Deployment of the NIO Next Generation IO™ Device by Special Forces in a Cadaver Lab

Keywords:
Intraosseous
Trauma
Emergency
Vascular

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 Next Generation IO™ device (New Intraosseous, PerSys Medical, Houston TX) using the NIO Simulation device. Chosen locations were proximal tibia and humeral head. Total of 36 insertions were made, 20 to the humeral head, 16 to the proximal tibia. Verification of placement was done by aspirating bone marrow and visualization of flush with no extravasation signs.

Results: A 30-minute training was conducted prior to the entering to the cadaver lab. The participants began live insertions after successful activation of NIO Simulation 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 Next Generation IO™ is a suitable device for emergency intraosseous access in emergency situations. The NIO Next Generation IO™ provides high success rates in humeral head and proximal tibia insertion. Prior training on the NIO Simulation 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 measurements were not obtained. In all

the subjects, the insertion site was clearly identified and 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 Next Generation IO™ device (Fig. 1) (New Intraosseous, PerSys Medical, Houston TX) using the NIO Simulation 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 the proximal tibia and the 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 outcomes 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 cardiac rhythms considered non-amenable to electrical cardio version. Vascular access in these cases is vital in order to allow the administration of the appropriate ACLS medications in a timely manner.

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 inexperienced military medics and showed higher success rates for the NIO Next Generation IO™ 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 complications of infection were noted.

L Szarpak. et al 2016 showed that NIO Next Generation IO™ device requires relatively short training period 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 body habitus types 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 bolstering product innovation, improving drug delivery using auto injectors, finding new anatomic placement and expanding the use.

Intraosseous access has proven to be a vital part of tactical trauma care during military operations due to its simplicity and speed of performance even in environments where patient position, lighting, and continued threat provide obstacles to patient care. The NIO Next Generation IO™ can be used as regular PVA line with all standard NATO medical IV equipment, and IV fluids including blood products may be administered rapidly and efficiently. This exercise shows that a short training conducted prior to deployment increases confidence when utilizing the NIO. The NIO Next Generation IO™ device showed high success rates on live tissue in this exercise.

Limitations: There was a short time interval between training and testing. To fully evaluate skills retention, it would be ideal to retest participants at a future date, weeks, or even months after receiving training. Additionally, time from indication for IO access to achieving access and securing the device should be measured in future studies

Fig. 1 – NIO-A

Fig. 2 – NIO-SIM

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