13. Ryder W: Methohexitone and epilepsy. Br Dent J 126:343, 1969

14. Hodkinson BP, Frith RW, Mee EW: Propofol and the electroencephalogram. Lancet 2:1518, 1987

15. Yate PM, Maynard DE, Major E, Frank M, Verniquet AIW, Adams HK, Douglas EJ: Anaesthesia with ICI 35,868 monitored by the cerebral function analyzing monitor (CFAM). Eur J Anesthesiol 3:159–166, 1986

16. Kaufman K, Finstead B: Status epilepticus following electroconvulsive therapy. Mt Sinai J Med 53:119–122, 1986

17. Weiner R: ECT-induced status epilepticus and further ECT: A case report. Am J Psychiatry 138:1237–1238, 1981

18. Weiner R, Volow M, Gianturco DT, Cavenar JO Jr.: Seizures terminable and interminable with ECT. Am J Psychiatry 137:1416–1418, 1980

19. Weiner R, Whanger A, Erwin CW, Wilson WP: Prolonged confusional state and EEG seizure activity following concurrent ECT and lithium use. Am J Psychiatry 137:1452–1453, 1980

20. Devanand D, Decina P, Sackeim HA, Prudic J: Status epilepticus following ECT in a patient receiving theophylline. J Clin Psychopharmacol 8:153, 1988

21. Peters S, Wochos D, Peterson G: Status epilepticus as a complication of concurrent electroconvulsive and theophylline therapy. Mayo Clin Proc 59:568–570, 1984

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Large Doses of Topical Lidocaine during Microvascular Surgery Are Not Associated with Toxic Blood Concentrations

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SURGEONS performing microvascular anastomoses often apply lidocaine topically in doses exceeding published safe limits without apparent systemic toxicity. Standard pharmacology and anesthesiology references list maximal doses of lidocaine as 750 mg or less.[1–3] Reconstructive surgeons, however, may apply several thousand milligrams of lidocaine, at concentrations of 4–20%, directly on blood vessels being anastomosed, to prevent vasospasm during finger reattachment or tissue transfer surgery.[4,5] To acquaint anesthesiologists with our resolution of this dose dilemma, we report four consecutive patients requiring free-flap reconstruction, during which topical lidocaine doses of 1,340–1,900 mg were used. After institutional review board approval and with the consent of each patient, we measured systemic blood concentrations of lidocaine in these patients before and every 15 min during and for 1 h after topical application.

Case Reports

Case 1

A 54-yr-old, 72-kg man with squamous cell carcinoma of the hypopharynx underwent total laryngopharyngectomy with bilateral modified radical neck dissections. He had a history of alcoholic cirrhosis, took amitriptyline, and was rated an ASA physical status 3. His tumor was treated preoperatively with radiation therapy. Anesthesia was induced intravenously with thiopental and 70 mg lidocaine and maintained with nitrous oxide, isoflurane, and fentanyl. The mucosal defect was reconstructed with a free fasciocutaneous radial forearm flap. Arterial inflow to the graft was from the facial artery; outflow was into the superior thyroid vein. Vascular anastomoses were secured with 9-0 nylon sutures. The surgeons applied 1,900 mg 4% lidocaine, using a 10-ml syringe with an 18-G intravenous catheter, onto the operative blood vessels during the 3 h required for anastomoses. Fifteen blood samples, collected from a radial artery catheter, throughout this period, all had less than 0.5 μg/ml lidocaine. Postoperatively the patient required surgical exploration for flap problems but was ultimately discharged in satisfactory condition. No evidence of systemic lidocaine toxicity was detected.

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Case 2

A 67-yr-old, 81-kg man with squamous cell carcinoma of the oral cavity underwent composite resection of the floor of the mouth, mandible, and cervical skin with bilateral modified radical neck dissections. Before surgery, he took no medicines but had received radiation therapy. Anesthesia was induced intravenously with thiopental and 100 mg lidocaine and was maintained with nitrous oxide and isoflurane. The soft tissue defect was reconstructed with a latissimus dorsi myocutaneous free flap. While suturing the vascular anastomoses, the surgeons applied 1,400 mg 4% lidocaine onto the facial artery and superior thyroid vein. Anastomoses required 75 min. Before the anastomoses, the blood concentration of lidocaine was less than 0.5 μg/ml, during anastomoses it increased to 0.8 μg/ml, and was 0.9 μg/ml 1 h after the last topical application of lidocaine. The patient awoke in normal fashion and was discharged in a satisfactory condition.

Case 3

A 45-yr-old, 83-kg man with squamous cell carcinoma of his left alveolar ridge underwent mandibulectomy and left modified radical neck dissection. He had a history of alcohol abuse. His tumor was treated preoperatively with radiation therapy. Anesthesia was induced intravenously with thiopental and 100 mg lidocaine and was maintained with 12 μg/kg fentanyl, nitrous oxide, and isoflurane. The surgeons injected 70 mg 1% lidocaine with epinephrine into the gingiva before teeth extraction. The soft tissue defect was closed with a left latissimus dorsi free flap. Vascular anastomoses started 8 h, 40 min after anesthetic induction and 6 h after teeth extraction and required 90 min to complete. The surgeons applied 1,340 mg 4% lidocaine onto the exposed vessels during this period. Before lidocaine was applied topically, the lidocaine blood concentration was 0.6 μg/ml. During anastomoses of the graft vessels, the peripheral blood concentration of lidocaine rose to 1.5 μg/ml and, 60 min after the last topical application of lidocaine, remained at 1.3 μg/ml. The patient awoke and recovered in routine fashion.

Case 4

A 64-yr-old, 63-kg woman with mucoepidermoid carcinoma of her tongue base underwent composite resection of the tonsil, tongue base, and mandible, along with a left modified radical neck dissection. Medical history included hypertension treated with atenolol and hydrochlorothiazide. Anesthesia was induced intravenously with thiopental and 60 mg lidocaine and maintained with nitrous oxide and isoflurane. Oral surgeons injected 150 mg 1% lidocaine with epinephrine before teeth extraction. The tissue defect after resection was closed with a radial forearm free flap. The surgeons applied 1,400 mg 4% lidocaine over 84 min, starting 9 h after induction of anesthesia and 8 h after teeth extraction, to the graft vessels during anastomosis. Before the anastomoses, the peripheral blood concentration of lidocaine was less than 0.5 μg/ml. The lidocaine concentration peaked at 0.6 μg/ml shortly after the last topical application, and declined to less than 0.5 μg/ml 1 h later. The patient awoke in the operating room after 13 h of anesthesia and was discharged in satisfactory condition.

Discussion

Surgical reconstruction of patients after tissue ablation for extensive cancer or trauma is often complex and difficult. Free-tissue transfers of muscle and skin have greatly facilitated both the cosmetic and the functional rehabilitation of these patients. Spasm of the blood vessels in the transferred tissue, during and after the surgery, can contribute to death of the transferred tissue. To prevent vasospasm, the liberal use of topical lidocaine has become a standard surgical procedure.[4,5] The quantity of lidocaine used depends on the duration of the procedure, the number of vessels anastomosed, and the amount of traumatic vasospasm, but the quantity usually exceeds the maximum recommended doses published in the anesthesia literature. Laboratory studies demonstrate that the greater the concentration of lidocaine used, up to 12% and 20%, the better the protective effect on the vascular anastomoses.[6,7] The response to lidocaine may even be biphasic, with low concentrations constricting arterioles, whereas high concentrations dilate them.[8] Our clinical experience is that direct application of 4% lidocaine, which is commercially available, is adequate to achieve vascular relaxation.

Lidocaine causes systemic toxicity because of actions upon the cardiovascular and central nervous systems after sufficient drug has been absorbed. These toxic effects generally occur after blood concentrations of lidocaine exceed 5–10 μg/ml.[9] The dose of lidocaine that leads to a toxic blood concentration varies with the site of injection, the use of adjuvant drugs, the ability of the patient to metabolize lidocaine, and other pharmacokinetic factors.[10,11] Lidocaine doses of 400 mg administered for intercostal nerve block produce peak blood concentrations of 4–6 μg/ml and, for epidural block, produce peak blood concentrations of 2–4 μg/ml.[12] Absorption of local anesthetics applied topically to tracheal membranes can be rapid and cause death from overdosage.[13] Any assumption, however, that occurrences of toxicity from all topical applications of lidocaine are similar is unfounded. Hou *et al.*, investigating the absorption of 10% lidocaine applied topically to anastomosed iliac and femoral arteries in rabbits, determined that peak absorption occurs between 5 and 15 min, is significantly greater through intact vessels than anastomosed ones, and changes at different anatomic sites and that most absorption of lidocaine is through perivascular tissue.[14]

Our experience, as illustrated by these case reports,

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Table 1. Summary of Lidocaine Doses and Results

Patient Age (yr)	Patient Weight (kg)	No. of Samples	Nontopical Dose (mg)	Topical Dose (mg)	Max Conc (μg/ml)
54	72	15	70	1,900	<0.5
67	81	10	100	1,400	0.9
45	83	11	170	1,340	1.5
64	63	6	210	1,400	0.6

Nontopical lidocaine includes intravenous before intubation and submucous before extraction of teeth. Topical applied over 84 to 180 minutes.

Max Conc = greatest concentration of lidocaine measured in peripheral blood.

is that doses up to 2,000 mg 4% lidocaine applied topically to arteries and veins being anastomosed during free-tissue transfer surgery do not cause toxic blood concentrations (table 1). The relatively low serum concentrations measured in our patients suggest that most of the administered lidocaine was never absorbed. We measured lidocaine concentrations in serum using commercially available fluorescence polarization immunoassay technology with a sensitivity of 0.1 μg/ml between 0.5 and 10 μg/ml. Decreased absorption of lidocaine drug from the surgical wound may be due to sludging of blood and drying of the transferred tissues during prolonged environmental exposure or due to changes induced by preceding radiation therapy of the underlying tissues. Also, after squirting lidocaine through an intravenous catheter onto the vessels being anastomosed, our surgeons absorb any excess with gauze sponges.

Fifty years after its induction, lidocaine remains the most widely used local anesthetic because of its extraordinary efficacy and safety.[1] The worldwide medical literature contains more than 20,000 articles referencing lidocaine.‖ Despite this massive database, the maximum safe dose of lidocaine for topical application during microvascular surgery is unclear. Our surgeons have successfully limited their topical applications of lidocaine to 2,000 mg of 4% solution. Laboratory studies would support greater concentrations to prevent vasospasm, but these may be toxic to exposed nerves.[15] Until additional clinical experience with large concentrations and doses of topically applied lidocaine during microvascular surgery is reported, we advocate continued caution, because toxicity could vary with surgical technique and anatomic site. Determinations of blood lidocaine concentrations are generally available in most hospitals that perform microvascular surgery and could be done whenever the lidocaine dose exceeds 750 mg. Our experience is that these measurements are not necessary, in the absence of clinical signs of toxicity, with topical doses less than 2,000 mg. We have not used regional anesthesia during these surgical operations except for the extraction of teeth, but we do inject 1–1.5 mg/kg lidocaine intravenously during anesthetic induction in patients with perioral tumors to decrease airway irritability. We keep midazolam or propofol available to treat central nervous system toxicity.[16]

In summary, microvascular surgeons often apply large doses of lidocaine topically to vessels undergoing anastomosis to prevent vasospasm. Clinically, doses of 4% lidocaine up to 2,000 mg are not associated with toxic blood concentrations. Pharmacokinetic studies are warranted to define the safe maximum topical doses.

‖ Astra: Personal communication. 1994.

References

1. Ritchie JM, Greene NM: Local anesthetics, The Pharmacological Basis of Therapeutics. Edited by Gilman AG, Rall TW, Nies AS, Taylor P. New York, Pergamon, 1990, pp 311–331

2. Carpenter RL, Mackey DC: Local anesthetics, Clinical Anesthesia. Edited by Barash PG, Cullen BF, Stoelting RK. Philadelphia, JB Lippincott, 1992, pp 509–541

3. Strichartz GR, Berde CB: Local anesthetics, Anesthesia. Edited by Miller RD. New York, Churchill Livingston, 1994, pp 489–522

4. Shaw WW, Tark KC: Principles of microvascular surgery, Plastic Surgery. Edited by Smith JW, Aston SJ. Boston, Little, Brown, 1991, pp 1015–1028

5. Swartz WM: Microvascular surgery, Vascular Surgery. Edited by Rutherford RB. Philadelphia, WB Saunders, 1989, pp 351–355

6. Geter RK, Winters RW, Puckett CL: Resolution of experimental microvascular spasm and improvement in anastomotic patency by direct topical agent application. Plast Reconstr Surg 77:105–115, 1986

7. Beekman WH, Dammeijer PF, Sluimers JE, Kort WJ, van des Meulen JHC: Improvement in blood flow and diameter of the postanastomotic rat tail artery by topical application of lidocaine in varying concentrations. Ann Plast Surg 24:248–251, 1990

8. Johns RA, DiFazio CA, Longnecker DE: Lidocaine constricts or dilates rat arterioles in a dose-dependent manner. ANESTHESIOLOGY 62:141–144, 1985

9. Foldes FF, Molloy R, McNall PG, Koukal LR: Comparison of toxicity of intravenously given local anesthetic agents in man. JAMA 172:1493–1498, 1960

10. Tucker GT: Pharmacokinetics of local anesthetics. Br J Anaesth 58:717–731, 1986

11. Thomson PD, Melmon KL, Richardson JA, Cohn K, Steinbrunn W, Cudihee R, Rowland M: Lidocaine pharmacokinetics in advanced heart failure, liver disease, and renal failure in humans. Ann Int Med 78:499–508, 1973

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12. Braid DP, Scott DB: The systemic absorption of local analgesic drugs. Br J Anaesth 37:394–404, 1965

13. Adriani J, Campbell D: Fatalities following topical application of local anesthetics to mucous membranes. JAMA 162:1527–1530, 1956

14. Hou S-M, Liu T-K, Yu H-Y: Absorption of lidocaine following topical application in microvascular procedures on rabbits. J Orthop Res 9:545–549, 1991

15. Lambert LA, Lambert DH, Strichartz GR: Irreversible conduction block in isolated nerve by high concentrations of local anesthetics. ANESTHESIOLOGY 80:1082–1093, 1994

16. Bishop D, Johnstone RE: Lidocaine toxicity treated with low-dose propofol. ANESTHESIOLOGY 78:788–789, 1993

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Pulmonary Artery Catheter Migration Causing Venous Cannula Obstruction during Cardiopulmonary Bypass

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EXTRACORPOREAL circulation during cardiopulmonary bypass (CPB) requires the intracardiac placement of large-bore cannulae for venous drainage and arterial return and generally is performed without incident. The presence of other intracardiac catheters (*e.g.*, central venous, pacing, or pulmonary artery (PA)) may interfere with proper pump function. We report a case in which an oximetric PA catheter was siphoned into the venous cannula of the CPB apparatus, resulting in intermittent occlusion of venous return. No previous reports have detailed premonitory signs of this complication.

Case Report

A 64-yr-old man with known coronary artery disease and progressively unstable angina presented for urgent coronary revascularization. Preoperative chest radiography noted a normal cardiac silhouette without chamber dilation. Preinduction monitoring, including peripheral intravenous catheters and a radial artery catheter, were placed under local anesthesia with intravenous sedation. An 8.5-Fr introducer was placed *via* a right internal jugular approach,[1] followed by flotation of a 110-cm 8-Fr balloon-tipped oximetric PA catheter (Opticath #50328, Abbott, Chicago, IL) to a wedged position at a depth of approximately 45 cm. Baseline measurements included PA and central venous pressures (27/18 and 12 mmHg, respectively), cardiac output (7.1 l/min), and mixed venous saturation (80%). Anesthetic induction and prebypass sternotomy proceeded uneventfully. A routine postinduction transesophageal echocardiographic (TEE) study confirmed appropriate right-heart passage of the PA catheter beyond the pulmonic valve.

After anticoagulation with heparin, a two-staged venous cannula (#TR3446L, Research Medical, Midvale, UT) was placed through a purse-string atriotomy into the right atrial appendage without resistance. Just before the onset of CPB, the PA catheter was withdrawn 4 cm while continuously demonstrating an appropriate PA tracing. CPB with mild hypothermia (32°C) commenced at a flow of 4.3 l/min for 98 min. After cross-clamping of the aorta, the mixed venous saturation increased to 100%, reflecting stagnant arterialized blood in the PA. Cold antegrade cardioplegia resulted in diastolic arrest.

Early in the bypass period, an alternating, persistently negative deflection of the PA waveform between −4 and −22 mmHg was noted, at which time the mixed venous saturation had precipitously decreased to ~80%. Later, during partial CPB (flow ~2.1 l/min), as ventricular ejection was evident on the radial arterial waveform, the PA waveform remained consistently negative and dampened. Therefore, the PA catheter was manipulated in an attempt to recover a normal tracing. During balloon inflation, sudden loss of venous return to the CPB reservoir was identified by the perfusionist, requiring a substantial reduction in pump flow to prevent air entrainment. Inspection of the CPB apparatus revealed no obvious extracardiac occlusion. After balloon deflation, venous return was restored, but the PA catheter could no longer be withdrawn. Repeated inflation and deflation of the PA catheter balloon yielded similar, abrupt changes in venous return; therefore, further manipulations were

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