The Safety of Bolus Infusion Through Intraosseous Access Using the EZ-IO in Terms of Extraosseous Flow

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**Purpose**: We evaluated the safety of bolus infusion through intraosseous access using the EZ-IO in adults in terms of extraosseous flow.

**Methods**: We conducted a prospective study of adults (over age 18) in whom intraosseous access through the tibia was performed by emergency physicians or residents from June 2010 to June 2011. We used ultrasonography to confirm extraosseous flow during infusion of 80 mL normal saline with a 4 mL/s flow rate through intraosseous access, immediately after confirmation of intraosseous needle insertion using conventional methods. Finally, we recorded any complications that occurred immediately in the area of intraosseous access.

**Results**: Of 30 patients enrolled in the study, 22(73.3%) were male and eight (26.7%) were female. The mean age of study participants was 62.78 ± 15.68 years; mean cortical thickness of participants’ tibias was 0.27 ± 0.03 cm. The mean time required for performance of the intraosseous access procedure was 16.00 ± 4.65 s; success rate on the first attempt, 100.0%. No immediate complications, including swelling or extraosseous flow at the area of intraosseous access, were observed.

**Conclusion**: In this study, bolus infusion through intraosseous access using the EZ-IO in adults in emergency departments was a safe option in terms of extraosseous flow.

**Key Words**: Infusion, Intraosseous, Ultrasonography

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**Introduction**

Intraosseous access is an important procedure in paediatric resuscitation, and the advent of newer intraosseous devices since the 1930s expanded its role to include resuscitation in adults. It is reasonable for providers to establish intraosseous access if intravenous access is not readily available. Therefore, intraosseous access is widely used not only in cardiovascular arrest but also in traumatic situations. Intraosseous access also provides an effective alternative IV access for critical patients in whom a peripheral IV line cannot be readily obtained before arriving in hospital.

Extraosseous flow of blood, normal saline, and drugs into the soft tissues is the most common complication in intraosseous access, and on occasion, these complications have led to compartment syndrome. The most serious adverse complications of intraosseous access noted in 1 large study were osteomyelitis, cellulitis, and skin abscesses.

Conventional methods to confirm successful intraosseous needle insertion are based on observing aspiration of bone marrow or blood and the ability to infuse normal saline easily without visible extraosseous flow or swelling. Ultrasonography has been recently proposed as a method to confirm successful intraosseous needle insertion and extraosseous flow. It may be more accurate than the conventional methods mentioned previously in case series or studies with cadavers. However, there is no study using ultrasonography to evaluate the safety of bolus infusion through intraosseous access using the EZ-IO in adults in terms of extraosseous flow. Therefore, we studied with ultrasonography to know whether bolus infusion through intraosseous access using the EZ-IO in adults is a safe option in terms of extraosseous flow, or not.
**Material and Methods**

After expedited review and approval from the Committee for Human Research, we conducted this study. The study enrolled collapsed adults (≥18 years old) who presented at our hospital between June 2010 and June 2011, and who achieved return of spontaneous circulation (ROSC) after emergency physicians or residents gained intraosseous access through the tibia. Patients were excluded if they had a fractured tibia, vascular injury, overlying skin infection or burn on the area of intraosseous access, or fragile bones due to conditions such as osteogenesis imperfecta or osteoporosis. Additional exclusion criteria were previous placement of an intraosseous needle at the site of intraosseous access or guardians’ refusal to approve this protocol

Basic data were recorded, including the patient’s age, sex, height, body weight, and causes of collapse, the time from taking out the needle to inserting the needle into the tibia, and the volume of normal saline given to the patient during cardiopulmonary resuscitation. We also collected details such as job positions of practitioners who performed the intraosseous access procedure. Intraosseous access was performed with EZ-IO (Vidacare Corporation, San Antonio, TX, USA) and a blue-capped adult needle (15 gauge and 25-mm long). All participants were senior emergency residents or emergency physicians who had practiced musculoskeletal ultrasonography for a year, or more. They received a 1-hour lecture on the intraosseous access device and its use, and all had practiced intraosseous access 2 or more times before the study began.

The site of intraosseous access was 1–2 cm distal to the tibial tuberosity on the anterior medial surface of the tibia. After inserting the needle, we confirmed the intraosseous needle insertion with conventional methods. These were that we aspirated bone marrow or blood with a 10-mL syringe, and then the practitioners infused 10–20 mL normal saline, finally started a drip infusion of normal saline via aliquots positioned approximately 1.8 m above the ground. We confirmed extraosseous flow with ultrasonography. We positioned a 3-Hz curved ultrasonographic transducer (Micromaxx; Sonosite Inc., Washington, USA) just cephalad to the intraosseous needle. While the machine was in colour power Doppler mode, we recorded images as 80-mL aliquots of normal saline solution were infused at 4 mL/s (Fig. 1). For statistical testing, SPSS version 15.0 software (SPSS, Chicago IL, USA) was employed, and data were presented as mean and standard deviation or as percentages. The Kruskal-Wallis test was applied to analyse the differences in procedure times between positions of practitioners at a significance level of $p<0.05$.

![Fig. 1. Simple radiologic study and ultrasonographic flow to confirm successful intraosseous needle insertion and extraosseous flow. These images showed that the needle was located at the intraosseous space in the anterior-posterior view (A) lateral view (B). Ultrasonography showed intraosseous flow (black arrow) in the short axis view (C), and intraosseous needle (white arrow) in the oblique view (D).](image-url)