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Continuous Brachial Plexus Blockade Using an Axillary Catheter for Treatment of Accidental Intra-arterial Injections

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Vascular insufficiency of the upper extremity is a common sequela of accidental intra-arterial injection of various drugs. Treatment usually is directed at controlling vasospasm by stellate ganglion block and/or injections of intra-arterial reserpine or intravenous papaverine, and at decreasing venous thrombosis by infusion of heparin, dextran, or fibrinolysin. The use of continuous brachial plexus block with constant infusion of bupivacaine through a Racz™ catheter to treat vascular insufficiency secondary to intra-arterial methylphenidate·HCl injection is described. Advantages of this technique include total pain relief while sustaining a continuous sympathetic blockade without invading the arterial supply. The particular catheter used helps eliminate the fear of migration of the catheter into the axillary artery or vein because of its blunt stainless steel tip. Theories of how intra-arterially injected agents cause vascular insufficiency and the rationale for therapeutic approaches are discussed.

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Patients with vascular insufficiency of the upper extremity secondary to accidental intra-arterial (IA) injection of drugs are referred frequently to pain clinics. Many of the patients are drug abusers who mistake arteries for veins. Complications resulting from IA injections were first reported by anesthesiologists who noted vascular insufficiency following IA injection of 5% or 10% thiopental.[2-5,7,9,13,15,22,27,29,30] Gangrene and severe necrosis have been reported following IA barbiturates, hydroxyzine, promazine, meperidine, promethazine, chloropromazine, and amphetamines.[1,6,9,11,16-18]

One approach to decreasing drug-induced vasospasm and increasing blood flow is to repeatedly administer stellate ganglion blocks. Although this form of sympathetic blockade is effective in some cases, it is intermittent and uncomfortable to the patient. The following case report emphasizes a technique that offers continuous sympathetic blockade as well as complete pain relief that can be useful in the management of these patients.

Case Report

History and Evaluation

A 30-year-old white male weighing 75 kg presented to the Emergency Room approximately 12 hours after inadvertently injecting dissolved methylphenidate HCl (Ritalin®) into his right radial artery. The patient said that he felt intense pain shortly after the injection and the pain became excruciating after 8 to 10 hours.

Physical Examination

The patient's blood pressure was 134/84, pulse was 96, and temperature was 37.1°C. His right hand was cyanotic and cold. The radial pulse was faint, sensation to pinprick was decreased in all dermatomes of the hand, and capillary refill was absent in all of the digits. The hand was markedly swollen and had an extremely limited range of motion. Past medical history was significant for open heart surgery secondary to a gunshot wound to the chest several years prior to admission. The patients had no allergies and denied any use of other medication except for occasional intravenous (IV) amphetamine injection. Initial work-up showed a normal ECG, coagulation profile, complete blood count (CBC), and electrolyte profile.

Treatment

The Pain Center was consulted while the patient was still in the emergency room. Continuous brachial plexus block was chosen as the therapy for relieving the vasospasm and pain. The right axilla was disinfected and draped in a sterile fashion. Then an 18-gauge Crawford epidural needle was introduced slowly into the axillary sheath. After the needle tip "popped" through the sheath, it was advanced several millimeters and the stylet removed. After negative aspiration, a reinforced epidural (Racz™) catheter was threaded approximately 5 cm without elicitation of paresthesias. An initial dose of 15 ml of 1.5% mepivacaine was injected, then another 15 ml were injected slowly. Betadine® ointment was applied to the catheter, which was taped to the axilla and secured with an OpSite dressing. The patient had complete pain relief and developed good capillary refill. He was taken to his room and given 5000 units of heparin IV followed by continuous IV infusion of heparin in his left arm. Papaverine (750 mg of papaverine in 1000 ml of 5% dextrose solution) was administered via IV in a foot vein at 40 ml per hour.

Over the next 10 days, the patient's heparin infusion was adjusted to keep the prothrombin time approximately 1.5–2.0 times normal. For the first 2 days, boluses of 0.25% bupivacaine were injected into the patient's axillary catheter as often as necessary to control the pain and to sustain sympathetic blockade. Then, a continuous infusion of 0.125% bupivacaine at 5 ml per hour was started through the axillary catheter to provide more constant relief than was being achieved with intermittent injections. The infusion rate was gradually increased over the next day and titrated to control the patient's pain. On day 4, the infusion concentration was increased to 0.25% bupivacaine and eventually sustained at a rate between 7 and 10 ml per hour until the tenth day, at which time the axillary catheter was removed. Venous plasma levels of bupivacaine were measured on the eighth, ninth, and tenth days to determine if toxic concentrations were being approached. Levels were consistently below toxic range (Table 1).[10,14-23] After removal of the catheter, the tip was placed in culture medium. There was no inflammation around the axillary site, and bacteria cultures were negative after 48 hours. The patient returned 3 months after discharge for removal of a small amount of necrotic material from the distal tips of all fingers on the right hand. A year later, he was doing well and has suffered no further complications.

Discussion

The mechanism of injury following IA injections of drugs remains a subject of controversy. Whatever the mechanism, thrombosis eventually develops in all cases in which tissue damage occurs. Therefore, primary treatment should be directed at maintaining blood flow by preventing or limiting thrombosis.

Treatment

It is important to initiate and maintain sympathetic block as early as possible after an accidental IA injection of a substance to preserve blood flow. Fibrin formation begins within 2 hours after an IA injection and continues for 4 to 5 days. Thus, sympathetic blockade should be administered in

Table 1. Plasma Levels of Bupivacaine during Continuous Brachial Plexus Infusion

Day of Infusion	Plasma Level (μg/ml)
8	0.24
9	0.40
10	0.54

conjunction with agents that decrease fibrin or eventual thrombin formation, such as intravenous fibrinolysin, heparin, or dextran, and in conjunction with methods that decrease venous congestion, such as elevation of the extremity.[6,25]

Many methods of sympathetic blockade have been used in cases of vascular insufficiency, including repeat stellate ganglion blocks, IA reserpine, IV papaverine, repeat brachial plexus blocks, and even surgical sympathectomy. Phelps, Rutherford, and Boswick[19] have also described a method for sympathetic blockade using a catheter placed adjacent to the median and ulnar nerves at the wrist to protect against vasospasm in revascularized digits.[19]

Papaverine is a good spasmolytic agent when there is marked vasospasm. In most IA injections, vasospasm plays only a minor role[15]; therefore, the response to papaverine is less than expected. Papaverine as well as tolazoline are inferior to sympathetic nerve block in producing vasodilation.[26] In large doses, papaverine has significant side effects that limit its use.

Reserpine inhibits the uptake of norepinephrine into storage vesicles following sympathetic nerve discharge, thereby acting as a long-lasting sympatholytic agent. It also inhibits storage of vasoactive amines in platelets, thereby decreasing the vasospasm that occurs secondary to release of these amines during platelet aggregation. Intra-arterial reserpine decreases vascular wall norepinephrine content for 2 to 4 weeks in peripheral arteries, although clinically an IA dose of 1.25 mg produces a chemical sympathectomy apparent within 2 hours that lasts up to 4 days.[12,20] Again, IA reserpine is less effective than is sympathetic nerve block in most cases not involving vasospasm as a primary component. Intra-arterial reserpine also requires invasion of the artery supplying the involved tissues, which on occasion can lead to further diminished blood flow. Repeat stellate ganglion blocks or brachial plexus blocks are effective although inconvenient and cause the patient marked discomfort and anxiety. The risk of complications also increases significantly with multiple blocks.

Brachial plexus block with a percutaneously placed axillary catheter offers an excellent and simple form of sympathetic blockade. It also offers the advantage of pain relief without the use of high doses of narcotics and sedatives. Placement of catheters in the axillary sheath has not been

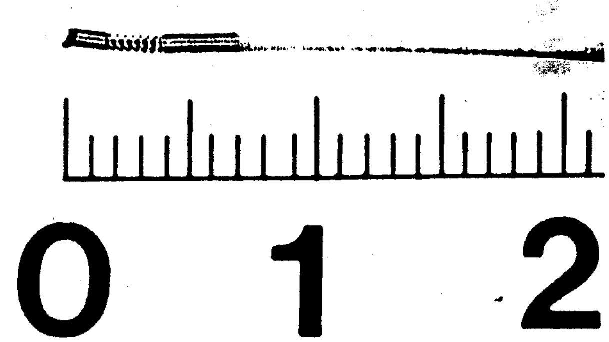

Fig. 1. Tip of reinforced catheter. Note blunt tip and open spirals through which fluid leaves the catheter.

popular in the past because of multiple problems, including damage to nerves on insertion, frequent kinking of the catheter under the skin, and migration of the catheter into an axillary vessel.

The risk of these complications has been minimized by the epidural catheter[21] used in this case, which has a stainless steel spiral core on the inside and a baked-on fluoropolymer coating on the outside. The spiral core helps eliminate kinking and the blunt tip of the catheter (which is the termination of the spiral core) tends to "bounce off" nerve roots rather than damage them on insertion (Fig. 1). The catheter is much less likely to migrate into vessels because it has no sharp edges.

Continuous Brachial Plexus Block Technique

Our technique is to place the reinforced catheter through an 18-gauge Crawford epidural needle inserted into the axillary sheath. The angle of the bevel of the Crawford needle is much greater than is the angle of other epidural needles, and will produce less trauma if nerve roots are encountered on insertion.[24] If the technique is applied carefully (with or without a nerve stimulator), the incidence of penetration into the axillary artery is low. Once the catheter is inside the axillary sheath, correct position can be verified with x-rays and contrast dye.

Bupivacaine was chosen for this patient, although other medium or long-acting local anesthetics can be used. Bupivacaine levels have been measured after continuous axillary infusion for 16 hours,[25] although we are aware of no other data on continuous infusion for prolonged periods. Bupivacaine blood levels in our patients were well below the threshold for seizures or other toxic side effects.[10,14,23] Continuous infusion of bupivacaine at a rate required to produce the desired effect results in lower maximum blood concentrations than does single or bolus techniques.[28]

A caution should be noted about using this technique or any other sympatholytic technique after intra-arterial injections. If there is venous thrombosis or inadequate venous return, sympathetic blockade will increase arteriolar intravascular pressure, and fluid transudation into the tissues will increase. The resulting edema will result in decreased blood flow to vital areas.[19] Therefore, increased edema and cyanosis following successful sympathetic blockade should warrant reevaluation of the use of a sympatholytic technique.

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