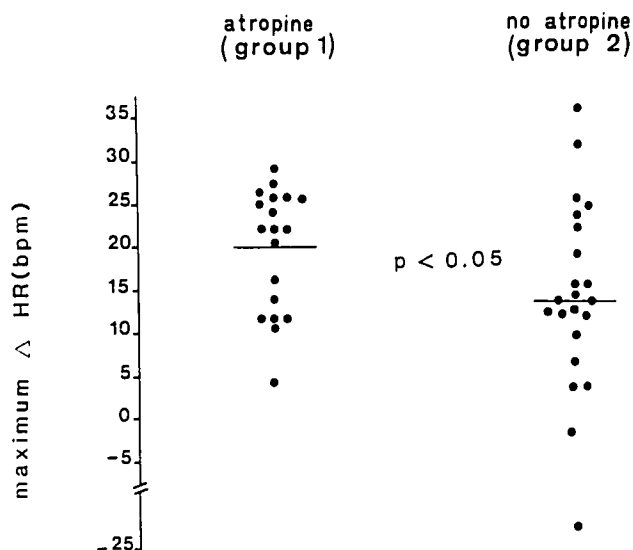


FIG. 1. Maximum increase in heart rate (HR) after test dose compared with T2 for each child in groups 1 and 2. The horizontal lines represent the mean of the maximum HR in each group. * $P < 0.05$: significance between the two mean maximum HR.

In group 1 the test dose increased heart rate at all time periods with a maximum of 18 ± 7 beats/min, whereas in group 2 heart rate increased only at 45 and 60 s after the test dose with a maximum of 10 ± 11 beats/min. Furthermore, after the test dose the increase in heart rate was significantly higher at each time interval in group 1 compared with similar time intervals in group 2. In groups 3 and 4 the test dose did not significantly change the heart rate (table 1).

Maximum increase in heart rate for each child in groups 1 and 2 is shown in figure 1: a total of seven children, one in group 1 and six in group 2, had a maximum increase in heart rate of less than 10 beats/min, and two of those children, both in the group that did not receive

TABLE 1. Changes in Heart Rate

	Group 1 (atropine, EPI)	Group 2 (no atropine, EPI)	Group 3 (atropine, no EPI)	Group 4 (no atropine, no EPI)
Heart rate (beats/min)				
Time				
Control (T1)	100 ± 17	102 ± 20	90 ± 20	107 ± 22
5 min after atropine (T2)	$129 \pm 21^*$	100 ± 21	$132 \pm 24^*$	107 ± 22
Δ Heart rate from T2 (beats/min)				
Seconds after test dose				
15	$11 \pm 2^*$	-1 ± 6	-1 ± 1	-1 ± 2
30	$13 \pm 7^*$	2 ± 24	-1 ± 2	-1 ± 2
45	$18 \pm 7^*$	$10 \pm 11^*$	-1 ± 2	-1 ± 2
60	$16 \pm 7^*$	$5 \pm 10^*$	-1 ± 3	-1 ± 2
90	$8 \pm 6^*$	1 ± 11	-1 ± 4	-1 ± 3
120	$5 \pm 5^*$	-2 ± 10	-1 ± 3	1 ± 3
180	$4 \pm 4^*$	-3 ± 10	-1 ± 4	1 ± 4

Heart rate when anesthesia is stable (T1), 5 min after atropine in groups 1 and 3, and 5 min after T1 in groups 2 and 4 (T2), and Δ Heart rate after 0.1 ml/kg 1% lidocaine with epinephrine (EPI: 0.5

μ g/kg) in groups 1 and 2, without EPI in groups 3 and 4. Results are expressed as mean \pm SD.

* $P < 0.05$.

TABLE 2. Changes in Systolic Blood Pressure

	Group 1 (atropine, EPI)	Group 2 (no atropine, EPI)	Group 3 (atropine, no EPI)	Group 4 (no atropine, no EPI)
Systolic blood pressure (mmHg)				
Time				
control (T1)	87 ± 11	85 ± 14	88 ± 14	85 ± 6
5 min after T1 (T2)	90 ± 13	85 ± 13	92 ± 12	85 ± 8
% change from T2 in SBP				
Seconds after test dose				
45	93 ± 12*	91 ± 10*	-3 ± 5	2 ± 7
90	9 ± 13*	9 ± 13*	-3 ± 4	1 ± 7
120	4 ± 13	5 ± 13	-3 ± 5	1 ± 6
180	1 ± 12	-1 ± 10	-4 ± 6	1 ± 4

When anesthesia is stable (T1), 5 min after atropine or 5 min after T1 (T2) and percent change in SBP after test dose with or without

epinephrine (EPI). Results are expressed as mean ± SD.

* $P < 0.05$.

atropine, had a decrease in heart rate after the test dose. Mean maximum increase in heart rate was 19 ± 7 beats/min in group 1 and 13 ± 12 beats/min in group 2 ($P < 0.05$). Interestingly, in our small population sample there was no difference in mean increase in heart rate between children younger than 2 yr old and those older than 2 yr in groups 1 and 2.

The injection of atropine did not increase systolic blood pressure in groups 1 and 3. Following the test dose the percent change in systolic blood pressure from T2 was significant in groups 1 and 2 at 45 and 90 s (table 2). No correlation was found between changes in heart rate and changes in systolic blood pressure in any of the children in either group.

Discussion

This study demonstrated that in children anesthetized with halothane and nitrous oxide, inadvertent intravascular injection of an epidural test dose of local anesthetic containing $0.5 \mu\text{g/kg}$ epinephrine will not reliably produce tachycardia unless preceded by atropine ($10 \mu\text{g/kg}$).

Some authors advocate the use of lidocaine with epinephrine to detect intravascular and intrathecal injections.¹⁻³ In children who are anesthetized with halothane, a motor block cannot be detected so a test dose is used solely to detect an intravascular injection. Moore and Batra¹ defined a positive response to a test dose in awake adults as an increase in heart rate of 30 beats/min. According to the present investigation, extrapolation of the standard of Moore and Batra¹ would result in an unacceptable 93% false-negative response rate. We believe a test dose should give a true-positive response 95% of the time. Thus, we selected as our standard an increase of 10 beats/min. Using this criterion, we had a positive response rate of 94% (19 of 20) in group 1, 71% (16 of 21) in group 2 children, and an overall positive response rate of 83%. This difference may be due to the effect of atropine, which is to block the permanent parasympathetic tone on heart

rate, thereby enhancing the sympathetic accelerator effect of epinephrine. This results in a greater increase in heart rate than when atropine is not given before the test dose.

The increase in systolic blood pressure after the test dose in groups 1 and 2 was intense but short-lived (less than 60 s) and could, if not looked for, remain undetected by most standard blood pressure monitors.

In the light of these results we recommend that iv atropine ($10 \mu\text{g/kg}$) be given to children anesthetized with halothane prior to the administration of a test dose of 0.1 ml/kg lidocaine with $1:200,000$ epinephrine ($0.5 \mu\text{g/kg}$) and use of the criterion of an increase in heart rate of 10 beats/min to signal an intravascular injection. However, this will not result in the detection of every intravascular injection even though pretreatment with atropine enhances the magnitude and the duration of the increase in heart rate due to epinephrine injection. It is possible that a higher dose of epinephrine would produce more marked tachycardia without causing dysrhythmias because the dose of epinephrine used here is far below the dose that induces arrhythmias in children during halothane anesthesia.⁴ Because false-negative responses may occur even when children have received atropine prior to the test dose, we further recommend that the total volume of local anesthetic be administered in incremental fractions.

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