Discussion

The application of peripheral nerve block techniques for controlling postoperative pain in children is underutilized in pediatric surgery. With an increasing emphasis on ambulatory surgery, especially in children, more emphasis should be placed on pain control issues to effect a smooth recovery and an expeditious discharge from the ambulatory unit.

Inguinal hernia repair lends itself well to infiltration nerve block, and can improve the ambulatory surgical experience for children undergoing this surgical procedure. The technique is easy to perform, requires very little extra time, and has very few side effects. Inguinal nerve blocks are especially effective for pediatric postoperative pain control. With a duration of analgesia of 6–8 h, these blocks allow most children to return home to a more familiar and comfortable environment.

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Intravenous Labetalol for Treatment of Postoperative Hypertension

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Hypertension may develop in the immediate postoperative period. Several studies have demonstrated increased levels of circulating catecholamines, suggesting a causal relationship.[1,2] The development of postoperative hypertension warrants immediate assessment and treatment to reduce the risks of myocardial infarction, arrhythmias, congestive heart failure, stroke, bleeding, and other end-organ damage.[1] Current therapy includes the use of vasodilators, alpha and beta adrenergic blocking drugs, and calcium channel blocking drugs. Often, a combination of these drugs is required to maintain a safe balance between myocardial oxygen consumption, cardiac output, and arterial blood pressure.

Labetalol hydrochloride (Trandate®, Glaxo) is a combined alpha- and beta-adrenoceptor blocking agent currently approved for oral and intravenous use in the treatment of hypertension. Labetalol has been utilized for the treatment of hypertensive emergencies,[3–7] but its use has not been reported in the surgical patient who develops hypertension during emergence from general anesthesia.

We speculated that labetalol may be an appropriate drug for controlling acute postoperative hypertension. We therefore sought to evaluate the potential efficacy, safety, and dose of labetalol necessary for the treatment of hypertension following general anesthesia. We report on the use of intravenous labetalol in 15 such patients.

Methods

This study was approved by the Institutional Review Board of Duke University Medical Center, and all patients gave written informed consent prior to surgery. The patients were A.S.A. Physical Status I–III scheduled for elective surgery requiring general anesthesia. Patients for whom beta-adrenergic blocking drugs were

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TABLE 1. Patient Demographic Data

Patient	Age (Yr)	Wt (Kg)	Preop Meds	Surgical Procedure	Anesthetic
1	35	73	Hydrochlorothiazide	Knee arthroscopy	Fentanyl, halothane
2	44	69	Atenolol	Renal transplant	Isoflurane
3	60	74	None	Below knee amputation	Fentanyl, halothane
4	54	90	Aldomet, reserpine	Cervical laminectomy	Fentanyl, isoflurane
5	38	75	Propranolol	Mastectomy	Sufentanyl, enflurane
6	64	64	Quinidine, clonidine	Hepato-renal bypass	Fentanyl, isoflurane
7	53	98	Hydrochlorothiazide	Intranasal ethmoidectomy	Fentanyl, isoflurane
8	66	101	None	Sigmoid colectomy	Fentanyl, enflurane
9	73	63	Propranolol, hydrochlorothiazide, nifedipine, digoxin	Lumbar laminectomy	Fentanyl, enflurane
10	36	92	Hydralazine, furosemide aldomet, diltiazem	Resect pheochromocytoma	Fentanyl, isoflurane
11	55	109	None	Nephrolithotomy	Fentanyl, enflurane
12	85	44	Hydrochlorothiazide	Transverse colostomy	Fentanyl, enflurane
13	68	47	Atenolol	Parathyroid adenoma	Fentanyl, isoflurane
14	60	88	None	Bilateral Caldwell-Luc	Fentanyl, isoflurane
15	70	58	Propranolol, hydrochlorothiazide	Abdominal hysterectomy	Halothane

contraindicated, or who had a history of myocardial infarction within the past 6 months, evidence of congestive heart failure, or asthma, were excluded.

Two hours preoperatively, all patients received oral diazepam (5 or 10 milligrams), and their required oral preoperative antihypertensive medications, excluding diuretics. The anesthetic agents and techniques chosen for each patient were determined by the anesthesiologist supervising the procedure. Upon arrival in the recovery room, patients were monitored with continuous electrocardiogram and blood pressure determinations by automated oscillometric methods (Dinamap®) every 5 min. All patients remained supine with the head of the bed elevated 10°. Patients received intravenous labetalol if, in the absence of inciting factors such as pain or tracheal intubation, their systolic blood pressure was ≥170 mmHg and/or diastolic blood pressure was ≥100 mmHg for greater than 10 min.

The initial dose of labetalol was 0.25 mg/kg administered over 2 min. The 2-min infusion was chosen because of reports of hypotension following the administration of large bolus doses.[3–5] An adequate antihypertensive effect was defined as achievement of either of two endpoints: 1) a reduction in systolic blood pressure of at least 10%; or 2) a decrement in diastolic blood pressure of ≥10% and up to 30%, either of which must achieve a diastolic BP ≤100 mmHg. If an adequate anti-hypertensive effect was not achieved within 10 min of the first labetalol dose, a second dose of 0.5 mg/kg was administered intravenously. If, after 10 min, hypertension persisted, 0.75 mg/kg labetalol was given, to be followed, if necessary, 10 min later by 1.0 mg/kg. Thus, a total of 2.5 mg/kg of labetalol could be administered over 40 min.

All measured hemodynamic variables were stored for later analysis. Statistical analysis was performed, utilizing two-way repeated measures analysis for variances (ANOVA) from the average baseline hemodynamic values.

RESULTS

The patient's demographic data are listed in table 1. The average age of the patients studied was 57 yr (range: 35–85 yr), and average weight was 76 kilograms (range: 44–109 kg). Ten of the treated patients were taking oral antihypertensive medications preoperatively. All of the patient's preoperative blood pressures were less than 180 systolic and 110 diastolic. None of the patients demonstrated any significant intraoperative hemodynamic instability, although two of the patients (numbers 6 and 10) required short-term intraoperative infusion of sodium nitroprusside for blood pressure control. None of the patients required any other antihypertensive medication during surgery.

One patient required only the initial dose of 0.25 mg/kg labetalol, six required two doses (total of 0.75 mg/kg), four required three doses (total of 1.5 mg/kg), and four required all four doses (total of 2.5 mg/kg). The average dose of labetalol administered was 1.38 mg/kg.

Figures 1 through 3 display the effect of labetalol on systolic pressure, diastolic pressure, and heart rate in all patients. Baseline mean and standard error of the mean hemodynamic parameters were as follows: SBP

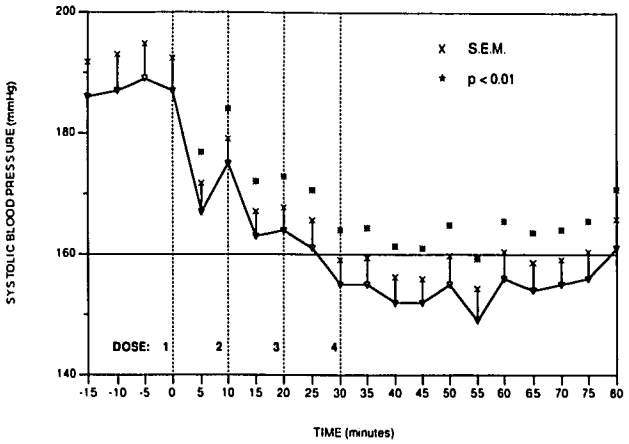

FIG. 1. The effect of labetalol on systolic blood pressure in 15 patients when administered in a step-wise regimen.

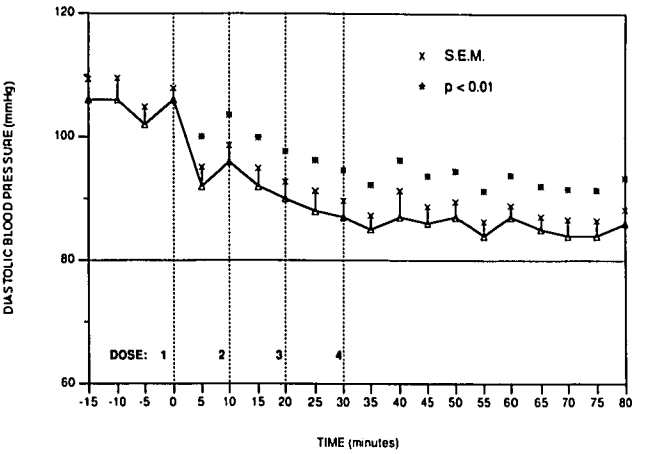

FIG. 2. The effect of labetalol on diastolic blood pressure in 15 patients when administered in a step-wise regimen.

187+/−5.2; DBP 105+/−2.1; HR 76+/−4.5. The combined group hemodynamic data, standard error of the mean, and ANOVA predicted *P* values (compared to baseline) are shown in figures 1–3.

The blood pressures measured during the 4 h after the labetalol treatment remained adequately controlled. Patient 6 received two additional intravenous doses of labetalol (0.5 mg/kg) at 6 and 10 h postoperatively. Patient 14 received one additional dose of labetalol (0.5 mg/kg) 6 h postoperatively. None of the patients experienced any untoward side effects from the labetalol, and there were no surgical- or anesthetic-related postoperative complications.

Discussion

Labetalol is a unique drug with combined alpha- and beta-adrenoceptor blocking activity. The drug is effective in blocking both the $beta_1$- and $beta_2$-adrenoceptors, but is highly selective for postsynaptic $alpha_1$-adrenoceptors.[7,8] Labetalol lowers blood pressure by decreasing peripheral resistance through $alpha_1$-blockade, while reflex mechanisms (*i.e.*, tachycardia) triggered by the vasodilation are reduced by the simultaneous beta-adrenoceptor blockade. The full anti-hypertensive effect of an intravenous dose of labetalol is evident within 5–10 min.[3,4,7]

The ratios of alpha- to beta-adrenergic blockade in humans are 1:3 after oral, and 1:7 after intravenous, administration, as compared to phenylephrine-induced blood pressure increases and isoproterenol-induced heart rate increases.[9–11] Labetalol is a weaker beta-adrenergic blocking drug than propranolol. Labetalol is devoid of intrinsic sympathomimetic activity at $beta_1$-adrenoceptors, but may possess intrinsic agonist activity at $beta_2$-adrenoceptors.[9,10] This may explain why the estimated relative $beta_1$-blocking potency is 4–6:1, and the $beta_2$-blocking potency is 11–17:1, for propranolol compared to labetalol.[11]

Acute postoperative hypertension may occur following surgery due to multiple factors, including pain, emergence excitement, reaction to tracheal intubation or extubation, volume overload, and chronic hypertension by history. The pathogenesis of this hypertension is thought to be the result of sympathoneuronal release of norepinephrine,[1,2] with the resultant increases in systemic vascular resistance and tachycardia. Labetalol would appear to be an appropriate drug for the rapid treatment of hypertension following general anesthesia.

The results of this study show that labetalol, given in a step-wise increasing dose based on the patient's

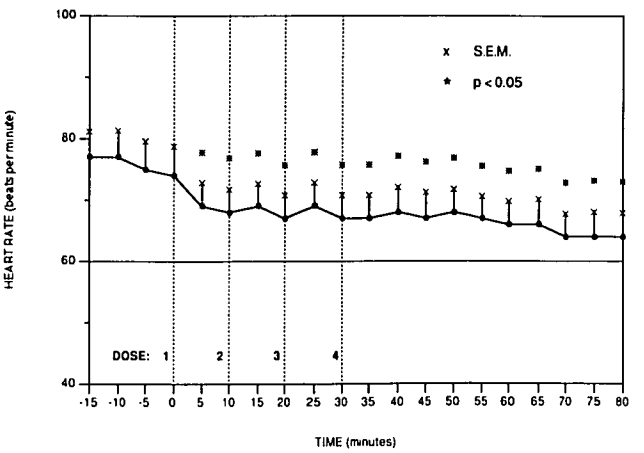

FIG. 3. The effect of labetalol on heart rate in 15 patients when administered in a step-wise regimen.

weight, was safe and effective in controlling the emergence-related hypertension in all patients. Both systolic and diastolic hypertension were controlled with minimal changes in heart rate, even at a total dose of 2.5 mg/kg. None of the patients experienced any untoward side effects, such as hypotension, significant bradycardia, bronchospasm, or electrocardiographic changes that may occur following beta- or alpha-adrenergic blocking drugs.

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Epinephrine Prolongs Lidocaine Spinal: Pain in the Operative Site the Most Accurate Method of Determining Local Anesthetic Duration

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Previous investigations report conflicting information with regard to the effect of adding epinephrine to solutions of hyperbaric lidocaine for spinal anesthesia. Chambers *et al.* concluded that anesthesia was not significantly prolonged by the addition of epinephrine to lidocaine for spinal anesthesia in patients undergoing transurethral prostatectomy.[1] Spivey arrived at the same conclusion after studying women undergoing vaginal deliveries.[2] Both studies involved the use of thoracic dermatome regression of sensory level to define duration of the block. Leicht and Carlson, however, also using such regression, found that the addition of epinephrine did prolong the analgesia of lidocaine spinal blockade for lower abdominal surgery.[3]

We question whether thoracic dermatome regression accurately reflects the duration of spinal blockade for surgical procedures involving the perineum and lower extremities which are innervated by the lumbosacral nerves. To clarify this issue, a blinded study was undertaken using hyperbaric lidocaine spinal anesthesia with or without the addition of epinephrine in day-care patients undergoing arthroscopic knee procedures. The definitive endpoint of subjective discomfort was used to determine the duration of anesthetic action.

Methods

Institutional Human Subjects Review Committee approval was obtained for a study involving 40 patients. Patients were assigned to one of two groups. Group 1 patients received spinal anesthesia with lidocaine not containing epinephrine. Group 2 patients received spinal anesthesia with lidocaine containing epinephrine. Informed consent was obtained, and the possibility of a headache or backache, and the use of a blood patch to treat headache, were explained. Patients were told that

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