

scribed above. In my experience during the past 10 yr, there has never been loss of globe contents as a result of the use of succinylcholine.

I am concerned that use of nondepolarizing muscle relaxants for rapid intubations in inexperienced hands may result in prolonged, difficult intubation, which may allow aspiration of gastric contents and significant increases in intraocular pressure.^{2,*}

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Confusion Regarding Experimental Studies of Intravenous Regional Anesthesia

To the Editor:—We were interested to read the initial report by Lillie *et al.* on the "Site of Action of Intravenous Regional Anesthesia"¹ and the subsequent response by Rosenberg and Heavner stating their belief that "Multiple and Complementary Mechanisms Produce Analgesia during Intravenous Regional Anesthesia."² Rosenberg and Heavner correctly point out that similar studies in the past often have had conflicting results. We would like to offer an explanation for these "puzzling differences." Most intravenous regional anesthesia (IVRA) studies have been based on the assumptions that an injected local anesthetic solution would remain isolated in a portion of the limb and that various markers would be adequate to identify accurately the location of injected solution. We believe that inadequate attention to the validity of these assumptions has marred many studies of IVRA.

Raj *et al.*³ and others have used radiopaque contrast medium as a marker for injected solution, whereas Lillie *et al.* and others have used radioisotopes. Two main factors detract from radiopaque studies. First, contrast medium represents a hyperosmolar solution (various products ranging from 1,000 to 2,150 mOsm/l undiluted) and may thereby induce abnormal flow and diffusion properties in the small vasculature. Second, the detection of contrast solution may be obscured by roentgenographic technique. A highly penetrated film may fail to reveal a small amount of contrast medium. We feel that radioisotopes provide a more precise evaluation of the location of injected solution. This is highlighted by considering the different findings after the injection of 40 ml of solution into a proximal cubital vein, after exsanguination, and with an upper arm tourniquet pressure of 300 mmHg. Raj *et al.* were unable to demonstrate evidence of solution reaching beyond the distal forearm, but Lillie *et al.* presented virtually indisputable evidence that solution can indeed reach the hand and fingertips under such circumstances.

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Various investigators have used either hand-tightened rubber tourniquets or inflatable tourniquets to isolate the injected solution. At least four different methods (radiopaque dye, indocyanine green, local anesthetic concentration in the opposite arm, and xenon-133) have demonstrated that injected solutions can leak past a correctly inflated tourniquet. Our work⁴ indicates that even a tourniquet pressure of 400 mmHg will not always prevent leakage. The possibility of leakage under a tourniquet must be considered in any IVRA study, and particularly in those that employ hand-tightened tourniquets. Lillie *et al.* recognized the possibility of tourniquet leakage and tested for this possibility.

After reviewing the literature, we believe that varying experimental techniques may have produced many of the results and conclusions that initially appeared to be contradictory. Because of the precise experimental design and technique, we feel that Lillie *et al.*'s work achieves a high degree of sensitivity and accuracy, and we support their conclusions.

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Use of Pulse Oximetry for Assessment of Collateral Arterial Flow

To the Editor:—Methods to assess collateral blood flow prior to percutaneous cannulation of a peripheral artery include the Allen's test, modified Allen's test, Doppler, and finger pulse analysis.

We have used the pulse oximeter* with the digit oxygen transducer in conjunction with the Allen's test to assess collateral arterial flow *via* the ulnar artery for radial artery cannulation and *via* dorsalis pedis or posterior tibial artery in arterial cannulation at the foot. The digit oxygen transducer is placed on the index finger or thumb for evaluation of ulnar collateral flow. A visual and audible measure of the pulse and saturation is provided by the pulse oximeter after approximately four to six pulsations. The radial and ulnar arteries are occluded with the examiner's fingertips until the pulse readout is absent. The occlusion of the ulnar artery is released, and the time to return of the pulse as detected by the pulse oximeter is noted. As with the Allen's test, times greater than 15 s are considered prolonged, and one may have reservations about cannulating the radial artery on that extremity. A similar examination of the dorsalis pedis and posterior tibial collateral arteries may be performed. Once arterial cannulation is performed, continuous monitoring of the

perfusion to that extremity may be achieved by leaving the transducer on the finger or great toe.

Despite conflicting evidence in the literature,^{1,2} we believe that an assessment of collateral arterial flow is useful when contemplating arterial cannulation. The pulse oximeter provides an accurate and practical evaluation of adequacy of collateral arterial circulation.

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Morphine-Induced Cardiac Pain?

To the Editor:—Butorphanol is not the only opioid that may produce excruciating right hypochondral pain.¹ Although it is well-known that these drugs may cause biliary spasm,²⁻⁴ the severity of the pain has not received sufficient emphasis. Relief of spasm may be achieved with a narcotic antagonist or, less effectively, nitroglycerin or atropine.^{2,4} Dr. Dolan's description of a patient writhing and crying out in agony is exactly what we have seen with morphine in 15 patients over the past 10 years. His patient had previously suffered a similar reaction to morphine.

All except one of our patients had received intramuscular morphine preoperatively. In three patients the pain spread to include the epigastrium and anterior chest and was thought to be of cardiac origin, and surgery was postponed. The most alarming case was that of a 57-yr-old

female patient who received morphine postoperatively in the recovery room and actually lost consciousness in the elevator while being taken back to her room. A cardiac arrest was called, although she did have a very slow, weakly palpable pulse; she regained consciousness within a few minutes. She was given nitroglycerin, and the pain eased over the next half hour. She was admitted to the coronary care unit, where investigations were pursued for 3 days. It was finally accepted that the pain had not been cardiac in origin, but from biliary spasm precipitated by morphine.

There have been four consistent features in this syndrome. No patient gave any history of heart disease, but all had previously undergone cholecystectomy. On direct questioning, each said that this pain was similar to, but