Case report of 54-year-old male obtunded patient requiring a CT angiogram to diagnosis a suspected massive pulmonary embolism. After several failed attempts to reestablish PIV access, 150mL of contrast were injected through the proximal tibia IO catheter placed by EMS. Excellent opacification of the pulmonary arteries was achieved and there were no immediate complications from the injection noted.

In a letter to the editor this study reports data collected (during a survey of one third of academic emergency medicine programs in the U.S.) regarding IO use in adults and comparing IO access with other vascular access techniques through simulation. Data suggest that IOs were used less than 5% of the time patients needed emergent access and a peripheral line was unobtainable. The EZ-IO was most often used IO device. Authors conclude IO use should be considered more frequently in critical, unstable patients. (This research was presented at the ACEP Research Forum in 2010).

An observational clinical study evaluating use of the EZ-IO in patients requiring urgent vascular access that would have otherwise received a central venous catheter due to a lack of other options. One hundred five (105) patients were enrolled across five hospitals. The authors concluded that use of IO access in place of CVCs provides time savings, safety, ease of use, and is effective at significant cost savings; IO access may be used as a bridge to CVC placement under optimal conditions; and IO access may be used to replace use of CVCs all together in selective patients. This study was sponsored by Vidacare Corporation.

A letter to the editor reporting a case study of skin necrosis after IO administration of norepinephrine following resuscitation of a 74 years old in septic shock. The EZ-IO was placed to the proximal tibia; approximately 45 minutes post-norepinephrine administration symptoms of necrosis were evident. Authors cite 3 hypotheses for the cause of necrosis and consider that amines’ high level concentration could induce local toxicity in the bone matrix and artery spasm; suggesting it is necessary to define an upper limit of amines’ concentration that should be administered through IO vascular access.

General discussion on use of the intraosseous vascular access route for infusion of CT contrast, with attention to clinical considerations pertinent to nurses working in the imaging suite. Author also reviews general IO principles and IO devices.

This article in German explores use of intraosseous access in a dental practice emergency. In a simulation study, dental students attempted to establish standard peripheral IV access and IO access using 3 different devices: EZ-IO, BIG, and manual IO. Results showed the manual was the fastest to insert however the EZ-IO had the highest first-attempt success rate as well as the lowest number of total attempts to IO access.

This article in German explores use of intraosseous access in a dental practice emergency. In a simulation study, dental students attempted to establish standard peripheral IV access and IO access using 3 different devices: EZ-IO, BIG, and manual IO. Results showed the manual was the fastest to insert however the EZ-IO had the highest first-attempt success rate as well as the lowest number of total attempts to IO access.

Kim S. Intraosseous access: an important clinical procedure for emergency physicians. Lifeline 2013;June:12-3
Article featured in June 2013 issue of California’s ACEP monthly newsletter. This article discusses general IO principles with examples of several short case reviews and highlights the EZ-IO.

Pre-clinical study comparing flow rates achieved after insertion with the EZ-IO in the proximal tibia, distal femur, and proximal humerus in a swine model. IO catheters were placed in each site and normal saline was infused for 10 minutes using a pressure bag at the highest achievable pressures greater than 300mmHg. The flow rates through the proximal humerus were statistically greater than that of the femur or proximal tibia. The femur flow rates were higher than the proximal tibia but similar. Post-mortem histopathologic evaluations done to assess for damage due to the high infusion pressures were consistent with IO catheter placement.


This article provides an overview of various vascular access modalities in emergency medicine including peripheral IV, venous cut-down, central venous catheter, intraosseous access, umbilical vessel access, and arterial access. The anatomy and physiology, indications and contraindications, procedure steps and special considerations are outlined for each access methods discussed.

Lyon RM, Donald M. Intraosseous access in the prehospital setting-Ideal first-line option or best bailout?. Resuscitation 2013;84:405-406. http://dx.doi.org/10.1016/j.resuscitation.2013.01.027

Editorial reviewing a case series of EZ-IO use in the pre-hospital setting in Switzerland by Santos et al., combined with a literature review. The authors conclude IO access should probably be used selectively and training on its use improved, insertion sites should be compared and further investigation of use of the EZ-IO in major trauma patients, infusing blood components, use in infants, and application of training warrant further investigation.


This article in French gives an overview of intraosseous vascular access including the physiology of IO infusion, insertion sites, indications, and complications. Available IO devices on the market are described including, time to insertion, success rate and cost. French


An observational study evaluating use of the EZ-IO by two ground and one air based physician staffed EMS and at a German surgical university hospital between January 1, 2008 and December 31, 2011. The EZ-IO was used to establish IO access 88 times in 87 patients; 83 insertions were performed in the EMS and 5 were performed in the hospital. The proximal tibia was the primary site used (97.7%) and the first attempt success rate was 94%. IO access was the first approach for vascular access in children compared to adults (38.9% vs. 86.2%). There were 5 failures attributed to missed insertions or extravasation and 2 for wrong needle length. There were no serious complications.


This article reviews the clinical effects of both high-quality chest compressions and the effects that interruptions during chest compressions have clinically on patient outcomes. The authors indicate intraosseous vascular access should be heavily considered as the first or at least second-line method used to help prevent prolonged compression interruptions for the purpose of establishing vascular access. The authors note that when using the EZ-IO this method of access is fast, effective, can handle all resuscitation fluids, and can minimize no flow time when used properly.


This article describes a case study of a 5-month old infant that suffered a head injury resulting in shock. She received 100 mL of red blood cells via the EZ-IO in the proximal tibia, resulting in rapid hemodynamic improvement. A literature search was completed for cases of IO blood transfusion in pediatric trauma. Authors note IO availability and knowledge play an important role in hemorrhagic shock; and RBC infusions via the IO route are feasible in this age group.


Article in German
Intraosseous Vascular Access Bibliography

EZ-IO Articles


This randomized, controlled study compared tissue concentrations at the surgical site of regionally and systemically administered prophylactic vancomycin, in 30 patients undergoing total knee arthroscopy. The antibiotic was administered using three methods: 250mg through IO regional administration in the proximal tibia (IORA); 500mg through IORA; and 1g administered systemically through IV. Results showed the tissue concentration of vancomycin was greater in the 250mg IORA group than the systemic IV group, and the 500mg IORA group had higher concentrations than both groups.

YEAR: 2012


This article discusses how IO access can be used to improve advanced life support therapy. The EZ-IO is described in this article; published comparative studies between other IO devices and peripheral IV access are cited, leading the author to conclude the EZ-IO is user friendly, and establishes intravascular access more quickly and more often on first attempt than other devices.


This pre-clinical study evaluated IO flow rates obtainable with infusion of lactated Ringer’s and hetastarch 6% through the proximal tibia and sternum IO insertion sites, using a swine model. The EZ-IO 25mm was used to facilitate tibial IO access; sternal access was established using a Jamshidi needle. Results showed that hetastarch flow rates were lower than lactated Ringer’s flow rates at both insertion sites; sternal infusion of hetastarch is likely to provide greater estimated intravascular volume expansion than lactated Ringer’s, despite the lower infusion rates; resuscitation using the IO rate is likely to benefit from pressure bag or high-pressure pump delivery. This study was sponsored by Vidacare Corporation.


This abstract presented at the 2nd World Congress on Vascular Access 2012 reports data collected on the knowledge gaps and barriers to IO vascular access use. Two focus group discussions were held at professional conferences (American College of Emergency Physicians and the Emergency Nurses Association) and facilitated by clinical researchers. Data was qualitatively evaluated and researchers identified several main areas of concern for clinicians in both implementation and knowledge gap areas. This study was sponsored by Vidacare Corporation.


This simulation study compared intraosseous (IO) vascular access, via EZ-IO, with peripheral venous (PIV) access for time to access, perceived ease of placement, rapidity, and safety, and which will be first choice in life threatening situation among 73 prehospital care providers with no prior experience with IO access. Results showed time to placement for IO access was significantly faster than that of PIV; the majority of device operators graded the device superior to PIV for ease of placement, rapidity and safety.


This abstract presented at the 2012 ACEP Research Forum discusses a swine pre-clinical study evaluating CT image opacification when contrast is delivered via IO and proximal humerus IO access. The EZ-IO was used to facilitate IO access. Results showed that under blinded radiology review the IV and IO images were judged adequately opacified to meet diagnostic criteria. Authors concluded that IO administration of contrast material may be a viable alternative if other vascular access is unavailable or if establishing other access will lead to a delay in diagnostic evaluation. This study was sponsored by Vidacare Corporation.


Pharmacokinetics of IO drug delivery was compared using the tibia or sternum, versus central venous delivery during CPR. Anesthetized swine with KCl arrest were used for this study, CPR was initiated 8 minutes post arrest. Using 2 study groups, dye was injected as a bolus with adrenaline through either the IO sternal and tibial needles or through the IO sternal and IV central venous needles. Results showed peak arterial blood concentrations were faster for sternal IO vs tibial IO administration. Tibial IO delivered 65% of the total dose delivered with sternal administration. Peak blood concentrations were similar for sternal IO and central venous administration. Sternal IO delivered 86% of the total dose delivered by central venous administration. The EZ-IO and Jamshidi were used to facilitate IO access. This research was sponsored by Vidacare Corporation.
Intraosseous Vascular Access Bibliography

**EZ-IO Articles**

Ibrahim M, Cairney K. Intraosseous (IO) infusion as a means of vascular access. British J of Resuscitation 2012; Autumn: 23-6

This article provides an overview of intraosseous vascular access, including applicable patient population, IO access sites, pain management, IO education and compares IO access to central venous access.


This article describes a study evaluating a new manual needle insertion device, the Needle Holder, which uses hollow-bore needles to establish IO access. In a comparative study, healthcare professionals attempted IO insertion in the proximal tibia insertion site of a mannequin using the NNH and a standard Cook manual IO needle. Participants then completed a questionnaire regarding their experience. The most reported complication was the plunging of the needle into the medullary space from the decrease in resistance once the cortex was penetrated. Other IO devices on the market are mentioned, including the EZ-IO.


This letter to the editor describes a case in which a 53-year-old male in ventricular fibrillation received IO access via the EZ-IO in the ED with suspected massive pulmonary embolism. The patient was successfully resuscitated. Necrosis of the anteromedial side of the leg, at the IO site, presented 48 hrs post IO use. After 18 weeks the patient underwent surgical grafting. The authors linked the necrosis to adrenaline extravasation and local ischaemia. While the authors conclude that thrombolysis or repeated high doses of adrenaline should be given via the IO route when needed, it is not without the risk of complication.


This clinical trial evaluated the time required to establish IO access versus central venous catheter (CVC) in adults undergoing resuscitation, who had failed peripheral IV access (PIV) attempts. IO and CVC placement were performed simultaneously; two IO devices, the EZ-IO and the BIG, were used to facilitate IO access in randomized format. Forty (40) patients were enrolled, first attempt success for IO was 85% vs 60% for CVC placement; median procedure time was 2 minutes for IO vs 8 minutes for CVC. The author concluded that though IO access is safe, reliable and rapid during resuscitation, it cannot replace CVC but should be considered as a valuable bridging technique.


This abstract presented at the 2012 NAEMSP scientific assembly described a retrospective study that evaluated success rates and features of chilled saline and infusion tubing submerged in an ice water bath provides the most effective means of cooling. This study was sponsored by Vidacare Corporation.


This abstract presented at the 2012 ACEP Research Forum discusses a literature review of intraosseous access publications since 1985 providing an updated safety profile for IO access. The search resulted in 192 articles describing IO access with 6 cases of osteomyelitis and 6 cases of compartment syndrome secondary to extravasation reported. Of the 192 articles identified, 140 described the EZ-IO. This study was sponsored by Vidacare Corporation.


This abstract presented at the 2012 ACEP Research Forum describes a preclinical swine study evaluating the ability to induce therapeutic hypothermia by infusing chilled saline via IV and IO access. The EZ-IO was used to facilitate IO access. Results showed statistical equivalence between IV and IO routes when used to deliver chilled saline to induce therapeutic hypothermia. Results also showed that use of chilled saline and infusion tubing submerged in an ice water bath provides the most effective means of cooling. This study was sponsored by Vidacare Corporation.


This abstract presented at 2012 NAEMSP scientific assembly described a retrospective study that evaluated success rates and features of prehospital IO placement in adults following implementation of the EZ-IO, over a 2 year period. First attempt success rate in 281 patients was 89.7%; overall placement success was achieved for 91.8%.
Intraosseous Vascular Access Bibliography

**EZ-IO Articles**


A literature review of articles describing intraosseous vascular access devices used in the pre-hospital setting. Twenty articles met the inclusion criteria and described the manual devices, BIG, Fast-1 and the EZ-IO. The authors concluded that the literature suggests that semiautomatic IO devices may be more effective than manual devices.

Page D. Intraosseous intrigue: Studies examine success rates on pediatric, adult & obese patients. JEMS January 2012;32-3

In this article, the author discussed five recent studies on intraosseous access providing his opinion about the quality of each study.


This letter to the editor describes a case in which sternal IO access was established using a Jamshidi needle to administer iodinated contrast for a thoraco abdominal CT on a 61-year old male who presented to the ED with respiratory distress. Picture quality was deemed excellent by the radiologists. The authors conclude that the sternal IO route can be used with excellent picture quality but it should be used only in exceptional cases due to the potential risks of a high-power injection through the bone. EZ-IO is mentioned as an alternative IO device available.


An article discussing the technique and safety profile of intraosseous access using the EZ-IO device. Needle selection, contraindications, insertion sites and techniques, catheter stabilization and removal are all discussed along with the safety profile of the EZ-IO against other IO devices and central venous catheters. The authors concluded that IO access should be considered whenever immediate vascular access is required. This article was co-written by an employee of Vidacare Corporation.


This abstract presented at the 2nd World Congress on Vascular Access 2012 describes the results of an analysis of published IO complications since 1985. The safety profile of the EZ-IO is also discussed in this abstract. The authors conclude that new devices and techniques have resulted in an approved IO safety profile. This study was sponsored by Vidacare Corporation.


This article presents a general overview of intraosseous (IO) vascular access in the pediatric population through an IO literature review. Available IO devices were discussed.


This pre-clinical study sought to evaluate the various pressure levels obtained by 22 veterinary clinicians when administering a 10ml normal saline flush of an IO catheter. &nbsp;The EZ-IO was used to establish access in an isolated, cadaveric swine femur. The authors found the median peak intraosseous pressure was 615 mmHg with a range of 57 to 1,100 mmHg. Authors concluded that there is a great deal of variability between clinicians and their flush pressure and that a standardized flush protocol may be beneficial.


This article describes a retrospective study in which 50 consecutive MRI images were evaluated of the humerus for the purpose of determining the optimal needle length necessary for successful proximal humerus IO insertion. Results showed the cortical thickness was 4mm in all cases and that an IO needle length ranging between 40-50mm should be used via the anterior approach. The EZ-IO is specifically discussed in relation to the proximal humerus IO insertion site; and a 24 patient post mortem review of the EZ-IO placed in the proximal humerus is discussed.


An observational study evaluating use of the EZ-IO in a Swiss pre-hospital EMS system between January 1, 2009 and December 31, 2011 and comparing those results to the literature. Sixty IO insertions were performed on 58 patients; the proximal tibia was used in all attempts except 1 attempt made in the proximal humerus. Overall success rate was 90%; the 6 failures were attributed to impossibility to infuse, difficult needle insertion, and incorrect insertion site (tibial plateau). Some of the indications for IO access included cardiorespiratory arrest, major trauma, and shock; general anesthesia was successfully inducted in 7 patients. Drugs infused are listed. There were no serious complications.

This prospective observational study compared flow rates between distal and proximal tibia IO access in adults, with each adult serving as their own control. The EZ-IO was used to facilitate IO access. IO infusion was performed with and without pressure. The authors concluded that infusion flow rates were significantly higher in the proximal tibia as compared to the distal tibia, and that flow rates are significantly higher with pressured infusion vs. non-pressured infusion. This study was sponsored by Vidacare Corporation.

Torres F, Galán MD, Alonso MD, Suarez R, Camacho C, Almagro V. Intraosseous access EZ-IO in a prehospital emergency service. Journal of Emergency Nursing 2012;http://dx.doi.org/10.1016/j.jen.2012.03.005

This observational pre-hospital study conducted in Madrid, Spain prospectively evaluated use of the EZ-IO Jan 2007- Dec 2009 as an alternative to peripheral IV access. During the study period, 107 patients underwent 114 EZ-IO insertions and all were successful on first attempt. IO access was established in the proximal tibia (49%), distal tibia (25.2%), radius (14.9%), and humerus (10.5%) and all lines were the first form of vascular access established in the patient. There were no adverse events or complications.


This poster presented at the 2012 International Conference of Emergency Medicine described a 4 month review of intraosseous access in UK military operations in Afghanistan. During the timeframe the EZ-IO was used to establish IO access in the proximal humerus and tibia sites; the FAST1 was used to establish sternal IO access. Of the 87 EZ-IO applications there were 12 functional issues and the placement success rate for both sites combined was 86.3%. In 24 FAST1 applications there were 4 functional issues and the placement success rate was 83.4%.


In this article the authors review the evidence supporting the use of IO access; determine the utilization IO access as described in the literature; and assess the level of specialty society support. Various IO devices are mentioned including the EZ-IO.


This study conducted by the San Antonio Fire Department evaluated the first-attempt success rate for humeral EZ-IO placement by paramedics in prehospital adult cardiac arrest patients. Humeral placement was attempted in 247 cardiac arrest patients; first attempt placement success rate was 91%. Authors concluded that humeral IO placement is a reliable method for vascular access in this patient population. This research was sponsored by Vidacare Corporation.


A literary search of electronic databases was performed to identify publications comparing IO access devices. Publications qualifying for study evaluation must have compared two or more semi-automatic IO devices or at least one semi-automatic device and a manual device. Reviews, editorials, surveys, and case reports were excluded. Ten comparative studies met the qualifications for inclusion and are briefly discussed. The studies evaluated suggested superiority of the battery powered IO driver over manual needles and other semi-automatic IO infusion devices.


A clinical study comparing Cefazolin concentrations found at the operation site following total knee arthroscopy when prophylactic antibiotics are administered systemically, through IV administration, and regionally, through IO injection directly at the site using the EZ-IO. Subcutaneous fat and bone samples were collected for evaluation from 22 subjects. Authors concluded that regional IO administration of prophylactic antibiotics can achieve tissues levels higher than with systemic administration.

YEAR: 2011


This article in German presents a case of a 67-year-old female patient with an arterial bleed and venous access difficulties in whom IO access was attempted unsuccessfully two times using two different IO systems. The author concluded that IO success is dependent upon IO anatomy and physiology knowledge as well as knowledge of the device being used.
This article describes an animal trial that assessed the ability of protected, experienced first responders and limited-experience first receivers to place IO lines for antidote administration using the Vidacare EZ-IO device. First responders placed IO lines successfully in 100% of cases, and first receivers placed IO lines successfully in 91% of the cases. Investigators concluded that IO lines may facilitate earlier administration of antidotes to hazardous material victims.

This article in Spanish describes an IO complication case in which a newborn infant developed tissue necrosis as a result of extravasation during IO infusion.

The case report describes a woman experiencing massive hemorrhaging following emergency caesarean delivery. Though the patient possessed a peripheral IV catheter, additional IV access was needed and gained through the proximal humerus IO space using an EZ-IO. This vascular stabilization and additional filling of the central volume through the IO route allowed placement of a subclavian central line. Authors concluded that a key to the resuscitation process was the rapid utilization of the IO.

This article presented a general overview of IO use in pediatrics. The history, techniques, anatomy and physiology, complications and a short discussion of most devices on the market, including the EZ-IO, were discussed.

An overview of available intraosseous vascular access devices, including the EZ-IO.

Case study of a 42 year-old woman with massive obstetric hemorrhage ultimately resulting in postpartum hysterectomy. Massive blood loss and inability to stop bleed prevented sufficient resuscitation via established PIV lines. IO access was established with the EZ-IO and used for fluid replacement and administration of cardiac resuscitation drugs. Fluid administered through IO access was 75% of the total infusion volume.

Dolister M, Miller ST, Borron S, Truemper E, Shah MR. Intraosseous vascular access can be used safely and effectively, and at a lower cost than central venous catheters, for pediatric and adult patients in the hospital setting. Ann Emerg Med 2011;58(4S):S311
This abstract describes the interim results of an observational clinical trial evaluating use of the EZ-IO to establish venous access in patients that would typically receive a central line due to lack of other options. At interim analysis, 50 patients had been enrolled in the study. First attempt IO access success rate was 96%; mean time to IO access was 95.1 seconds. The authors concluded that IO access in place of or as a bridge to central venous catheters is safe, fast, and effective for adult and pediatric patients in the hospital setting with substantial cost savings potential. &nbsp;This research was sponsored by Vidacare Corporation.

This article describes an observational study to assess the safety and efficacy of the EZ-IO when using a management algorithm for difficult vascular access in an out-of-hospital setting. Over a one-year period, the device was used in 30 cardiac arrest and 9 other cases. Overall success rate was 97% and first attempts success was 84%. There was one complication—transient local inflammation. Investigators concluded that the device is suitable as a first-line option for difficult vascular access in the out-of-hospital setting.

General overview of PALS updates. Various IO devices were specifically mentioned in the vascular access section, including the EZ-IO.
Intraosseous Vascular Access Bibliography

EZ-IO Articles

This article describes a military study in which post-mortem preautopsy multidetector CT was used to assess placement of tibial IO needles in battlefield trauma deaths where IO was used as part of the medical intervention. Results showed 58 of 61 (95%) tibial IO needles were correctly placed. In this study, the device used for IO placement was not recorded, but may have been the manual device or EZ-IO as the Army has access to both.

This article summarizes the case-based observations made by the Armed Forces Medical Examiner System on soldiers killed in action/died of wounds who had evidence of sternal intraosseous access. The Pyng Fast-1 is noted in the article as the sternal IO device most widely distributed by the department of defense (DOD); the EZ-IO is listed as another device that may be seen in emergency care facilities within the DOD. Of 98 cases, 78 (80%) showed proper placement; 20% were unsuccessful. It should be noted that the article incorrectly states that the EZ-IO using the powered driver is indicated for sternal placement.

Howarth D. Adult intraosseous access: experiences in a remote emergency department. Australian Family Physician 2011;40(7):510-1
In this article, the author makes a supporting case for remote emergency departments to stock adult intraosseous kits by referencing two adult septic shock cases in which IO access was used for rapid IV fluid replacement as well as IV antibiotics and inotrope support.

This manuscript describes two studies conducted to assess the function and longevity of EZ-IO catheter when placed in the goat model. The authors concluded that the EZ-IO catheter can be left in place for more than 24 hours in animals and can be used in many different veterinary settings when IV access is not immediately available. They also concluded that the EZ-IO system is useful in larger or adult bones.

Khan LAK, Anakwe RE, Murray A, Godwin Y. A severe complication following intraosseous infusion used during resuscitation of a child. Inj Extra 2011;doi:10.1016/j.injury.2011.05.015
This article describes the case of an 11-year-old boy who suffered compartment syndrome of the lower leg following use of the EZ-IO for resuscitation and 24 hours of intraosseous infusion of adrenaline, calcium and potassium. The author concluded that further work is needed to develop recommendations for maximum duration, dose, volume and rates for intraosseous infusion.

This article reports a case in which IO access was used to deliver intravenous contrast agent in an adult blunt trauma patient. After placement in the proximal humerus, contrast agent was administered via the IO route, and clinicians found the CT scans of the thorax, abdomen, and pelvis to be adequate for diagnostic purposes and subjectively equivalent to those of studies using central venous access. There were no complications and the authors concluded that IO catheterization appeared to be an effective alternative to traditional venous access for administering contrast agents for CT evaluation in adult blunt trauma patients.

This abstract describes a swine study presented at the 2011 National Association of EMS Physicians Annual Conference that examined infusion rates through 3 anatomical sites via the powered EZ-IO device. Investigators concluded that the infusion rate was greater via the humerus compared to the tibia and femur.

This study compared the effectiveness of infusing ice cold saline via IO and IV to induce mild therapeutic hypothermia (temperature drop to 34°C) within a 30 minute timeframe, in a swine model of cardiac arrest. Five swine were evaluated in each the IV and IO groups. Goal temperature was reached in 4/5 animals in the IV group and 0/5 animals in the IO group in the allotted time frame; IV was superior in terms of rate of infusion, rate of temperature change, and time to achieve target temperature.

This study evaluated the use of telesimulation by Canadian pediatricians to teach a relatively new IO insertion technique (EZ-IO System) to physicians in Africa. Self-assessment questionnaires were completed before and after training, multiple-choice tests were given and a demonstration of competency was done within 3 training sessions. Twenty-two physicians participated; the sessions improved physicians’ knowledge, self-reported confidence, and comfort level in inserting the IO needle. The author concluded that telesimulation offers potential for teaching other procedural skills over distances.


This abstract describes an evaluation performed in the goat model, using the EZ-IO, to determine the ability of IO access to accommodate a typical contrast dye infusion and withstand the power injection pressure. Bench testing was done to determine the max pressure deliverable through the EZ-IO using the power injector; various injection occlusion scenarios were established. Results showed the mean pressure through the humerus was 56.5psi; through the tibia was 163.5psi. There were 2 tibial extraosseous distal venous ruptures visible by fluoroscopy but not on gross examination. Under bench testing, for all tests, at pressures up to 750psi no failure or leakage was observed in the IO catheter. The EZ-IO extension tubing should not be used for power injection, particularly if the IO is in the tibia. This research was sponsored by Vidacare Corporation.

Miller LJ, Philbeck TE, Puga TA, Montez DF, Escobar GP. A pre-clinical study to determine the time to bone sealing and healing following intraosseous vascular access. Ann Emerg Med 2011;58(4S):S240

The objectives of this study were to evaluate the amount of time necessary following IO insertion and infusion for the bone to heal such that a second IO catheter can be placed in the same bone without the risk of extravasation from the first hole; and to determine the length of time required to show radiological evidence of closure. Four anesthetized goats were used for the study. Twenty-four hours post insertion, extravasation was observed in 2 of 4 tibial sites with no extravasation in 4 humeral sites. Forty-eight hours post insertion, no extravasation was observed in tibial or humeral sites. Authors concluded that IO infusion should not be attempted in the same bone as a previous IO insertion within 48 hours of removal of the first IO catheter. Radiological examination showed evidence of bone healing as early as 6 days post IO placement. &nbsp;This research was sponsored by Vidacare Corporation.


This article describes the changes in practice experienced when a 12-site statewide ambulance service changed from the manual to the semi-automatic IO device (EZ-IO). There was no statistically significant change in first-attempt success or the number of successes per attempt. However, the use of IO access more than tripled when changing from the manual to the semi-automatic device and PIV access attempts before IO access went from occurring in 35.5% of patients to 1.7% of patients.

Myers LA, Russi CS, Arteaga GM. The introduction of a semiautomated (EZ-IO) device in pediatric prehospital care replacing a manual intraosseous (IO) device improves the success rate for attempts at vascular access. Prehospital Emergency Care 2011;15(1):110

This abstract describes a 93 patient study presented at the 2011 National Association of EMS Physicians Annual Conference that examined the characteristics of pediatric patients receiving IO infusions and the primary EMS clinical impressions, success rates, and subsequent treatments delivered via manual IO vs. the powered EZ-IO device. Investigators concluded that for the pediatric cohort use of the powered device offered a marginally higher first-attempt success rate compared to the manual device; and that the rate of IO access utilization by EMS more than tripled after adoption of the powered device.


This article provides an overview of intraosseous vascular access for pediatrics and discusses general indications, contraindications, complications, and intraosseous devices.


This article in German discusses use of IO access and its multiple applications, focusing on the EZ-IO Infusion System.
Intraosseous Vascular Access Bibliography

**EZ-IO Articles**


This article describes a pre-hospital clinical study comparing IO first-attempt success between humeral and tibial sites. Of 88 cardiac arrest patients analyzed, 58 and 30 IO access attempts were made in the tibia and humerus, respectively. Of those, there was a 90% first attempt success rate for the tibia, compared to 60% for the humerus. Of successful insertions, 6% of tibial insertions became displaced during transport, compared to 33% of humeral insertions. Investigators concluded (the obvious) that “proximal tibial IO needle placement was associated with a significantly higher frequency of first-attempt success and lower incidence of needle dislodgements... compared to humeral placements.”


The objective of this study was to determine the frequency of first-attempt success of humeral IO, tibial IO, and peripheral IV (PIV) insertions during out-of-hospital cardiac arrest. Patients were randomized to receive one of the 3 methods. There were 182 patients enrolled, 64 were assigned to tibial IO, 51 to humeral IO and 67 to PIV. Of all patients 130 (71%) were successful on first attempt with 17 (9%) needles dislodged. First attempt success within the treatment groups was 91% for tibial IO, 51% for humeral IO, and 43% for PIV.


This article describes a case in which systemic fibrinolysis was administered through the intraosseous route in a patient with ST-segment elevation myocardial infarction. Fibrinolytics and antiarrhythmic drugs were administered though the IO line, resulting in resolution of coronary ischemia and electrical instability, without complications. Authors concluded that intraosseous cannulation represents a novel route for administration of systemic fibrinolysis in cases of difficult peripheral venous access in the out-of-hospital setting.


This study conducted in Germany and Switzerland evaluated use of the EZ-IO in the prehospital setting over a 24 month period. The decision to use IO access was left to the discretion of the onsite clinician, a paramedic or an emergency physician. Results showed IO access was attempted in 77 patients, and was successful on first attempt in 75 patients. Significant pain with infusion was reported in the majority of responsive patients.

Sheehan C, Sodhi V, Esler M. Intraosseous needles on the delivery suite. Intraosseous access for neonatal and newborn resuscitation in the national park service (NPS).

This article discusses how a group of obstetricians and anesthesiologists prepared for what they expected to be a difficult delivery with limited venous access. The EZ-IO was brought into the delivery suite as a back-up option if they were unable to achieve venous access in an emergency situation. The authors did note their concern with the pain associated with IO infusion. Ultimately, the IO device was not needed for the delivery in question, but it has been added to their resuscitation kit within the delivery suites.


This article describes IO access in terms of efficacy, indications/contraindications for use, and the IO procedure and comparison of devices to make a case for IO use in oral and maxillofacial surgical practice. In discussing IO devices citing published data, the author identified the EZ-IO device as the most accurate, efficacious, and precise system when trying to achieve IO access.


This article in German concludes that the introduction of IO in pre-hospital pediatric emergency system has markedly reduced the number of critically ill or severely injured pediatric patients without vascular access or with less reliable alternative administration routes in the last 20 years.


This article describes two cases of leg amputation after intraosseous infusion in a 5-month-old girl and a 17-month-old boy. The author concluded that fluid extravasation, exacerbated by tibial fracture and needle dislodgement during transportation, caused limb ischemia in these two patients, and that adherence to the principles of careful needle placement, splinting/securing the catheter and limb, limited length of infusion and repeated monitoring of the limb will help avoid this devastating complication.
Intraosseous Vascular Access Bibliography

EZ-IO Articles

This article in Danish discusses use of the IO route for second line vascular access when peripheral IV access is difficult or impossible.

This article is a response to the Taylor and Clarke 2011 report of two amputations required following development of compartment syndrome after IO infusion. The author notes that complications are possible with all methods of establishing IO access including manual, spring loaded and power driven needles and that it is not accurate to directly relate the adverse events to the power driven device only.

YEAR: 2010

This abstract, which was presented at the 2010 ACEP Research Forum, describes a study conducted by investigators from the Medical College of Georgia to determine the frequency of intraosseous vascular access use in adult emergency patients. They surveyed academic emergency departments across the country and, at their own facility, compared ease and speed of standard emergency vascular access methods—including intraosseous. They concluded that IO access is underutilized and generally not the second-line choice of vascular access in unstable adult patients in academic institutions. Their simulation showed IO placement was considerably faster than both central lines and ultrasound guided peripheral IV. They opined that IO should be considered more frequently in critical unstable adult emergency department patients.

This veterinary study evaluated 3 IO access devices, impact driven, automatic rotary, and manual, to compare the placement feasibility and amount of bone trauma induced when used in adult feline cadavers. Seventy-two IO insertion locations were used, the 3 devices were equally randomized to the insertion site. The rotary device was found to have shorter time to insertion and better ease of insertion. No statistically significant differences between number of bone fragments, defect diameter, or success rate were found between devices.

This article reviews intraosseous vascular access and its increased use in adult resuscitation. The IO route is described, including indications, contraindications, insertion sites and devices.

Gillum L. All access pass: mastering the use of IO devices. JEMS 2010;35(6):30,32
This article discusses training methodology and applies the concept to the implementation of the EZ-IO in the Montgomery County Hospital District EMS, a participant in the EZ-IO beta test.

An article evaluating various methods of obtaining vascular access in the management of 21st century battlefield trauma including, peripheral IV access, intraosseous access, venous cut-down, and central venous access. The authors conclude that IO access should be the first line vascular access in casualties with severe trauma to avoid delay initiating resuscitation in pre-hospital or hospital setting.

An article evaluating various methods of obtaining vascular access in the management of 21st century battlefield trauma including, peripheral IV access, intraosseous access, venous cut-down, and central venous access. The authors conclude that IO access should be the first line vascular access in casualties with severe trauma to avoid delay initiating resuscitation in pre-hospital or hospital setting.

This article in German describes the results of a survey of rescue assistants and physicians, in which they found that IO use was still a rarity in the Berlin emergency medical service and, therefore, presumably nationwide.

Authors describe an early observational study (N=120) comparing intraosseous access in the humerus and the tibia, using the EZ-IO. Investigators concluded that the humerus is an acceptable IO site, which may be preferable under certain clinical conditions. This research was sponsored by Vidacare Corporation.


In an abstract presented at the 2010 ACEP Research Forum, investigators describe a swine study designed to compare IO infusion rates using the Belmont FMS 2000 rapid infusion device and a pressure bag through the proximal tibia and proximal humerus. Investigators concluded that infusion rates were highest using the pressure bag via the proximal humerus.


Authors describe a randomized, controlled trial comparing two different IO access devices in adults in the hospital setting. Twenty patients received the BIG and 20 received the EZ-IO. Success rate on first attempt was 80% for the BIG and 90% for the EZ-IO. Mean procedure time was 2.2 minutes for the BIG vs. 1.8 minutes for the EZ-IO. Differences in success rate and procedure time were not statistically significant, and there were no significant complications for any patients. Investigators concluded that IO access is a reliable and safe method for rapid vascular access for in-hospital adult patients under resuscitation.


This article provides an overview of intraosseous vascular access and discusses general indications, contraindications, complications, and intraosseous devices.


In this study, using a swine model, investigators concluded that mild therapeutic hypothermia can be effectively induced after successful resuscitation of prolonged ventricular fibrillation through infusion of chilled saline via the IO catheter.


This abstract, presented at the 2010 ACEP Research Forum, describes study designed to determine the relative precision of intraosseous needle placement using only tactile feedback. The study also assessed the ability to access simulated osteoporotic bone without damage using the 3 methods. Investigators concluded that, using tactile feedback only, rotary power may allow precise IO catheter placement with greater success and confidence than manual or hammer-assisted devices. Powered insertion may facilitate penetration into fragile bone without damage. This research was sponsored by Vidacare Corporation.


This abstract, presented at the 2010 ACEP Research Forum, describes a study designed to determine infusion flow rates through the proximal humerus and proximal tibia. Investigators found that, at all infusion pressure levels, the humerus provided substantially greater flow rates than the tibia. They concluded that, for most situations, adequate IO infusion rates can be achieved using the tibial site, but the proximal humerus site should be strongly considered when greater infusion flow rates are required. This research was sponsored by Vidacare Corporation.


This abstract presented at the 2010 ACEP Research Forum describes a study designed to compare Lidocaine’s effect on pain during fluid infusion through the tibial and humeral IO routes. Authors concluded that, for adequate IO infusion rates with minimal and tolerable pain, 40mg of preservative-free Lidocaine may be needed; followed by a rapid normal saline syringe flush of at least 10mL and another 20mg of Lidocaine. Additional dosing and flushing may be required. For less overall pain due to IO infusion, and greater infusion flow rates, the proximal humerus should be strongly considered, using a longer IO needleset. This research was sponsored by Vidacare Corporation.
Intraosseous Vascular Access Bibliography

**EZ-IO Articles**

**Miller LJ, Philbeck TE, Montez D, Spadaccini CJ. A new study of intraosseous blood for laboratory analysis. Arch Pathol Lab Med 2010;134:1253-60.**

Authors describe a 10 subject volunteer study that compared intraosseous (IO) blood samples to venous blood samples for complete blood count (CBC) and chemistry profile testing. They concluded that IO blood may serve as a reliable alternate for hemoglobin and hematocrit levels, as well as for most analytes in a basic blood chemistry profile. Exceptions are CO₂ levels, platelets, and WBC. &nbsp;This research was sponsored by Vidacare Corporation.

**Mitchell C, Taufner D, Huebner K. Placement of the EZ-IO sternal and EZ-IO manual needle sets with and without chemical protective equipment: a cadaveric study. Prehosp Emerg Care 2010; 14: 14-5.**

In this abstract of a study presented at the 2010 National Association of EMS Physicians Meeting, researchers describe a study in which sternal and tibial IO devices were evaluated with and without chemical protective equipment. Researchers concluded that the use of the protective equipment did not affect the success rate or time to placement for the two IO devices.


This article describes an online questionnaire study in which the Heads of Department of 20 EDs in Denmark were asked about IO infusion within their institution. Nineteen responses were received; 14 hospitals (74%) reported having IO devices available with the median number of IO procedures performed as 5. In 9 departments training had not been provided and 8 departments didn’t have IO guidelines. The favored device was the EZ-IO found in 18 of the EDs, 2 had EZ-IO and Cook Surfast and 1 had the BIG.


Authors report an observational study of 14 children in whom semi-elective IO infusion was performed under anesthesia after peripheral IV had failed. IO infusion was successful for all 14 patients, using the EZ-IO system for 8 patients and the Cook system for 6 patients.

**Philbeck TE, Miller LJ, Montez D, Puga T. Hurts so good; easing IO pain and pressure. JEMS 2010;35(9):58-69**

This article describes two studies designed to compare Lidocaine’s effect on pain during fluid infusion through the tibial and humeral IO routes and to determine infusion flow rates. Authors concluded that, for adequate IO infusion rates with minimal and tolerable pain, 40mg of preservative-free Lidocaine may be needed; followed by a rapid normal saline syringe flush of at least 10mL and another 20mg of Lidocaine. Additional dosing and flushing may be required. For less overall pain due to IO infusion, and greater infusion flow rates, the proximal humerus should be strongly considered, using a longer IO needle set. &nbsp;This research was sponsored by Vidacare Corporation.


A simulation study evaluating if use of a laryngeal mask airways (LMA) and intraosseous (IO) lines established using the EZ-IO leads to improved resuscitation in a simulated cardiac arrest when compared to standard endotracheal intubation and central line placement. Results showed mean time to airway, mean duration of airway attempt, and time to vascular access was shorter in the IO group than the CVL group. Time to defibrillation and percent hand off time was not significantly different between the groups.


This abstract describes an animal study, presented at the 2010 ACEP Research Forum, that examined shear and pressure changes within the medullary space during intraosseous infusion. Results suggest that resistance to flow depends of cannula placement site, IO pressure rises rapidly with infusion rates, and medullary compression and axial shear are present at high infusion rates.


This letter to the editor is written in response to the case report by Landy titled, &quot;Complication of intraosseous administration of systemic thrombolysis for a massive pulmonary embolism with cardiac arrest.&quot; The author suggests that the tissue necrosis described by Landy may have been due to the removal of the IO needle while there was still significant fibrinolytic activity &nbsp;at the needle insertion site. The author suggests a change in medical care after return of spontaneous circulation (ROSC) in patients following thrombolytic administration through IO access to convert the functioning IO line to a non-flowing saline lock. The EZ-IO was used to provide IO access in the case report by Landy.
Intraosseous Vascular Access Bibliography

This article describes a longitudinal study of intraosseous vascular access in pre-hospital emergency medicine handled by helicopter emergency medical services. Of the 78 IO insertion attempts made on 70 patients, overall success rates were 50% using manual needles, 55% using the Bone Injection Gun, and 96% using the EZ-IO. Investigators concluded that newer IO techniques may enable faster and more reliable vascular access; and that all emergency services should be familiar with IO techniques.

Tobias JD, Ross AK. Intraosseous infusions: A review for the anesthesiologist with a focus on pediatric use. Anesthesia & Analgesia 2010;110(2):391-401
The authors describe literature that support the use of IO access for administering anesthesia in the ICU, perioperative and operating room, including a study in which IO access was used successfully for providing intraoperative anesthesia for 106 of 109 patients. Among their conclusions, the authors reported that, even though rarely reported in anesthesia literature, IO access is a technique anyone providing care to children should consider when the patient has difficult IV access. They also concluded that IO access should be a part of an algorithm that includes numbers of attempts at peripheral access, feasibility of central access and the need for continued postoperative access; and that considering that IO access may be occasionally used in the perioperative setting in both emergent and nonemergent scenarios, it may be beneficial to have appropriate IO needles in the OR.

Vizcarra C, Clum S. Intraosseous route as alternative access for infusion therapy. Journal of Infusion Nursing 2010;33(3):162-74
This article provides an overview of IO anatomy and physiology, IO access indications, care, and management; describes therapies administered via IO access; and discusses the expanding use of IO access into areas within hospitals during nonemergency clinical situations. It also includes a table addressing indications for IO access in the hospital, as well as a table addressing the general insertion procedure for IO access.

This retrospective study evaluated humeral IO placement success rates, using the EZ-IO, in the out of hospital cardiac arrest patient. Over a 9 month period, humeral placement was attempted in 247 patients. First attempt successful placement was 91%; successful placement within two attempts was 94%. The authors concluded that humeral IO is a reliable method of fluid and drug delivery in the out of hospital cardiac arrest population. This research was sponsored by Vidacare Corporation.

This study was designed to evaluate the effect of education on knowledge, attitudes and skill performance of IO access by Level 1 EMTs in Korea. After a two-hour program, the knowledge and attitude of IO access improved significantly.

In a goat study, researchers assessed the hemodynamics of hydroxocobalamin (OHCo) and normal saline (NS) by the IO route and concluded that the effects of OHCo given by the IO route in non-CN-poisoned goats are mild and well tolerated.

This letter to the editor discussed the experience of one ground emergency rescue service in Germany and their trial implementation of the EZ-IO, as compared to the David et al evaluation of the BIG by emergency physicians in which the rate of failure was 55%. Over a one year evaluation of the EZ-IO in the field, it was used in 20 patients, of which 19 were successfully placed (95%). The success of the field evaluation and a human cadaver study resulted in the addition of the EZ-IO to the receiving University Hospital emergency department.

Case report of IO infusion in 79-year old woman with hematemesis after intestinal surgery.

This article provides a general overview of intraosseous access and its use in emergency situations. A description of available IO access devices is provided.
Prospective study of 246 EMS providers at 14 EMS agencies. Reports successful IO placement in 95% of cases (18 of 19).

Training study with nurses and physicians comparing EZ-IO to IV lines under Hazmat conditions. IO procedure significantly shorter.

This article describes a study conducted at an urban Level I trauma center in Munich, Germany. Ten consecutive patients for whom PIV was difficult or impossible were simultaneously given a central line and an EZ-IO. Procedure times were measured and defined as the time the device package was taken off the shelf until the first drug or solution was administered. First attempt success rate was 90% for EZ-IO and 60% for CVC. The mean procedure times were 2.3 minutes for EZ-IO and 9.9 minutes for CVC, a clinically and statistically significant difference. Investigators concluded, because CVC was &quot;...slower and less efficacious...&quot; IO may improve the safety of patients requiring resuscitation in the ED.

This article describes a cadaver study to determine skill acquisition and performance by use of the EZ-IO system by novices. Overall success rate for the 99 operators was 97%, and mean insertion time was 6 seconds. All operators rated the device faster and easier than using a central line, and 99% expressed willingness to use the device for cardiac arrest patients.

This article describes IO use in general, and the EZ-IO in particular. The author describes its use by the emergency staff at her hospital and how they became advocates for IO access in both emergent adult and pediatric patients. She found that its use improves the quality of our care by providing vascular access to our most critical patients.

This abstract for a presentation at the 2009 ACEP Research Forum describes a swine study designed to determine the feasibility of inducing therapeutic hypothermia (TH) after resuscitation by giving an IO infusion of iced saline. Researchers concluded that rapid, large volume IO infusion of iced saline is as effective for lowering core body temperature after resuscitation as central access and peripheral IV. &nbsp;This research was sponsored by Vidacare Corporation.

This abstract describes a retrospective study to determine the time from EMS dispatch to IV or IO drug delivery, time savings to drug delivery if vascular access preceded intubation, the internal validity of that point estimate using matched cases in which IV/IO was performed first, and the theoretical increase in rate of return to spontaneous circulation. Investigators concluded that time from dispatch to IV/IO delivery could be reduced by 4 minutes if vascular access preceded intubation and could, potentially double ROSC.

This abstract for a presentation at the 2009 ACEP Research Forum describes a swine study that evaluated crystalloid fluid flow through an IO needle following nitroglycerin infusion in a swine model. Investigators concluded there was not a significant increase in flow rate after administration of IO nitroglycerin.

This abstract for a presentation at the 2009 ACEP Research Forum describes a volunteer study that examined the relationships between IO and venous blood samples when analyzed for complete blood count and chemistry profile. Researchers concluded that the IO space is a reliable source for blood used for CBC and chemistry profile. Results may be moderately reliable for carbon dioxide, but unreliable for WBC counts that appear to be elevated and platelet counts that appear lower.
Miller LJ, Philbeck TE, Montez DF, Spadaccini CJ. A new study of intraosseous blood for laboratory analysis. Arch Pathol Lab Med 2009;133:1628
This abstract for a presentation at the College of American Pathology 2009 meeting describes a volunteer study that examined the relationships between IO and venous blood samples when analyzed for complete blood count and chemistry profile. Researchers concluded that the IO space is a reliable source for blood used for CBC and chemistry profile. Results may be moderately reliable for carbon dioxide, but unreliable for WBC counts that appear to be elevated and platelet counts that appear lower.

This article describes a prospective, observational study involving a convenience sample of 25 medical students, physicians and nursing staff recruited evaluate the EZIO powered drill device on a bone model. Twenty-three (92%) of the 25 study subjects required only one attempt at placing the EZ-IO. Investigators concluded that the device was easy to use with high success rates of insertion with inexperienced participants.

This article describes a case in which IO access, using the EZ-IO, was attempted in a patient with osteogenesis imperfecta. In each of 3 attempts, the needle became loose immediately after IO insertion. The author acknowledged that during emergencies it is difficult to assess and consider every possible contraindication for every intervention; and that IO access using the EZ-IO is the author's choice for emergency vascular access when peripheral access is difficult or has failed.

Comparison of tibial and humeral IO use in 24 adults. Both sites suitable for IO infusion.

This article describes a prospective, observational study involving a convenience sample of 25 medical students, physicians and nursing staff recruited evaluate the EZIO powered drill device on a bone model. Twenty-three (92%) of the 25 study subjects required only one attempt at placing the EZ-IO. Investigators concluded that the device was easy to use with high success rates of insertion with inexperienced participants. (Note: This study was also described in an earlier article published in American Journal of Emergency Medicine)

In this 1,598 patient case series, investigators studied the effects of &quot;...serial standard of care changes...&quot; in the EMS system over time.&quot; They concluded that IO access is an essential component for a proven algorithm for the management of OOH-CA.

This article describes the first clinical study that focuses on the proximal humerus as an IO site. It is also the first article describing a comparison between IO access and peripheral IV (PIV) and central venous catheters (CVC). They found that IO catheter placement was significantly faster than PIV or CVC placement, and concluded that IO access is life-saving when PIV or CVC is difficult or impossible.

This abstract for a presentation at the 2009 ACEP Research Forum describes a volunteer study to determine the optimal Lidocaine dosing and sequencing for patients receiving fluids through the IO route and to determine if adequate fluid flow rates can be delivered through the proximal humerus IO site. Researchers concluded that for adequate IO infusion rates with minimal and tolerable pain, 40mg of preservative-free Lidocaine may be needed, followed by a rapid normal saline flush of 10ml. Additional dosing and flushing may be required. For humeral insertion, a longer IO needleset should be considered.

This article describes an observational study performed by the French military air surgical team in Chad. There were 11 patients with no insertion failures. For 7 patients, the insertion site was the proximal tibia and for the remainder the site was the proximal humerus. The authors concluded that the EZ-IO is a device that is simple, reliable and which gives satisfaction for the administration of drugs.


Shavit I, Hoffmann Y, Galbraith R, Waisman Y. Comparison of two mechanical intraosseous infusion devices: a pilot, randomized crossover trial. Resuscitation 2009; 80: 1029-33. Authors of this article describe a pilot study designed to compare the success rate for insertion and ease-of-use of the Bone Injection Gun (BIG) spring-loaded device and the EZ-IO battery-powered device on a turkey bone model. Investigators concluded that the EZ-IO demonstrated higher success rates than the BIG (28/29 vs. 19/29, p=0.016), and the EZ-IO was the preferred device.

Sunde GA, Thoresen A, Heltne J-K. Intraossøs tilgang på kritisk syke pasienter - gammel teknikk får ny heder, eller kun for spesielt interessert?. NAForum 2009;22(1):33-7. [German] This article, in German, describes the technique of IO access, the introduction of two different IO devices (Cook and EZ-IO) and describes IO use in pediatric emergency care.


Truhlar A, Skulec R, Rozsival P, Cerny V. Efficient prehospital induction of therapeutic hypothermia via intraosseous infusion. Resuscitation 2010;81(2):262-3. Epub 2009 Dec 16. This letter to the editor describes the first case reported in the clinical literature in which therapeutic hypothermia was administered using the intraosseous route. The patient, a 2-year-old boy who was found submerged in a cesspool and had been asystolic for 5-10 minutes, survived without neurological complications.

Von Hoff DD, Kuhn JG, Burris HA, Miller LJ. La perfusion intraosseuse est-elle equivalente a la perfusion intraveineuse?. Urgence Pratique 2009;36:36-40. This French version of an article previously published in American Journal of Emergency Medicine describes a 25-patient clinical study that compared the pharmacokinetics of intraosseous using the Vidaport (a predecessor of the Vidacare EZ-IO) vs. intravenous administration of morphine sulfate in adults. Results showed no differences between IO and IV administration of morphine for nearly all pharmacokinetic parameters, including maximum plasma concentration, time to maximum plasma concentration, and area under plasma concentration-time curve. There was a significant difference in the volume of distribution in the central compartment, which investigators attributed to a minor deposition effect near the IO port or in the bone marrow. Investigators concluded that the results support the bioequivalence of IO and IV administration of morphine in adults. &nbsp;This research was sponsored by Vidacare Corporation.


Wright JK, Christy RJ, Tharp RV, Kalns JE. Evaluation of intraosseous delivery of factor VIIa during hemorrhagic shock in the pig. Mil Med 2009; 174: 119-23. This swine study was designed to determine if intraosseous infusion is suitable to delivery recombinant human factor VIIa (rFVIIa) during hemorrhagic shock. Investigators concluded that administration of rFVIIa via IO infusion is a safe route for delivery and is likely to produce blood levels required to improve hemostasis during shock.
Intraosseous Vascular Access Bibliography

YEAR: 2008


This article discusses the importance of proper technique, attention to detail, and serial monitoring of limb involved when using IO vascular access to avoid potential compartment syndrome and other complications. The author reports the case of a 2-year-old boy who suffered compartment syndrome of the lower limb following use of IO infusion for resuscitation. Early detection of and response to changes in the affected limb resulted in the patient’s successful recovery.


Animal (goat) study to determine if IO administration of hydroxocobalamin for antidotal treatment for exposure to cyanide and other poison agents would be faster and require less fine motor coordination and sensitivity; and would result in similar hemodynamic changes compared to IV administration. Using the EZ-IO device, researchers concluded that hemodynamic effects of hydroxocobalamin given by the IO route in non-poisoned goats are mild and similar in magnitude to those of saline control animals.


Animal (goat) study to determine the capacity and time required for protected hazardous materials responders and receivers to accomplish vascular access and hydroxocobalamin administration for antidotal treatment for exposure to cyanide and other poison agents. Using the EZ-IO device, researchers concluded that the time required for IO administration of the drug was shorter than intravenous administration; and that IO placement is readily accomplished wearing all levels of chemical protective garments and equipment.


Study comparing manual intraosseous insertion with EZ-IO using adult human cadavers as a model. No significant difference in insertion time between &nbsp;39 manual insertions and 45 EZ-IO insertions. Found a difference in the success rate (manual, 79.5% vs. EZ-IO 97.8%, p&lt;0.01). The EZ-IO had fewer complications (manual, 15.4% vs. EZ-IO 0.0%, p&lt;0.01) and scored higher on user friendliness (school grading system: manual, 1.9±0.7 vs. EZ-IO 1.2±0.4, p&lt;0.01).


Describes the experience of the UK Defence Medical Service using the EZ-IO for emergency vascular access in Afghanistan. They used the device for 26 patients, including 10 children. Of the 26 EZ-IO placements, 23 were made in the emergency department. There was a 97% insertion success rate with no infection. Significant infusion pain was felt by three patients.


Describes common drugs used in pediatric resuscitation and &nbsp;evidence supporting their use. Also describes routes of administration including intravenous, intraosseous, and intratracheal. Describes IO systems including Bone Injection Gun, FAST-1, and EZ-IO.


This article describes IO infusion devices - including Jamshidi, Cook, WaisMed, and Vidacare devices - and placement sites. It also addresses assessment and care of the infant receiving fluids and medications through the IO route.


Large retrospective study of patients for whom emergency vascular access was obtained using the Vidacare EZ-IO intraosseous system. Insertion success was 92% and within 10 seconds for 84% of the one-attempt successful cases. Complication rate was low (4.8%), none were serious, and extravasation was the most frequent (0.8%). The device was rated easy to use 72% of the time, and researchers concluded that the powered IO device is safe and effective for achieving vascular access in the resuscitation and stabilization of emergency patients.

A retrospective clinical study was conducted to demonstrate the safety and effectiveness of the EZ-IO intraosseous access device for pediatric patients. For the 95 eligible patients in the study, successful insertion and infusion was achieved in 94% of the patients. Insertion time was 10 seconds or less in 77% of the one-attempt successful cases reporting time to insertion. There were 4 minor complications (4%), but none significant. The results of this study support the use of the EZ-IO for children in emergency situations. The complication rate suggests that the powered IO device is safe and effective for the resuscitation and stabilization of pediatric patients.


Article describing IO access.


Interim report for quasi-controlled prospective study of emergency department patients for whom emergency vascular access using the Vidacare EZ-IO intraosseous (IO) system (n=6) inserted in the proximal humerus was compared to access using central or peripheral intravenous (IV) lines (n=60). Researchers concluded that proximal humerus IO insertion is significantly faster than central or peripheral intravenous (IV) line insertion. Complications and pain profiles were similar for IO and IV techniques.


This article describes an observational study in which two intraosseous devices were compared: the Pyng Medical F.A.S.T.1 and the Vidacare EZ-IO. For the 117 patients on which the F.A.S.T.1 was used, there was an 84% success; compared to a 97% success rate for the EZ-IO (n=71).


This article describes a 25-patient clinical study that compared the pharmacokinetics of intraosseous vs. intravenous administration of morphine sulfate in adults. Results showed no differences between IO and IV administration of morphine sulfate for nearly all pharmacokinetic parameters. Investigators concluded that the results support the bioequivalence of IO and IV administration of morphine in adults.


This article describes thoracic trauma in the pediatric population. Includes a review of the assessment of pediatric patients. Circulation section of the article strongly recommends rapid intravascular volume expansion by the intraosseous route, and recommends the EZ-IO for "...quick and reliable vascular access during resuscitation ...".

YEAR: 2007


This abstract for a presentation at the 2007 American College of Emergency Physicians Research Forum describes an observational study in which the EZ-IO was used to provide emergency vascular access for 95 pediatric patients. Successful insertion and infusion was achieved in 94% of the patients, and insertion time was within 10 seconds for 81% of the placements. There were four minor and no serious complications.


This article reviews and assesses the literature on the use of IO drug administration during cardiopulmonary resuscitation. It addresses the risks and benefits of using IO in adults and children. The article describes the FDA-cleared devices available for use including the Pyng F.A.S.T.1, Waismed Bone Injection Gun and the Vidacare EZ-IO.


This review article states the availability of intraosseous (IO) needles for pediatric patients, outlines the limitations of traditional venous access, and discusses the various IO devices currently available, including the Vidacare EZ-IO®.
This article summarized the challenges and methods of providing vascular access for infants. It describes IO techniques and devices, including the Jamshidi, Cook, EZ-IO® and Bone Injection Gun (BIG) devices.


Fowler RL. Prehospital intraosseous access: elemental to the field?. Journal of Emergency Medical Services 2007; doi:http://jems.com/print/9198
Discussion of the role intraosseous vascular access can play in the prehospital setting where vascular access is often difficult or impossible to establish. The EZ-IO is named as a new IO device along with descriptions of Jamshidi, Pyng Fast 1, and BIG needles.

This article describes authors’ evaluation of provider performance using two IO devices; the Pyng Medical F.A.S.T.1™ and the Vidacare EZ-IO®. Of 89 insertions with each device, success rate for 72% for the F.A.S.T.1 and 87% for the EZ-IO, a significant difference (p=0.009). The time to fluid insertion for the EZ-IO was also faster (p=0.02). Authors noted that the EZ-IO is unique and much more useful than the F.A.S.T.1.

Article in Italian describing IO access and EZ-IO

This abstract for a presentation at the 2007 American College of Emergency Physicians Research Forum describes an observational study done at Boston Medical Center in which the Vidacare EZ-IO was used to provide emergency vascular access for 50 critically-ill adult patients. Successful insertion was achieved in 92% of the patients; with 90% success on the first attempt. There was one immediate complication—a dislodgement during transport. Investigators concluded that the device is a safe and feasible device for adult patients requiring out-of-hospital vascular care.

Results from this, study which sought to compare drug delivery time using the proximal humerus IO route to delivery time using the sternal IO route, suggest that IO proximal humerus is comparable to IO sternal for prompt drug delivery during CPR.

Overview of IO access. Includes historical aspects, current status, indications for use, advantages and disadvantages, IO kinetics, insertion sites, complications and contraindications and description of available IO devices, including EZ-IO®.

In this study, presented at the NAEMSP 2007 annual meeting, authors compared the success rate of conventional IO access with the EZ-IO during 245 cases in the prehospital setting. They concluded that using EZ-IO® results in a statistically significant increase in IO success rate, compared to conventional IO methods.

Myers BJ, Lewis R. Induced cooling by EMS (ICE): year one in Raleigh/Wake County. JEMS 2007; 32: s13-5.
This article describes the experience of the Wake County (NC) EMS System in inducing hypothermia for patients with return of spontaneous circulation after cardiac arrest. Authors describe their use of the Vidacare EZ-IO for the administration of chilled saline; with 414 placements and an overall success rate of 94%.
Intraosseous Vascular Access Bibliography

EZ-IO Articles

Potyka JS, Gordon DJ. Stories behind the numbers: IO experiences in providers’ own words. JEMS 2007; 32: s30-1.
Qualitative study focuses on EMS caregivers’ experiences with Vidacare’s EZ-IO device and personal opinions. The study used a narrative approach to gain insight from EMS practitioners working with an IO access device under real field conditions.

Pye D. NY Paramedics get the EZ-IO. Journal of Emergency Medical Services 2007; doi: http://www.jems.com/print/5184
This article in JEMS discusses an EMS system in New York following their adoption of the EZ-IO, and the advantages.

Article in Dutch describing IO access and EZ-IO.

The article describes a prospective observational study conducted by several EMS agencies in Portland, OR to determine the safety, efficacy and benefits of using the Vidacare EZ-IO in the prehospital environment. The IO device was successfully placed in 95% of the 280 cases. In 98% of the cases, placement was made within six seconds.

Study investigating time difference in obtaining IO vs. IV access while wearing personal protective equipment (PPE) in simulated HazMat scenarios. With provider in PPE and mannequin not in PPE, vascular access was faster with &nbsp;IO (14 seconds vs. 46 seconds, p&lt;0.001); also, fluid infusion time (28 seconds vs. 46 seconds, p&lt;0.001). With provider and mannequin in PPE, all the following favored IO: needle to skin time (13 seconds vs. 25 seconds, p&lt;0.001), vascular access time (17 seconds vs. 63 seconds, p&lt;0.001), and fluid infusion time (30 seconds vs. 66 seconds, p&lt;0.001). Investigators conclude that EZ-IO under HazMat conditions provides vascular access and fluid more quickly than IV access.

Article describes a controlled study in which the time difference between IV and IO access was compared while providers and simulated patients (mannequins) were wearing personal protective equipment (PPE). Twenty-two EMT-P providers measured the times to skin access, vascular access and fluid infusion in three scenarios: no PPE for providers or mannequins; providers only in PPE; and both providers and mannequins in PPE. In all scenarios, there was a statistically significant difference in vascular access and fluid infusion time, in favor of the EZ-IO. Investigators concluded that, overall, the EZ-IO provides vascular access and fluid more quickly than standard IV access, and that donning PPE does not hinder providers’ use of the EZ-IO.

Wayne MA. Intraosseous vascular access: devices, sites and rationale for IO use. JEMS 2007; 32: s23-5.
This article reviews intraosseous vascular access in general, and summarizes the various devices available. These include the Waismed B.I.G., the Vidacare EZ-IO, and Pyng F.A.S.T.1.

This article in German (with abstract in English) describes IO infusion in detail. It includes techniques, indications, complications, and recommendations. Also describes the various devices available, including Cook, Bone Injection Gun (BIG), First Access for Shock and Trauma (F.A.S.T.1), and the EZ-IO®.

YEAR: 2006

In this study, presented at the NAEMSP 2006 annual meeting, investigators reported the results of a study that evaluated the performance of the EZ-IO® compared to an earlier evaluation of the Pyng F.A.S.T.1 system. There was a statistically significant higher success rate using the EZ-IO® compared to Pyng system, and investigators concluded that the EZ-IO® appears to be a superior device with regard to insertion success.

Prospective observational study evaluating EMT-B ability to provide care in out-of-hospital cardiac arrests. Found that EMT-Bs were able to place the EZ-IO with a 94% success rate. Median time to placement was 72 seconds.

Hoskins SL, Kramer GC, Stephens CT, Zachariah BS. Efficacy of epinephrine delivery via the intraosseous humeral head route during CPR. Circulation 2006;114:II_1204

Results from this study which sought to determine the efficacy of intraosseous drug delivery using the proximal humerus during CPR in swine showed that the humeral route generated higher mean arterial pressures than central venous or endotracheal delivery.


Article in French describes IO access and IO devices, including B.I.G., F.A.S.T.1 and EZ-IO®.


The author provides an overview of intraosseous vascular access discussing evolution of the practice, equipment, treatment options and contraindications.

YEAR: 2005


Observational study evaluating use of the EZ-IO®. Found 97% success rate for insertion and infusion into the IO space by paramedics, nurses, physicians and other EMS personnel in using the device for emergency vascular access. No serious complications reported.


Article describes intraosseous access for adults and pediatrics. Describes and discusses IO devices available including Jamshidi, Bone Injection Gun, F.A.S.T.1, and EZ-IO®.


Observational study of initial use of the EZ-IO® in 125 patients by EMS providers. Found 94% success rate for insertion and infusion into the IO space. No complications reported.

Heightman AJ. The rebirth of adult IO: a first-hand account of recent advances in intraosseous infusion for adults, drawn from a scientific workshop and practical lab experience. JEMS 2005;30(10):s4-7.

Editorial article highlighting recent advances in intraosseous (IO) infusion and IO devices based on the author’s experience at a scientific seminar hosted by Vidacare. Makes recommendations on the efficiency and safety of the devices.


This animal study compared IO drug delivery in the tibia versus the sternum during CPR. Researchers concluded that during CPR IO infusions delivered via both sites were effective—although sternal delivery was faster; and that IO sternum access is comparable to IV access for drug delivery during CPR.


This study abstract discusses use of the EZ-IO to determine the pharmacokinetics (PK) and efficacy of tibial IO drug delivery during treatment of cardiac arrest in the swine model, as compared to IV access. Results showed that PK analysis of IO drug delivery via the tibial route showed a delay of 20-50 seconds compared to IV; however, physiologically significant levels of epinephrine were reached as MAP. This research was sponsored by Vidacare Corporation.

Animal study compared the sternal and tibial routes for IO drug delivery during CPR. Investigators concluded that both the sternal and tibial routes can effectively deliver near equivalent doses during CPR in swine.

http://www.aemj.org/cgi/content/abstract/12/5_suppl_1/67

Miller LJ, Kramer GC, Bolleter S. Rescue access made easy: Intraosseous infusion, once limited to use in children, is now becoming a reliable access site for adults. JEMS 2005;30:s8-18.

Overview of IO therapy. Includes "10 Myths about Adult IO," and description of available IO devices, including EZ-IO®