Gangrene of the leg following intraosseous infusion

Tareq Al-Ayed

From the Department of Pediatrics, King Faisal Specialist Hospital and Research Centre, Riyadh, Saudi Arabia

Correspondence and reprints: Tareq Al-Ayed, MD · Consultant Pediatric Intensivist · Department of Pediatrics MBC 58 King Faisal Specialist Hospital and Research Centre · PO Box 3354, Riyadh 11211, Saudi Arabia · T: +966-1-442-7763 F: +966-1-442-7784 · tayaed@kfshrc.edu.sa; mdatu@kfshrc.edu.sa · Accepted for publication January 2008

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According to Pediatric Advanced Life Support (PALS) guidelines, intraosseous (IO) infusion should be started without delay in a critically ill child with shock, cardiopulmonary failure or arrest if intravenous access is not rapidly secured.¹ Starting an IO is considered an emergency procedure with a good success rate and a very low incidence of complications in trained hands. We present the case of a patient who developed gangrene following extravasation of fluid and irritant medication.

CASE

A 14-month-old female child was brought to the emergency room of the Children's Hospital with features of septic shock following fever, vomiting and diarrhea. She presented with high-grade fever (41°C) and tachycardia. Initial IV access did not last long. As the blood pressure was unrecordable, rapid IV access was attempted again and failed. Intraosseous access was attempted on the right leg. The procedure was done just below the tibial tuberosity as per the guidelines, using a non-threaded IO needle. Marrow was aspirated and a total of 500 mL of normal saline was infused. No signs of extravasation were noted initially. For the next 6 hours, the child was managed in the emergency room because of the non-availability of a PICU (Pediatric Intensive Care Unit) bed. Dopamine, dobutamine and adrenaline were infused through the IO line. This was followed twice by sodium bicarbonate and later by calcium chloride. When the child arrived in the PICU after 6 hours of IO infusion, a bluish discoloration and swelling were noticed in the upper third of the right leg surrounding the IO needle. Though a definite femoral pulse was felt, dorsalis pedis and posterior tibial pulses were not palpable in the right leg. The limb was pale and cold; the child did not move the right leg and foot drop was observed. Acute limb ischemia was suspected and the IO needle was removed immediately upon arrival in the PICU. A Doppler ultrasound study on the right

lower limb revealed triphasic flow in the right femoral artery. No flow was observed in the popliteal artery and no thrombus was seen. The popliteal vein was patent. There was no evidence of compartment syndrome. The features were suggestive of extravasation of irritant drugs such as sodium bicarbonate, calcium chloride and inotropes, causing damage to the vessels and nerves. The child was initially treated with heparin IV infusion and tissue plasminogen activator. Vascular and pediatric surgeons were consulted but no further management could be offered. Though the swelling subsided in 36 hours, color and perfusion did not improve. The limb became gangrenous in the next few days, and we performed a below-knee amputation.

DISCUSSION

IO infusion is a life-saving emergency procedure performed in the emergency room during resuscitation of a critically ill child. On some occasions it is also performed in pre-hospital situations by the emergency medical team. In this situation, getting an IV or IO access within a few seconds is the foundation of commencing the resuscitation. The ultimate outcome entirely depends on how quickly the access is achieved. The concept of IO infusion is a boon for the critical care physician, because of the high success rate and low complication rate. Most pediatricians are trained to insert an IO needle in the PALS course. It can be used in all age groups from preterm neonates to adults. The commonly used site is the upper tibial end, 2 to 3 cm medial and inferior to the tibial tuberosity. Other areas less commonly used are the lower end of the femur, the medial malleolus and anterior superior iliac spine. In older children, the distal tibia, anterior superior iliac spine, distal radius and distal ulna are used. Available for adults is a sternal IO cannula system, which is known as FAST (First Access for Shock and Trauma). Though IO infusion is a safe procedure, complications do occur rarely, less than 1% of the time in experienced hands.² The commonest com-

plication is extravasation of fluid. Other complications include tibial fracture, lower extremity compartment syndrome, cellulitis, sepsis and osteomyelitis. The risk of infection is higher in children with bacteremia. There are many case reports of various complications of IO infusion in the literature. According to Gayle,³ an infant developed a fracture when a 15-gauge IO needle was used instead of a smaller needle. Though microscopic fat embolism has been demonstrated in animal models, this has never been reported in humans in clinical studies. Riberto reported compartment syndrome of the lower extremities and in one case, compartment syndrome occurred even with extravasations of a smaller volume, such as 35 mL of fluid.⁴ Tibial osteomyelitis was reported by Dogan in a 5-month-old infant with sepsis.⁵ There are also other reports of complications after IO infusion.^{3,6,7} Compartment syndrome as a complication of IO infusion was also reported by Vidal.⁸ Gunal conducted an experimental study in dogs and concluded that compartment syndrome may develop despite the meticulous utilization of IO technique.⁹ Because compartment syndrome developed in all dogs, after approximately 350 mL of infusion and after the technical errors were eliminated, it was suggested that a dose- and time-dependant relationship exists in the development of compartment syndrome with IO infusion. Gayle and Kisoon made the interesting observation that needle design is an important factor in the development of complications. They observed that use of a threaded needle was associated with fewer complications.¹⁰ Threaded needles resist dislodgement and a non-threaded needle may create an opening in the bony cortex that is larger than the needle diameter due to rocking during insertion. Whenever possible, pumps should be set at low pressure and flow under gravity should be established prior to use. Though the complication rate is lower, even one child with a serious complication like gangrene will lead to grave consequences for the child, his family and for the medical team. Incomplete pen-

etration of the bony cortex, dislodgement of the needle during injection or transport, inadvertent penetration of the posterior cortex or leaking from another hole such as a previous IO attempt are considered possible causes of extravasation. In this case, the cause for gangrene is due to the extravasation of irritant medications such as dopamine, dobutamine, adrenaline, sodium bicarbonate and calcium. Complications like extravasations and compartment syndrome can be prevented by frequent examination of the IO site, every 5 to 10 minutes. This should be done by visually inspecting for discoloration and by palpation for swelling, induration and for distal pulses.¹¹ Continuous uninterrupted flow of the IV fluid should not be taken as evidence for a good line, because these IV lines are often infused under pressure by infusion pumps.

IO infusion is performed in a critically ill child with cardiac arrest, decompensated shock or status epilepticus when rapid IV access is not possible. These complications are avoidable by using careful techniques and monitoring for complications. However, in an actual clinical setting all the attention will be on ventilation, perfusion, vital signs, and acute metabolic disturbances like hypocalcaemia, acidosis and dyselektrolytemia. In the initial hours less attention may be paid to the IV or IO site and early signs of extravasation are often overlooked. As per PALS guidelines, a critically ill child is assessed by rapid cardiopulmonary assessment in a sequential manner as airway, breathing, circulation, disability assessment and exposure ("A, B, C, D, E"). This "E" should also include checking another "E", the entry points of IV or IO sites and the tracheal tube. This will serve as a reminder during the critical hours. One must be always cautious and anticipate the complications. Early identification by careful monitoring of the access site will prevent the complication and reduce the mortality and morbidity. This case is reported mainly to focus on the need for frequent examination and to create awareness among healthcare providers about a major complication of a life-saving procedure that is increasingly used in resuscitation.

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