Safe use of power injectors with central and peripheral venous access devices for pediatric CT

Abstract  Purpose. We report our experience in the safe use of power injectors with central and small-gauge peripheral venous access devices for intravenous administration of contrast agent to children undergoing computed tomography (CT) examinations.

Materials and methods. We reviewed the medical records of 500 patients randomly selected from the 3121 children who underwent intravenous contrast-enhanced CT examinations at our institution from November 1993 through July 1995.

Results. The group of 500 patients, all younger than 18 years of age, accounts for 16% of the contrast-enhanced CT examinations performed during the study period. Medrad MCT 311 Mark V or Medrad MCT Plus 311 power injectors were used to intravenously administer Omnipaque 300 (2 ml/kg, maximum dose = 150 ml) through venous access devices. These devices comprised Hickman or Broviac lines (n = 228), subcutaneous Port-A-Caths (n = 55), small-gauge butterfly needles (n = 215), and percutaneous intravenous central lines (n = 2). Two complications, one involving a Hickman line and the other a subcutaneous Port-A-Cath, occurred in the study population. These complications correspond to a frequency of 0.4%. Six cases of contrast extravasation, all of them with the use of 23- (n = 1) and 25-gauge (n = 5) butterfly catheters (frequency = 0.2%), occurred among the remaining 2621 cases.

Conclusion. In light of the low frequency of complications, power injectors and central venous access devices or small-gauge butterfly catheters are safe systems for delivery of intravenous contrast material to pediatric patients. We feel that our strict adherence to manufacturers’ guidelines and previously reported techniques partially accounts for our success with these modes of delivery.

Introduction

Although intravenous contrast material is frequently used during computed tomography (CT) studies, we are unaware of any published report that addresses the safety and efficacy of power injectors for its delivery in pediatric patients. Further, few published data exist on delivery of contrast agents to children through central venous access systems or peripheral small-gauge butterfly catheters. Here we discuss our experience of power injectors with venous access devices for delivery of intravenous contrast material to children and adolescents who were evaluated by CT at St. Jude Children’s Research Hospital.

Materials and methods

We retrospectively reviewed 500 randomly selected pediatric patients who received intravenous contrast material for CT performed between November 1993 and July 1995. In total, 3121
contrast-enhanced CT scans were performed during the study period. The study population comprised 254 male and 246 female patients who were younger than 5 years (n = 131), 5-12 years (n = 128), or 12-18 years (n = 241) of age.

All patients in the study group received Omnipaque 300 (Nycomed, Princeton, N.J.) intravenously through venous access devices that were coupled to Medrad MCT 311 Mark V or Medrad MCT Plus 311 power injectors (Medrad, Pittsburgh, Pa.). These power injectors were flow controlled and preset by the manufacturer to a pressure limit of 300 psi. Central venous access devices comprised Hickman lines (Davol, Bard Access Systems, Salt Lake City, Utah; 9.6 French, internal diameter 1.6 mm) or Broviac lines (Davol, Bard Access Systems; 2.7-6.6 French, internal diameter 0.5-1.0 mm; n = 228) and subcutaneous Port-A-Caths (Davol, Bard Access Systems) of the same size as the Hickman lines (n = 55). Peripheral intravenous devices comprised 23- or 25-gauge butterfly needles placed in the dorsum of the hands, feet, or wrists (n = 215) and percutaneous intravenous central catheters (PICC lines, n = 2). As recommended by Medrad to minimize motion artifact created by table incrementation [1], a coiled 60-inch length of low-pressure tubing connected each central venous access device to the power injector. Discofix stopcocks with attached 20-inch tubing extensions (Burron Medical, Bethlehem, Pa.) were the conduits between the power injector and peripheral venous access devices. Because it provides better stability of the butterfly catheter during table movement, we prefer the Discofix system over a stopcock without additional tubing. All connector tubing was pressure-rated to 300 psi.

The 232 patients scanned on the Siemens DRH scanner (Siemens, Iselin, N.Y.) received a dose of 2 ml/kg (maximum dose = 150 ml) at an injection rate of 0.3 ml/s. The 268 patients scanned on the Siemens Somatom Plus scanner received the same dose at a rate of 0.5-0.8 ml/s. The different rates of administration of contrast material reflect the differences in scanning speeds for spiral and conventional acquisition of CT data. The total volume of contrast material injected ranged from 10 ml to 150 ml.

Prior to injection, central and peripheral venous lines and butterfly needles were flushed with 10 ml sterile saline to verify adequate blood flow. All patients and/or accompanying family members were instructed to notify the CT technologist if pain or other change in sensation occurred at the insertion site during injection of contrast material. Patients in whom the stability or intraluminal position of the venous access was questionable, in whom there was resistance to the pre-contrast saline flush, or whose i.v. site was painful did not receive contrast material administered by a power injector.

During administration of the contrast material, the CT technologist closely monitored the injection sites for any evidence of contrast extravasation or catheter failure. The injection sites of sedated patients (n = 25) were closely monitored by the sedation nurse and accompanying family member. After delivery of contrast agent, the Hickman and Broviac catheters and PICC lines were flushed with 10 ml sterile saline, then with 10 USP heparin. The subcutaneous Port-A-Caths were flushed with saline followed by 100 USP heparin.

Two complications occurred in this series of 500 examinations. During injection, one Hickman line split where a clamp had been placed previously, and the line required repair. In the second incident, a PICC line placed in the antecubital fossa broke at the connector site. These complications represented a frequency of 0.4%.

Although extravasation of contrast material into the tissues surrounding the insertion site is a potential concern, there were no cases of this complication in the study population. However, six cases of extravasation occurred among the remaining 2621 contrast-enhanced CT scans performed during the study period. These events were associated with use of 23- (n = 1) or 25-gauge (n = 5) butterfly catheters and corresponded to a frequency of 0.2%. None of these patients required treatment beyond application of warm compresses to the area of extravasation. Including these six incidents, the overall frequency of complications in the total population of 3121 patients was 0.3%.

**Discussion**

Many radiologists are reluctant to administer contrast material through central venous lines. Potential complications include extravasation of contrast material into soft tissues, subintimal venous or myocardial injection, and catheter fragmentation [2, 3]. Radiologists are particularly hesitant to deliver contrast material through these devices in children, especially with power injectors, for the same reasons.

The few prior reports that discuss power injectors for intravenous administration of CT contrast material have addressed use of these devices neither in pediatric patients nor with central venous access devices or peripheral small-gauge butterfly catheters [3, 4]. Nearly 10 years ago, Shuman et al. reported their experience with adults in whom 18- to 22-gauge intracatheters were coupled with power injectors for CT contrast administration. They reported three instances of contrast extravasation among 240 cases, which amounts to a complication frequency of 1.3% [3].

Delivery systems that combine power injectors with venous access devices for administration of contrast agents may improve image quality [3, 5-7], preclude additional venipuncture [8], improve patient throughput [5], and markedly decrease exposure of personnel to radiation [3, 5, 8]. In addition, these systems may optimize the reproducibility of CT scans [4, 5], which is especially important in those patients who are repeatedly evaluated for disease response to oncotherapy, development of metastatic disease, or tumor recurrence. Because even subtle imaging changes may prompt modifications in clinical and therapeutic management, any procedure that reduces artifactual differences is beneficial.

Previous reports of complications following administration of contrast material by power injectors assessed findings from adults. The flow rates in those patients ranged from 1 to 5 ml/s [6, 8]. The slower rates of administration that we use for children probably provide additional protection against subcutaneous extravasation of contrast material, catheter damage, and subintimal contrast injection.

For more than 7 years, we have routinely used power injectors with venous access devices to intravenously administer contrast material to children. We have experienced few complications with this procedure and feel that our success is due, at least in part, to our strict adherence to guidelines supplied with the equipment [1] and to techniques described in previous reports [3, 8].