

YEAR: 2015

- Anson JA, Sinz EH, Swick JT. The versatility of intraosseous vascular access in perioperative medicine: a case series. J Clin Anesth 2015;27(1):63-7. <http://dx.doi.org/10.1016/j.jclinane.2014.10.002>** 729
- This article presents a 5-case series describing use of IO vascular access by anesthesiologists in the perioperative and critical care settings. All insertions were made in the proximal tibia and there were no adverse events reported. The devices cited as being used were the EZ-IO and the Cook Surfcast manual needle. A proposed perioperative vascular access algorithm incorporating IO access is presented. The authors address key topics around IO access including use of same drug dosing as IV administered drugs, frequent palpation and monitoring of the insertion site for extravasation, low complication rate and actual risks associated with fat emboli and bone injury, pain and anxiety management in the awake patient and clinician-perceived pain. Administration of blood products, ACLS drugs, Lactated Ringer's solution and anesthetics are noted without complication. Use of IO aspirate for laboratory testing is noted, however use of the initial aspirate is indicated. Several patients in the case series were reported to find the discomfort of IO insertion preferable to multiple intravenous attempts. The authors concluded: IO lines can be placed quickly and safely in emergency situations or in elective surgical patients with difficult intravenous access; IO access can be useful in a wide variety of clinical settings; and is an important skill for anesthesiologist to learn.
- Frascone RJ, Salzman JG, Adams AB, Bliss P, Wewerka SS, Dries DJ. Evaluation of intraosseous pressure in a hypovolemic animal model. J Surg Res 2015;193(1):383-90. <http://dx.doi.org/10.1016/j.jss.2014.07.007>** 736
- Preclinical study to determine whether intraosseous pressure (IOP) could be consistently recorded and similarity of IOP to central venous and arterial pressure in a porcine hemorrhagic shock model. IOP tracings were tracked reliably from the proximal humerus, distal femur, and proximal tibia. Baseline IOP ranged from 16-18 mm Hg among the three sites, which was approximately 23% of arterial pressure. This study was sponsored by Vidacare LLC.
- Grabel Z, DePasse JM, Lareau CR, Born CT, Daniels AH. Intra-articular placement of an intraosseous catheter. Prehosp Disaster Med 2015;30(1):1-4. doi:10.1017/S1049023X14001290** 741
- Case report of a prehospital misplacement of an IO catheter into the intra-articular space of the knee joint when access was attempted in the field. Upon ED arrival IO placement was noted to be high and intra-articular placement was confirmed by xray. A sterile NS lavage was done and patient recovered without complication. Authors note this as a previously unidentified complication of IO placement and advise xray confirmation of affected sites with follow-up of intra-articular placements for the septic arthritis. (Picture of site appears to be an EZ-IO).
- Helm M, Haunstein B, Schlechtriemen T, Ruppert M, Lampf L, Gäßler M. EZ-IO® intraosseous device implementation in German Helicopter Emergency Medical Service. Resuscitation 2015;88:43-7. <http://dx.doi.org/10.1016/j.resuscitation.2014.12.015>** 737
- Retrospective analysis of IO needle insertions performed in all HEMS missions during the first three years (2009-2011) using the EZ-IO® system. Overall success rate of EZ-IO procedures (N=348) was 99.6%, with a first attempt success rate of 85.9%; and high user satisfaction rate of 93%. IO as access was mostly second line overall but first line in children <7, trauma and cardiac arrest. There was 1 failure and 4 needle insertion problems noted; no serious complications.
- Germany
- Pasley J, Miller CHT, DuBose J, et al. Intraosseous infusion rates under high pressure: a cadaveric comparison of anatomic sites. J Trauma Acute Care Surg 2015;78(2):295-9. DOI: 10.1097/TA.0000000000000516** 750
- A cadaveric study evaluating intraosseous (IO) vascular access insertion sites for attainable flow rates under 300 mmHg. The EZ-IO was used to establish IO access at the proximal humerus and proximal tibia sites; the FAST1 was used to establish sternal IO access. The total volume of fluid infused at the three IO access sites was 469 ± 190 mL for the sternum; 286 ± 218 mL for the humerus; and 154 ± 94 mL for the tibia. The mean flow rate infused at each site was as follows: 93.7 ± 37.9 mL/min for the sternum; 57.1 ± 43.5 mL/min for the humerus; and 30.7 ± 18.7 mL/min for the tibia. First attempt placement success was 100% for the sternum and proximal humerus and 81% for the tibia.
- Rubal BJ, Meyers BL, Kramer SA, Hanson MA, Andrews JM, DeLorenzo RA. Fat intravasation from intraosseous flush and infusion procedures. Prehosp Emerg Care 2015;19(3):376-90. doi: 10.3109/10903127.2014.980475** 748
- This preclinical study evaluated the occurrence of fat intravasation resulting from intraosseous (IO) flush and infusion in anesthetized swine. Intravasated fat was assessed using a lipophilic fluoroprobe (Nile red) and by vascular ultrasound imaging. Fat intravasation was observed during all IO infusion regimens, with subclinical pulmonary fat emboli persisting 24 hours post infusion. It was noted that initial flush was a significant factor in fat intravasation, low levels of intravasation occurred with infusions ≤300 mmHg, fat intravasation and bone marrow shear-strain increased with IO infusion rates, and intravasation was influenced by cannula insertion site.

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Bibliography

- Strandberg G, Larsson A, Lipcsey M, Michalek J, Eriksson M. Intraosseous and intravenous administration of antibiotics yields comparable plasma concentrations during experimental septic shock. Acta Anaesthesiol Scand 2015;doi: 10.1111/aas.12454** 738
Preclinical study using a porcine model to determine whether there were differences in intraosseous (IO) and intravenous (IV) antibiotic (cefotaxime and gentamicin) concentrations during septic shock. Both methods of administration yielded comparable concentrations. Authors concluded in an emergency, IO administration of these antibiotics may be considered in severe infections when venous access is difficult
Sweden
- YEAR: 2014**
- Abbal B, Perbet S, Pereira B, et al. Utilisation de la voie intraosseuse chez l'adulte en France en 2012 [Use of the intraosseous access in adult patients in France in 2012]. Annales Francaises d'Anesthesie et de Reanimation. 2014;http://dx.doi.org/10.1016/j.annfar.2014.02.006** 696
This article in French is a survey of residents and doctors in France that practice in ED, ICU and anesthesiologists units seeking their opinions and practice habits in regard to IO access. Only 29% had ever used an IO kit; with a correlation between years of experience in practice and use of IO access. 555 had received some IO access training; 90% of untrained doctors believed training was necessary. The powered system was the most utilized (EZ-IO).
France
- Barlow B, Kuhn K. Orthopedic management of complications of using IO catheters. Am J Orthop 2014;43(4):186-90** 694
Literature search for complications associated with IO access included 5759 patients with overall complication rate of 2.1 %. Two cases involving retained needle fragment discussed; one with a proximal tibial EZ-IO that required surgical removal. Authors concluded IO catheters are reliable tools for fluid and drug delivery to critically ill patients with low complication rates (which can be potentially serious but managed).
- Barnard EBG, Moy RJ, Kehoe AD, Bebartá VS, Smith JE. Rapid sequence induction of anesthesia via the intraosseous route: a prospective observational study. Emerg Med J 2014;doi:10.1136/emmermed-2014-203740** 702
A prospective observational study that evaluated use of intraosseous vascular access for delivery of rapid sequence intubation (RSI) drugs. Data was collected between January and May 2012 at a combat hospital in Afghanistan. Thirty-four (34) patients underwent RSI with drug delivery via the IO route. Access was established in the proximal humerus and tibia using the EZ-IO and in the sternum using the FAST-1. All placements were successful on first attempt; first pass intubation success rate was 97%; a Cormack-Lehane (C-L) laryngoscopic grade view of 1 was reported 91%. Authors concluded that IO access is a safe and feasible route for delivery of anesthetic drugs for RSI.
- Bebartá VS, Vargas TE, Castaneda M, Boudreau S. Evaluation of extremity tissue and bone injury after intraosseous hypertonic saline infusion in proximal tibia and proximal humerus in adult swine. Prehosp Emerg Care 2014;doi:10.3109/10903127.2014.912704** 697
Randomized comparative study of adult pigs infused intraosseously with either: 7.5% hypertonic solution (HTS), 3% HTS or normal 0.9% isotonic saline. The animals were observed daily for infection, necrosis and gait up to 5 days, then necropsy and histological analysis was performed for tissue necrosis. Observations included regular tissue morphology and normal gait scores over the 5 day observation period; and absence of gross tissue necrosis and microscopic ischemia post IO HTS infusion in this swine model. Authors concluded this study confirms the clinical safety of IO HTS infusion and its use as an alternative lifesaving treatment.
- Burgert J, Mozer J, Williams T, et al. Effects of intraosseous transfusion of whole blood on hemolysis and transfusion time in a swine model of hemorrhagic shock: a pilot study. AANA Journal 2014;82(3):198-202** 733
Preclinical study using a porcine model to determine whether there were differences in intraosseous (IO) and intravenous (IV) whole blood transfusion relative to hemolysis and transfusion time. IO transfusion does not significantly increase hemolysis (using free hemoglobin as outcome measure) or transfusion time compared with IV transfusion. Authors concluded transfusion of whole blood through an IO device is an effective transfusion method that may be used until other vascular access is obtained.
- Cullen PM. Intraosseous cannulation in children. Anaesth Intensive Care Med 2014;15(12):567-9** 734
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.
UK

Bibliography

- Danz M, Schulz G, Hinkelbein J, Braunecker S. Breaking the needle: A rare complication on EZ-IO removal.. Eur J Anaesthesiol 2014;31:172-80** 742
 This letter to the editor describes a single case of a needle breaking off after a proximal tibial insertion of the EZ-IO into a volunteer (one of the letter's authors) during a training session. "Divergent from manufacturer instructions the sterile steel stylet was put back into place to achieve better grip for a manual pull-out. Under steady pull in strict axial alignment and gentle clockwise turn, the needle broke away from the plastic connector". The needle was extracted using combination pliers and there is no evidence of damage to the leg. Authors acknowledge this can be avoided by adherence to manufacturer's directions for use.
Germany
- Demir OF, Aydin K, Akay H, Erbil B, Karcioğlu O, Gulalp B. Comparison of two intraosseous devices in adult patients in the emergency setting: a pilot study. Eur J Emerg Med 2014;DOI:10.1097/MEJ.0000000000000187** 735
 This was a prospective, randomized controlled clinical pilot study comparing the BIG and EZ-IO intraosseous (IO) vascular access devices in 52 adult patients admitted to an emergency department with difficult peripheral venous access. Twenty-six patients were randomized to each device; results were first attempt insertion success BIG 92.3%, EZ-IO 84.6% (P=0.668); procedure time: BIG 2.8 ± 1.2 seconds, EZ-IO 5.2 ± 2.2 seconds (P<0.001), significant; difficulty of use (with visual analogue scale): BIG 8.6 ± 6.4 mm, EZ-IO 25.4 ± 12.6 mm (P<0.001), significant. Authors concluded both EZ-IO and BIG are shown to be reliable and safe methods for insertion of intravascular access in emergency conditions. There were no adverse events or complications reported.
Turkey
- Derikx HJGM, Gerritse BM, Gans R, vander Meer NJM. A randomized trial comparing two intraosseous access devices in intrahospital healthcare providers with a focus on retention of knowledge, skill, and self-efficacy. Eur J Trauma and Emerg Surg 2014;doi:10.1007/s00068-014-0385-8** 706
 This article describes a randomized trial comparing the retention knowledge, skill and self-efficacy among anesthesiologists and registered nurses of anesthesia with use of the EZ-IO and Bone Injection Gun (B.I.G.). Participants were randomized to be trained on one device and were tested at 0, 3, and 12 months post training. The authors concluded that training anesthesiologists on use of the EZ-IO with the educational tools provided by the manufacturer will ensure optimal performance for a period of one year.
The Netherlands
- Dev SP, Stefan RA, Saun T, Lee S. Insertion of an intraosseous needle in adults. N Engl J Med 2014;370(24):e35(1)-e35(5). Doi:10.1056/NEJMvcm1211371** 700
 Text article that accompanies video featured in The New England Journal of Medicine on intraosseous access which provides a general overview of IO access and demonstration of IO insertion using the EZ-IO and one manual IO needle set.
- Johnson D, Dial J, Ard J, et al. Effects of intraosseous and intravenous administration of Hextend on time of administration and hemodynamics in a swine model. J Spec Oper Med 2014;14(1):79-85** 713
 A preclinical study comparing intraosseous (IO) and intravenous (IV) administration of Hextend in 27 swine for time of administration and hemodynamics. IO access was established in the proximal humerus using the EZ-IO. Results showed time for administration was not significant; there were no significant differences between IV and IO relative to hemodynamics. The author concluded that the IO route is an effective method of administering Hextend
- Kurowski A, Timler D, Evrin T, Szarpak T. Comparison of three different intraosseous access devices for adults during resuscitation: randomized cross-over manikin study. Am J Emerg Med 2014;32:1490-3. DOI: http://dx.doi.org/10.1016/j.ajem.2014.09.007** 739
 Manikin study conducted in Poland with 107 paramedic operators designed to investigate the success rate, time of insertion and perceived difficulty of intraosseous access devices during simulated resuscitation using the EZ-IO, Bone Injection Gun and Jamshidi needles. Results were first attempt success: B.I.G.: 91.59%; EZ-IO: 82.66%; Jamshidi: 47.66%; mean procedure time: B.I.G.: 2.0 min ± 0.7; EZ-IO: 3.1 min ± 0.9; Jamshidi: 4.2 min ± 1.0; and ease of use (1-very easy to 5-very hard): B.I.G.: 1.83; EZ-IO: 2.92; Jamshidi: 4.68.
Poland
- Lewis P, Wright C. Saving the critically injured trauma patient: a retrospective analysis of 1000 uses of intraosseous access. Emerg Med J 2014;31(9):784. doi:10.1136/emered-2014-203588** 714
 This retrospective study reported IO use over a 7-year period during combat operations in Afghanistan by the UK Defence Medical Services. The EZ-IO and FAST1 IO devices were available for use; IO use data was collected from the front line, during helicopter evacuation and at the combat hospital. A total of 1014 IO devices were inserted into 830 adult patients; various medications infused via IO access are listed. Across all cases there were no serious IO complications and 14 minor complications. The author concluded that in the pre-hospital setting in particular and in severely injured trauma patients, IO access should be considered a primary method of obtaining vascular access.

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- Case study of 36 year-old in septic shock with co-morbidities of IV drug abuse, endocarditis, tricuspid valve insufficiency and pulmonary embolism. Initially impossible to obtain PIV or CVC access; then unable to give desired fluids through 22 gauge PIV when finally placed. Proximal humerus IO access was established with the EZ-IO 45 mm needle set and the patient was resuscitated with 30 mL/kg fluids and multiple medications given in first hour. Conclusions included that CVCs are not always possible and volume treatment with an IO placed sooner rather than later, especially in children but also in adults, can be lifesaving. IO systems should be extensively available throughout the clinical setting. Article in German.
Germany
- Loughren M, Banks S, Naluan C, Portenlanger P, Wendorf A, Johnson D. Onset and duration of intravenous and intraosseous Rocuronium in swine. West J Emerg Med 2014;XV(2):241-5** 721
- A preclinical study comparing the time to onset, time to onset peak, and time to recovery of peripheral intravenous and tibial intraosseous administration of Rocuronium. Study results demonstrated there was no statistical difference from the time of administration to complete neuromuscular blockade between the IO and IV administration of Rocuronium; and the recovery of neuromuscular function was significantly longer after IO administration, however was not deemed clinically significant. The authors concluded that Rocuronium can effectively be used via the IO route without the need for dose adjustments.
- Martin Reyes B, Abolafia del Balazo R, Estepa Sanchez A, Garcia Cazalilla M, camara Anguita S, Rojas Jimenez AM. Emergencies medical services: intraosseous drill in CPR. Resuscitation 2014;85(S):S24** 715
- This abstract describes an observational study evaluating use of the intraosseous drill (EZ-IO) in 20 patients assisted by EMS and receiving CPR within a 3 year period. The study includes 4 pediatric and 16 adult patients. The authors concluded that IO access is a reliable alternative to peripheral venous access and can be implemented fast and with high success rate of CPR in which drugs and fluids are given.
Spain
- Nadler R, Gendler S, Chen J, Lending G, Abramovitch A, Glassberg E. The Israeli Defense Force experience with intraosseous access. Military Medicine 2014;179(11):1254-7** 740
- Retrospective study of the Israeli Defense Force (IDF) registry from January 1999 through October 2012 to identify all cases in which IO access was attempted. The Bone Injection Gun (B.I.G.) was the device used for IO access. A total 37 attempts were made in 30 patients. First attempt success was 53% with an overall success rate 49% when factoring subsequent attempts. Most frequent cause for failure related to providers skill level, and due to the device design allowing little room for error. This study prompted the IDF to seek an alternative for the B.I.G.
Israel
- Neuhaus D. Intraosseous Infusion in elective and emergency pediatric anesthesia: when should we use it?. Curr Opin Anaesthesiol 2014;27(3):282-7. DOI: 10.1097/ACO.000000000000069** 723
- General review of IO access, with particular attention to perioperative setting and includes published guidelines of the German Scientific Working Group for Pediatric Anesthesia for use of intraosseous access. The author recommends that for children with known difficult venous access physicians discuss the possibility of IO access preoperatively with the family.
Switzerland
- Oesterlie GE, Petersen KK, Knudsen L, Henriksen TB. Crural amputation of a newborn as a consequence of intraosseous needle insertion and calcium infusion. Ped Emerg Care 2014;30(6):413-4** 699
- Case study of newborn girl resuscitated with 15 mm EZ-IO catheter placed to her right proximal tibia. Medications given included antibiotics, "fluids" and calcium. Demarcation of the infants skin was noted immediately post-calcium administration; with progression to necrosis. Trans-tibial amputation was performed 1.5 months after initial IO access. Authors concluded calcium extravasation most likely caused the injury but were unable to identify extravasation cause; citing possible needle displacement. Cautionary steps to reduce risk emphasized by authors.
Denmark

Bibliography

- Pasley J, Miller C, Dubose J, et al. Intraosseous infusion rates under high pressure: a cadaveric comparison of anatomic sites. 2014 Annual Scientific Assembly for the Eastern Assoc for the Surgery of Trauma meeting. <http://www.dtic.mil/cgi-bin/GetTRDoc?AD=ADA597324>. Published January 2014. Accessed May 12, 2014** 728
- This report describes a study conducted by the Air Force Research Laboratory comparing intraosseous infusion rates between IO sites in a cadaveric model to determine if there is a site that is most effective for volume resuscitation. Using 16 cadavers procured within 72 hours of death, IO access was established in the proximal tibia and proximal humerus using the EZ-IO and in the sternum using the FAST1. Results showed the mean flow rate in the sternum was 1.6 times greater than the humerus and 3.1 times greater than the tibia. An abstract describing this report was presented by oral presentation at the 2014 annual scientific assembly for the Eastern Association for the Surgery of Trauma meeting.
- Polat O, Oguz AB, Comert A, Demirkan A, Gunalp M, Tuccar E. Intraosseous access learning curve; is it really practical?. *Am J Emerg Med* 2014; 32(12):1543-4.doi: 10.1016/j.ajem.2014.09.018** 747
- This letter to the editor describes a cadaver study performed by 50 interns who had never performed IO insertion, to determine if there is a learning curve associated with use of the EZ-IO for establishing IO vascular access in the proximal tibia. Following training each intern performed 10 IO insertions and were timed. The results showed a difference between the first and the eighth attempts resulting in a decrease in time to insertion by half. The authors concluded that practice insertions are necessary to become comfortable with the device.
Turkey
- Rush S, D'Amore J, Boccio E. A review of the evolution of intraosseous access in tactical settings and a feasibility study of a human cadaver model for a humeral head approach. *Rush S, D'Amore J, Boccio E*** 726
- This article explores use of IO vascular access in combat and tactical settings through a brief review of the literature describing this practice. A small feasibility study is discussed that evaluated the use of cadavers for training 26 U.S. Air Force Pararescuemen (PJs) on establishing IO access in the humeral head using the EZ-IO, both drill-assisted and manually inserted needles. First attempt placement success with the EZ-IO drill was achieved in 25 of 26 attempts; first attempt placement success using the manual occurred in 19 of 21 attempts. The authors concluded that the humeral head IO site is the most appropriate site within the tactical setting; and that use of a human cadaver model for training is an appropriate model.
- Schlump CJ, Solomon C, Keibl C, et al. Recovery of fibrinogen concentrate after intraosseous application is equivalent to the intravenous route in a porcine model of hemodilution. *J Trauma Acute Care Surg* 2014;76(5):1235-42** 717
- A preclinical study comparing the recovery of fibrinogen in a porcine model when fibrinogen concentrate is administered via IV and IO access. The study results suggested intraosseous administration of fibrinogen concentrate results in a recovery of fibrinogen similar to that of intravenous administration.
- Sontgerath JS, Rubal BJ, DeLorenzo RA, Morgan TL, Ward JA. Variability in intraosseous flush practices of emergency physicians. *Am J Emerg Med* 2014;<http://dx.doi.org/10.1016/j.ajem.2014.03.001>** 719
- This prospective study sought to evaluate intraosseous flush practices of emergency physicians. Using cadavers, 15 emergency physicians were asked to flush an IO catheter placed in the proximal tibia and proximal humerus IO insertion sites with 10 mL normal saline as they would in clinical practice; IO pressure measurements were recorded using an IO catheter inserted in the diaphysis of the target bones. Results showed the median IO pressure generated was 903 mmHg and the median flush duration was 5.2 seconds. Result showed significant interoperator variability with greater than 35-fold difference in flush forces. The authors concluded that it may be prudent practice for providers to extend the flush over several seconds to limit the maximal pressures.
- Winkler M, Talley C, Landwehr K, et al. Use of intraosseous needles for power injection of iodinated contrast media for emergency computed tomography angiography. *J Cardiovasc Comput Tomogr* 2014;9th annual scientific meeting abstracts:S76-7** 701
- Abstract presented at the Society of Cardiovascular Computed Tomography on preliminary findings of an observational study done after training ER physicians and techs on intraosseous (IO) catheter use and implementation of a policy for IO access use. Authors report high injection rates and excellent computed tomography angiography (CTA) scans safety with use of an IO for power injection of iodinated contrast media (ICM). Authors concluded cardiovascular imaging physicians, surgeons, ER physicians, and CT technologists should be familiar with the techniques of IO needle placement and use for power injection of ICM for CTA. The diagnosis and treatment of critically ill and unstable patients may be hastened by this technique.
- YEAR: 2013**
- Ahrens KL, Reeder SB, Keevil JG, Tupesis JP. Successful computed tomography angiogram through tibial intraosseous access: a case report. *J Emerg Med* 2013;<http://dx.doi.org/10/1016/j.jemermed.2012.11.091>** 632
- 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.

Bibliography

- Bloch SA, Bloch AJ, Silva P. Adult intraosseous use in academic Eds and simulated comparison of emergent vascular access techniques. Am J R Emerg Med 2013. <http://dx.doi.org/10.1016/ajem.2012.11.021>** 652
- 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).
- Byars DV, Tsuchitani SN, Yates J, Knapp B. A multijurisdictional experience with the EZ-IO intraosseous device in the prehospital setting. Am J Emerg Med 2013. <http://dx.doi.org/10.1016/j.ajem.2013.08.056>** 656
- This letter to the editor describes a prospective, observational, trial that evaluated use of the EZ-IO in critically ill and injured patients (adult and pediatric) in a multijurisdictional prehospital setting; 9 EMS agencies were included. The 25mm needle set was the only needle size allowed for the study. One-hundred-eleven EZ-IO placements were performed by EMT-Intermediates and EMT-Paramedics with 96 successful placements (86.5%); the most common cause for failure reported by the author was thought to be patient obesity and inadequate needle length. Cardiac arrest patients made up 74.7% of the study population and the most common site accessed was the proximal tibia. Device operators rated the ease of use 7.87 using a 0 to 10 scale where 10=extremely easy.
- Dolister M, Miller S, Borron S, et al. Intraosseous vascular access is safe, effective and costs less than central venous catheters for patients in the hospital setting. J Vasc Access 2013;14(3):216-24. doi:10.5301/jva.5000130** 583
- 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.
- Erdmann L, Doll S, Ihle B, Kirsch J, Mutzbauer TS. Evaluation of the sternal intraosseous route as alternative emergency vascular access for the dental office: a manikin and cadaver model pilot study. Oral Surg Oral Med Oral Pathol Oral Radiol 2013;116(6):686-91** 657
- This article describes a mannequin and cadaver study that evaluated use of the EZ-IO sternal device and the Illinois needle to establish sternal IO vascular access by dental students. Results of the cadaver study showed two cases of perforation of the posterior sternal cortex when the Illinois needle was used and one EZ-IO insertion in the soft tissue without entering the IO space. The authors concluded use of the EZ-IO sternal device with the insertion site template and scalpel incision may be more efficient and less predisposed to complication than use of the Illinois needle.
- Fetissov H, Nadaud J, Landy C, Millot I, Paris R, Plancade D. Amines on intraosseous vascular access: A case of skin necrosis. Ann Fr Anesth Reanim 2013;32(5):e89-90.<http://dx.doi.org/10.1016/j.annfar.2013.02.022>** 644
- 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.
- Frascone RJ, Salzman JG, Bliss P, Adams A, Wewerka SS, Dries DJ. Decreasing intraosseous pressure and increasing respiratory variability track fluid volume reduction in a porcine hypovolemia model. Ann Emerg Med 2013;62(4S):S14** 666
- A pre-clinical study that evaluated use of intraosseous (IO) pressure as an indicator of changes in fluid volume status during a hemorrhagic shock protocol. Central venous and arterial pressures were used as comparators. Results showed IO pressure decreased consistently during the controlled shock protocol. Authors concluded IO pressure appears to be equivalent to CVP as an indicator of fluid volume status. This study was sponsored by Vidacare Corporation.
- Frascone RJ, Salzman JG, Bliss P, Adams A, Wewerka SS, Dries DJ. Intraosseous pressure tracings mimics arterial pressure tracings in timing and contour. Ann Emerg Med 2013;62(4S):S13 - 4** 665
- A pre-clinical study that compared intraosseous (IO), central venous and arterial pressure tracings in a porcine model. Results showed that IO pressure was approximately 25% of arterial pressure. A sampling of IO blood gases revealed oxygenation levels of venous blood. This study was sponsored by Vidacare Corporation.

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- A case study describing intraosseous pressure monitoring, through tibial IO access, using a standard arterial pressure monitoring transducer during resuscitation of a 31-year-old male in cardiac arrest. Pressure readings were recorded for approximately 53 minutes and were compared to non-invasive blood pressure cuff monitoring at the same time points. IO systolic, diastolic and mean IO pressures were approximately 40% of arterial pressures. This is the first case report demonstrating IO space has a measureable blood pressure and it correlates with pressure obtained through conventional techniques.
- Grossman V. Hot Topics: CT contrast and intraosseous lines: friends or enemies?. J Radiol Nurs 2013; 32(1):41-4. http://dx.doi.org/10.1016/j.jradnu.2012.12.004** 643
- 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.
- Hafner JW, Bryant A, Huang F, Swisher K. Effectiveness of a drill-assisted intraosseous catheter versus manual intraosseous catheter by resident physicians in a swine model. Western Journal of Emergency Medicine 2013;XIV(6):629-32** 668
- This is a preclinical study comparing the EZ-IO and the Cook manual IO needle when used by 21 resident physicians to establish IO access in anesthetized swine. Results showed the drill-assisted needle was successfully placed 100% of attempts vs 76.2% successful placement with manual; time to placement and user preference also favored the EZ-IO. Technical issues reported included bending of the manual needle 33% of attempts.
- Hallas P, Brabrand M, Folkestad L. Complication with intraosseous access: Scandinavian users' experience. West J Emerg Med 2013;14(5):440-3. doi:10.5811/westjem.2013.1.1200** 669
- A questionnaire study in which Scandinavian emergency physicians, anesthesiologist and pediatricians reported complications they have experienced with IO vascular access based on recollection alone. Complications were reported related to establishing IO access and using established IO access. Out of 1,802 IO cases reported by 386 responders, the most frequently reported complications included difficulty with periosteum penetration and bone marrow aspiration when establishing IO access; and slow infusion and needle displacement with established IO access. Osteomyelitis and compartment syndrome were reported with an occurrence of 0.4% and 0.6%. Researchers concluded that potential complications following IO insertion should be addressed during training. Devices discussed included the EZ-IO, BIG, Cook-Surfast, and other unidentified IO devices
Denmar
- Helm M, Richter D, Schramm A, Lampl L, Hossfeld B.. Ist die intraossare punktion ein alternativer gefabzugang beim notfall in der zahnarztlichen praxis?. Notfall Rettungsmed 2013;16:27-32. Doi:10.1007/s10049-012-1629-y** 612
- 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.
German
- Hunsaker S, Hillis D. Intraosseous vascular access for alert patients. Am J Nurs 2013;113(11):34-9** 672
- This article presents an overview of IO access focused on nurses' use of the technique. A list of available devices, history and support for use and possible complications are included.
- Junkin R, Litchfield K. Intraosseous vascular access skill acquisition in labour ward staff: results of a training programme. Int J Obstet Anesth 2013;22(1):S31** 674
- This abstract describes a study in which 66 obstetric anesthetists, obstetricians and midwives were training on the EZ-IO and evaluated for successful application of the skill in a mannequin study. The participants also completed a survey following their insertion attempt regarding their perceived ease of use and likeliness to consider IO use in the future. Results showed first attempt success was 95.5%; respondents indicated they found the EZ-IO to be easier than establishing PIV access and 100% indicated they would consider IO use in the future.
UK
- Junkin R, Selfridge J, Litchfield. Intraosseous vascular access in obstetric emergencies: an OAA approved national survey. Int J Obstet Anesth 2013; 22(1):S31** 673
- This abstract describes the results of an online survey taken by members of the Obstetric Anaesthetists' Association, evaluating use of IO access in obstetric emergencies, and availability of IO equipment on UK labor wards. Results showed many members are trained on IO access, consider it a viable option during emergencies however have limited access to equipment.
UK

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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.
- Lairet J, Bebarta V, Lairet K, et al. A comparison of proximal tibia, distal femur, and proximal humerus infusion rates using the EZ-IO intraosseous device on the adult swine (Sus scrofa) Model. Prehosp Emerg Care 2013;17:280-284.** 642
Doi:10.3109/10903127.2012.755582
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.
- Lee BK, Jeung KW, Lee HY, et al. Confirmation of intraosseous cannula placement based on pressure measured at the cannula during squeezing the extremity in a piglet model. Resuscitation 2013.<http://dx.doi.org/10.1016/j.resuscitation.2013.09.001>** 678
In this pre-clinical study, investigators sought to determine if the pressure readings at the proximal tibia IO site served as a good indicator of proper IO placement when the foot of the limb was squeezed. Traditional methods used to determine correct IO placement, including needle stability, aspiration of blood, and easy infusion, were used as comparators. Results showed the increased pressure reading at the IO site successfully predicted correct IO placement in all cases; traditional methods did not consistently correctly identify proper IO needle placement.
- Lewis GC, Crapo SA, William JG. Critical skills and procedures in emergency medicine- vascular access skills and procedures. Emerg Med Clin N Am 2013;31(1):59-86. doi: 10.1016/j.emc.2012.09.006** 631
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>** 615
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.
- Mills A, Pappin D, Field V, Thorp-Jones D. Intraosseous access in the peripartum patient: is your needle long enough?. Int J Obstet Anesth 2013;22(1):S30** 675
This abstract describes a study in which the investigators sought to determine the approximate patient population in which the 25mm EZ-IO needle set was sufficient length to establish IO access in peripartum patients. Ultrasound was used to determine the tissue depth at four insertion sites. Twenty-six women were recruited with a median gestation of 34 weeks. In 88% of patients with a BMI<40 kg/m² the 25mm needle is sufficient to reach the bone marrow at both tibial sites. For the humeral site, IO placement may be more difficult for patients with a BMI>25 kg/m².
UK
- Montez DF, Puga TA, Garcia MR, et al. Intraosseous blood correlates with venous blood in healthy subjects using point-of-care analyzers. Ann Emerg Med 2013;62(4S):S40** 676
A clinical study evaluating the relationship between IO blood and peripheral venous blood lactate levels analyzed using the i-STAT point-of-care analyzer in healthy volunteers. Results showed IO blood lactate levels were comparable to venous blood lactate levels with a positive statistical correlation. This study was sponsored by Vidacare Corporation.
- Oksan D, Ayfer K. Powered intraosseous device (EZ-IO) for critically ill patients. Indian Pediatrics 2013;50(7):689-91** 685
A retrospective chart review evaluating use of the EZ-IO in 25 pediatric patients between July 2008 and August 2010 at a Turkish university affiliated hospital. All attempts were made in the proximal tibia and IO access was attempted following failed PIV access within 60 seconds. First attempt success was 80%; the most reported complication was simple extravasation (3 cases) and needle dislodgement (1
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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

Pozza M, Lunardi F, Pflipsen M. Emergency intraosseous access: a useful, lifesaving device use in Afghanistan. J Spec Oper Med 2013;[13\(1\):25-8](http://dx.doi.org/10.1016/j.som.2013.02.008). 684

A case study describing use of the EZ-IO in Afghanistan by US military on 5 patients with traumatic injury including one pediatric patient. Access was obtained in the proximal tibia on first attempt and was used to administer crystalloids in all patients along with opioids, analgesics and antibiotics. All ultimately received central venous access and peripheral access was established in one patient. There were no IO complications.

Reinhardt L, Brenner T, Bernhard M, et al. Four years of EZ-IO system in the pre- and in-hospital emergency setting. Central European Journal of Medicine 2013;[8\(2\):166-71](http://dx.doi.org/10.2478/s11536-012-0125-6). Doi:[10.2478/s11536-012-0125-6](http://dx.doi.org/10.2478/s11536-012-0125-6) 618

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.

Souchtchenko SS, Benner JP, Allen JL, Brady WJ. A review of chest compression interruptions during out-of-hospital cardiac arrest and strategies for the future. J Emerg Med 2013. <http://dx.doi.org/10.1016/j.jemermed.2013.01.023> 624

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.

Weiser G, Poppa E, Katz Y, Bahouth H, Shavit I. Intraosseous blood transfusion in infants with traumatic hemorrhagic shock - a case report and review of the literature. Am J Emerg Med 2013. <http://dx.doi.org/10.1016/j.ajem.2012.10.036>. 646

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.

Wiese CHR, Semmel T. Aktuelles zum intraossaren Zugang- Weib das team bescheid?. Notfall + Rettungsmedizin. 2013;[Doi:10.1007/s10049-013-1698-6](http://dx.doi.org/10.1007/s10049-013-1698-6) 621

Article in German

Young SW, Zhang M, Freeman JT, Mutu-Grigg J, Pavlou P, Morre GA. Higher tissue concentrations of vancomycin with low-dose intraosseous regional versus systemic prophylaxis in TKA. Clinical Orthopaedics and Related Research 2013;[Doi:10.1007/s11999-013-3038-z](http://dx.doi.org/10.1007/s11999-013-3038-z) 620

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

Abrams-Ogg AC, Defarges A, Foster RA, Bienzle D. Comparison of canine core bone marrow biopsies from multiple sites using different techniques and needles. Vet Clin Pathol 2012;[41\(2\):235-42](http://dx.doi.org/10.1111/j.1939-165X.2012.00422.x). doi: [10.1111/j.1939-165X.2012.00422.x](http://dx.doi.org/10.1111/j.1939-165X.2012.00422.x) 664

A pre-clinical study that compared the EZ-IO 15 gauge 25mm needle set and the 13 gauge Jamshidi aspiration/biopsy needle when used to obtain core biopsy specimens in canines.

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This article describes a questionnaire study that was given to UK Role One military clinicians deployed to Afghanistan to assess the level of experience and confidence rating with use of IO access, using the FAST-1 and EZ-IO, and IV access. Thirty-three responses were received; clinicians felt more confident with IV access over IO access; clinicians felt more confident with FAST-1 IO access than EZ-IO IO access.
UK
- Burgert J, Gegel B, Loughren M. Comparison of tibial intraosseous, sternal intraosseous, and intravenous routes of administration on pharmacokinetics of epinephrine during cardiac arrest: A pilot study. AANA Journal 2012;80(4):S6-S10** 660
Preclinical study using a porcine model comparing the maximum concentration and time to maximum concentration of epinephrine administered via the tibial IO, sternal IO and IV routes during CPR. The IV route of administration of 1mg of epinephrine resulted in a serum concentration 5.87 and 2.86 times greater than the tibial route and sternal route respectively. The times to peak concentration was similar for IV and sternal IO groups but delayed for the tibial route. Authors conclude that due to limitations of their study the guidelines of administering 1mg of epinephrine via the IO route should not be changed; further studies using larger sample size, larger volume flush, arterial blood samples and the use of a more precise method of measuring serum epinephrine should be done.
- Cairney K, Matthew I. Options for intravascular access during resuscitation of adults. Emergency Nurse 2012;20(1):24-8** 536
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.
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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 route is likely to benefit from pressure bag or high-pressure pump delivery. This study was sponsored by Vidacare Corporation.
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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.
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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.
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This abstract presented at the 2012 ACEP Research Forum discusses a swine pre-clinical study evaluating CT image opacification when contrast is delivered via IV 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.

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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.
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This article describes a study evaluating a new manual needle insertion device, the Near 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.
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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.
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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.
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This abstract presented at the 2012 NAEMSP scientific assembly described a randomized, cross-over study in which 8 swine were administered chilled saline via IV and IO routes to determine if the two routes were equivalent. The results suggested no clinical or statistical difference between IV and IO routes for infusion of chilled saline for therapeutic hypothermia. This study was sponsored by Vidacare Corporation.
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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.

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 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.
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 In this article, the author discussed five recent studies on intraosseous access providing his opinion about the quality of each study.
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 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.
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 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.
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 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.
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- 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.
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- 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 induced in 7 patients. Drugs infused are listed. There were no serious complications.
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- 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.
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- 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.
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