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Brief Reports

COMPARISON OF COMPUTED TOMOGRAPHY IMAGE QUALITY USING INTRAVENOUS VS. INTRAOSSEOUS CONTRAST ADMINISTRATION IN SWINE

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□ **Abstract—Background: Vascular access is essential in managing patients with significant injuries. It is required for medications, fluids, blood products, and radiographic contrast administration. Generally, this is accomplished through peripheral intravenous (i.v.) cannulation. In some patients, however, i.v. cannulation may be difficult or impossible. Intraosseous (i.o.) access is an acceptable alternative for many uses during resuscitation. However, adequacy of vascular enhancement with i.o. administration of contrast has not been studied. Objectives: This study was performed to assess the efficacy of i.o. administration of contrast agents for enhanced computed tomography (CT) imaging of the chest and abdomen. Methods: We carried out a crossover study in mature mini-swine with peripheral i.v. and i.o. access established. Intraosseous access was obtained in the proximal humerus with fluoroscopic confirmation. Each animal underwent two trauma-protocol CT scans successively using the i.v. or i.o. routes of contrast administration. Washout between studies was established. The order for route of administration was randomized. Images were evaluated for adequacy of enhancement by two blinded board-certified radiologists. Results: All images obtained with successful administration of i.o. contrast were judged adequately enhanced, whereas two from the i.v. route were judged to be inadequate by at least one of the radiologists. Two occurrences of failed i.o. needle placement occurred. One animal had complete contrast extravasation resulting in inadequate opacification. Conclusions: In this model, injection of contrast through a proximal humerus i.o. resulted in adequate enhancement of trauma-protocol CT images. Our results suggest that i.o. administration of contrast merits further investigation of its potential utility in patients when i.v. access would delay diagnostic evaluation.** © **2015 Elsevier Inc.**

□ **Keywords—intraosseous; contrast; trauma; CT scan; vascular access**

INTRODUCTION

Vascular access is a high priority in the management of seriously injured patients. Some patients have conditions that make peripheral intravenous (i.v.) cannulation impossible (e.g., drug abuse, obesity). When peripheral i.v. access is unsuccessful, options include central venous or intraosseous (i.o.) access. The advent of spring-loaded and motorized drill devices has allowed i.o. access to be performed safely and easily in adults. Multiple sources, including the American College of Surgeons, American College of Emergency Physicians, and American Academy of Orthopedic Surgeons, recommend this as an early alternative in all critically ill patients when attempts at

This study was completed after full review and approval by Albany Medical Center's Institutional Animal Care and Use Committee.

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obtaining peripheral intravenous access fail (1–3). Studies have shown i.o. access can be performed more rapidly and with fewer complications than central venous access (4,5). This makes i.o. access well-suited for situations where timeliness is critical.

Initial diagnostic evaluation of trauma patients often requires contrast-enhanced computed tomography (CT). Concerns regarding pressurized contrast injections through i.o. devices have historically been cited as a reason for avoiding this route of administration. A recent animal study and multiple case reports have demonstrated the feasibility of i.o. contrast administration using power injection (6,7–10). Given the risks and delays inherent to central venous access, the ability to perform contrast-enhanced CT scans using i.o. access is potentially beneficial. To date, no controlled studies have been published evaluating image quality after i.o. contrast administration. We performed this study to 1) assess feasibility of contrast-enhanced CT scans using i.o. access and 2) determine relative image quality of i.o. compared to i.v. administration.

METHODS

Research protocol was approved by the Institutional Animal Care and Use Committee and was in compliance with the Animal Welfare Act and other relevant federal statutes and regulations. Strict adherence was maintained to the National Institutes of Health *Guide for the Care and Use of Laboratory Animals* (11). Studies were performed under the supervision of board-certified veterinarians in compliance with Institutional Animal Care and Use Committee guidelines.

Study Design

This was a crossover trial comparing i.v. and i.o. injection of contrast for thoracic and abdominal/pelvic imaging. The order of contrast injection (i.v. followed by i.o. or vice versa) was determined by block randomization.

Animals

Eight skeletally mature mini-swine (*Sus scrofus domesticus*) weighing 30–60 kg were obtained from Marshall BioResources (North Rose, NY). After 1-week quarantine, the pigs were fasted for 12 h. Ketamine, xylazine, and tiletamine were given for sedation as an intramuscular injection. Pigs were then intubated and anesthesia maintained with 2–5% inhaled isoflurane. Pulse oximetry, heart rate, and temperature were continuously monitored. Animals remained anesthetized during all interventions. After imaging, pigs were returned to the animal facility and vascular access devices removed. They were then extubated and recovered.

Intravenous and Intraosseous Access

After induction of anesthesia, the swine underwent placement of a 25-mm, 15-gauge i.o. catheter (EZ-IO®, Vidacare Corporation, Shavano Park, TX). The proximal humerus was identified by palpation, the skin prepared with chlorhexidine, and the i.o. needle advanced through skin and soft tissue until contact with bone. The battery-powered drill was used to advance the needle through the cortex into the medullary space. Correct placement of each needle was verified by tactile sense of firm placement, return of marrow, ease of flushing, and fluoroscopy with a C-arm device (OEC Medical Systems, Inc., Salt Lake City, UT) (Figure 1). Once placement was confirmed, the EZ-IO device was secured with the EZ-Stabilizer® adhesive device when possible to prevent dislodgment. Patency was maintained by continuous infusion of 0.9% saline. Peripheral i.v. access was obtained via the posterior auricular vein with a 20-gauge angiocatheter (BD Autoguard, Becton-Dickinson, Franklin Lakes, NJ) and secured. Infusion flow rates of 2–5 mL/s were verified for both access sites prior to transport to the CT scanner.

Imaging

The swine were placed supine on the CT scanner (General Electric, LightSpeed VCT, GE Healthcare, Waukesha, WI) and covered for warmth. The access device used first, based on randomization, was connected to the power-infusion pump (Medrad Stellant CT Injection System, Warrendale, PA). A test flush of saline was delivered via the power-infusion system to ensure patency and flow. Iodinated contrast (Omnipaque 350,

Figure 1. Fluoroscopic image of intraosseous device in the proximal humerus.