Deployment of the NIO (New Intraosseous) Device by Special Forces in a Cadaver Lab

Keywords:
Intraosseous
Trauma
Emergency
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Abstract

Background: In patients undergoing resuscitation for whom intravenous (IV) access is not readily available, the American Heart Association (AHA) and the European Resuscitation Council (ERC) recommend the establishment of an intraosseous access (IO**) (**Neumar RW, Shuster M, Callaway CW, et al. Part 1: Executive summary: 2015 American Heart Association guidelines update for cardiopulmonary resuscitation and emergency cardiovascular care. Circulation. Nov 3, 2015;132(18 Suppl 2): S315–67. 2. Khalifa GEA, Alfonzo A, Arntz H-R, et al. European Resuscitation Council Guidelines for Resuscitation 2015. Resuscitation. 2015(95):1–80.
This procedure is also used widely for casualty treatment in military and other field scenarios. The 2015 update of the U.S. Army Committee on Tactical Combat Casualty Care (CoTCCC) recommends using IO access in any resuscitation scenario in which IV access is not obtainable **(TCCC Co. Tactical Combat Casualty Care Guidelines for Medical Personnel 2015. Available at: https://www.jsomonline.org/TCCC.html Accessed April 6, 2016.)**

Methods: 3 fresh cadavers were used for this study. The participants (Ukrainian army physicians & paramedics , special operations division) were trained on the NIO device (New Intraosseous, PerSys Medical, Houston TX) using the NIO Sim device. Chosen locations were proximal tibia and humeral head. Total of 36 insertions were made, 20 to humeral head, 16 to proximal tibia. Verification of placement was done by aspirating bone marrow and visualization of flush with no extravasation signs.

Results: 30-minute training was conducted prior the entrance to the cadaver lab. The participants started live insertions after successful activation of NIO Sim on both tested locations. 35 of 36 insertions were successful (97.2% success rate), 20/20 humeral head (100% success rate), 15/16 proximal tibia (93.7% success rate).

Conclusions: The NIO is a suitable device for emergency intraosseous access in emergency situations. The NIO provides high success rates in humeral head and proximal tibia insertion. Prior training on the NIO Sim is very important for successful activation of the device.

Methods

This study design contained 3 fresh cadavers. The subjects' ages were 47 (male), 56 (female) and 73 (female) y/o according to local death certificates. BMI were not obtained. In all the subjects the insertion site was clearly identified & palpated by the users. The subjects had no history of significant skeletal disease according to local documentation. There were 8 military physicians and paramedics from the special operations division in the Ukrainian

Army. They were trained on the NIO device (Fig. 1) (New Intraosseous, PerSys Medical, Houston TX) using the NIO Sim device (Pic 2.). Overall training was conducted for 30 minutes and included the technical aspects of NIO activation and practical session on the chosen locations of insertion. Chosen locations were proximal tibia and humeral head. The participants were required to identify the location, activate the NIO device and verify correct cannula placement. Verification of placement was done by aspirating bone marrow (red/yellow) and visualization of flush with no extravasation signs. Total of 36 insertions were performed, 20 to humeral head, 16 to proximal tibia.

Measurable outcome

Primary outcome were: 35 of 36 insertions were successful (97.2% success rate), 20/20 humeral head (100% success rate), 15/16 proximal tibia (93.7% success rate). During the unsuccessful insertion to a proximal tibia, the participant could not extract the trocar from NIO cannula, following failed insertion. One of the cannulas inserted to the humeral head was found to be bent after its extraction (successful position verification).

Discussion

The IO access was first described in 1929 and was used in a systematic manner during World War II. Over the last nine decades, it has been applied as a safe alternative to peripheral venous access (PVA). According to the ERC and AHA guidelines for CPR [2010], the IO access has become a standard of care in adult advanced life support, and the first recommended alternative PVA in adult sudden cardiac arrest (SCA) patients. Moreover, according to the ERC and AHA guidelines, the IO access is the recommended primary vascular access in pediatric emergencies such as SCA.

Rapid vascular access is an essential component of CPR, especially in non-shockable rhythms, allowing administration of epinephrine or other medications and/or intravenous fluids. However, in emergency patients, PVA might be difficult or impossible to obtain, especially in dehydrated patients, those in hypovolemic shock, obese, IV drug users, following chemotherapy, or under SCA. As reported in many studies, failure rates of PVA in emergency conditions between 10% to 40%. Of course, there are many alternative vascular access techniques under CPR with difficult PVA access, such as central venous cannulation (CVC) or ultrasound-guided PVA. CVC results in shorter drug circulation times and higher peak drug concentrations than PVA. Moreover, CVC is relatively time-consuming and associated with numerous complications in the emergency setting, such as CVC malposition, hematoma, arterial puncture, venous thrombolysis, pneumothorax, hemothorax or catheter-related infections. The complications are reported to affect between 15% to 20% of cases. 14–16 Lee et al, showed that first-pass success was significantly higher for the IO access than for a central venous catheter (90.3% vs. 37.5%; $P < 0.001$).

A. Shina et al 2016, performed a comparison study between unexperienced military medics and showed higher success rates for the NIO device when compared to EZ-IO device (Teleflex, USA, Wayne Pennsylvania).

Lt. Colonel BR Cooper et al 2007 described an experience with intraosseous access in a military related trauma. A total of 32 needles were inserted, with 97% effective function. IO needles were used to administer fluid (crystalloid, packed red cells and fresh frozen plasma) and medications (analgesics, cardiac arrest meds, antibiotics, medications for both rapid sequence induction and maintenance of anesthesia). No complication of infection werenoted.

L Szarpak. et al 2016 showed that NIO device requires relatively short training and features a unique training device which allows the users to train on their classmates with no actual needle insertion. This particular feature allows the trainers to become familiarized with different types of body habits and simulate real treatment in a better way. All other IO devices in the market require a manikin training model.

Conclusions

Intraosseous devices (IO) provide a safe and reliable way of achieving timely vascular access in the critically ill or injured patient. They also have been used in non-emergent conditions in which multiple attempts at central or peripheral intravascular access have failed. New devices have addressed the mechanical difficulties and complications associated with the old versions. These new, improved intraosseous devices provide healthcare providers with choices beyond the traditional manual intraosseous needle for administering fluids, medications, and blood products to both adults and children in various settings. These devices have become widely available in the prehospital arena, EDs, and the military. With their ease of use, their role in resuscitation and treatment of mass casualties has expanded greatly beyond the pediatric population. Current research is focused on product innovation and improving drug delivery using intraosseous auto injectors, finding new anatomic sites for placement, and expanding the use of the different intraosseous devices to the adult population.

Intraosseous access becomes more and more relevant when used in tactical care phase of military treatment due to its simplicity, speed of performance and the ability to be used as regular PVA line. This exercise shows that short training prior the deployment increases confidence with NIO device deployment. In this particular exercise, the NIO device showed high success rates on live tissue.

Limitations: further evaluation needs to be verified of the military medics after longer period of time between intraosseous trainings. Insertion time needs to be measured as well.

Fig. 1 – NIO-A

Fig. 2 – NIO-SIM

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