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Letter to the Editor

The development of a newborn intraosseous infusion simulator for neonatal resuscitation training for emergency medical services

To the Editor,

International current resuscitation guidelines in neonatology recommend the use of simulation-based medical education (SBME) to improve patient safety and health, especially in pre-hospital emergency situations (e.g. out of hospital new-born resuscitation, preterm delivery).[1,2] Specialities such as Emergency Medicine (EM) profits from SBME by practicing i) rare and ii) live-saving procedures. The implementation of an intraosseous infusion line (IO) in newborn resuscitation is such a high acuity, low occurrence (HALO) skill and poorly trained in EMS-physicians. Besides, significantly low one-attempt success and malposition rates for IO devices in paediatric bodies was not to be assumed regarding the success rates of 80% and higher in previously published studies.[3] Available simulator devices regarding newborn resuscitation airway management are also lacking in the simulator physiology, which deviated significantly from preterm infants' reference values.[4]

Three-dimensional printing (3D-printing) now allows accurate landmarking from 3D reconstructions of computed tomography (CT) scans creating real anatomical features, even in the earliest stage of life. As we have access to high-resolution helical CT-examinations of pre- and term new-born cadavers (ethical committee approval No: 16-408) from other former studies,[5] we were able to design and create novel 3D-printed newborn tibial IO simulation trainer that can serve as an simulation device for placement of an intraosseous cannula (Fig. 1). A dedicated 3D post-processing/engineering software (Mimics Innovation Suite, Materialise, Leuven, Belgium) was used to extract the lower limb from a preterm and term newborn CT scan. Finally, a 3D file (.stl) was generated and printed on a PolyJet-technology 3D printer as a 3D model including both flexible parts (soft tissue) and solid parts (bones) using polymers. In a previous study, we have proven that the process described above generates 3D-printed models of high anatomical fidelity with minimal variation in spatial deviation (±120 μm).[6] The IO simulation trainer offers the possibility to palpate landmarks and to cannulate the bone marrow of the femur and the tibia using commercially available IO infusion needles. Correct placement of the needle can be controlled through the canal created piercing through the bone marrow and the soft tissue. We demonstrate, that accurate three-dimensional printing of pre- and newborn lower limbs in an accurate anatomical scale is possible.[6] Moreover, we can create preterm and term dummies for further neonatal resuscitation training.[7]

Our models should serve as an IO training simulator for EMS physicians in order to practice the complex task of correctly placing an IO infusion needle in a newborn in emergency situations. The next steps in our feasibility study will be to expose our dummies on "real EMS-physicians" in a field study to test different material compositions and further identify requirements posed to an IO simulation trainer. Moreover, the simulators can serve as an application model for further modifications of intraosseous stylets and needles for newborn resuscitation.

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Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

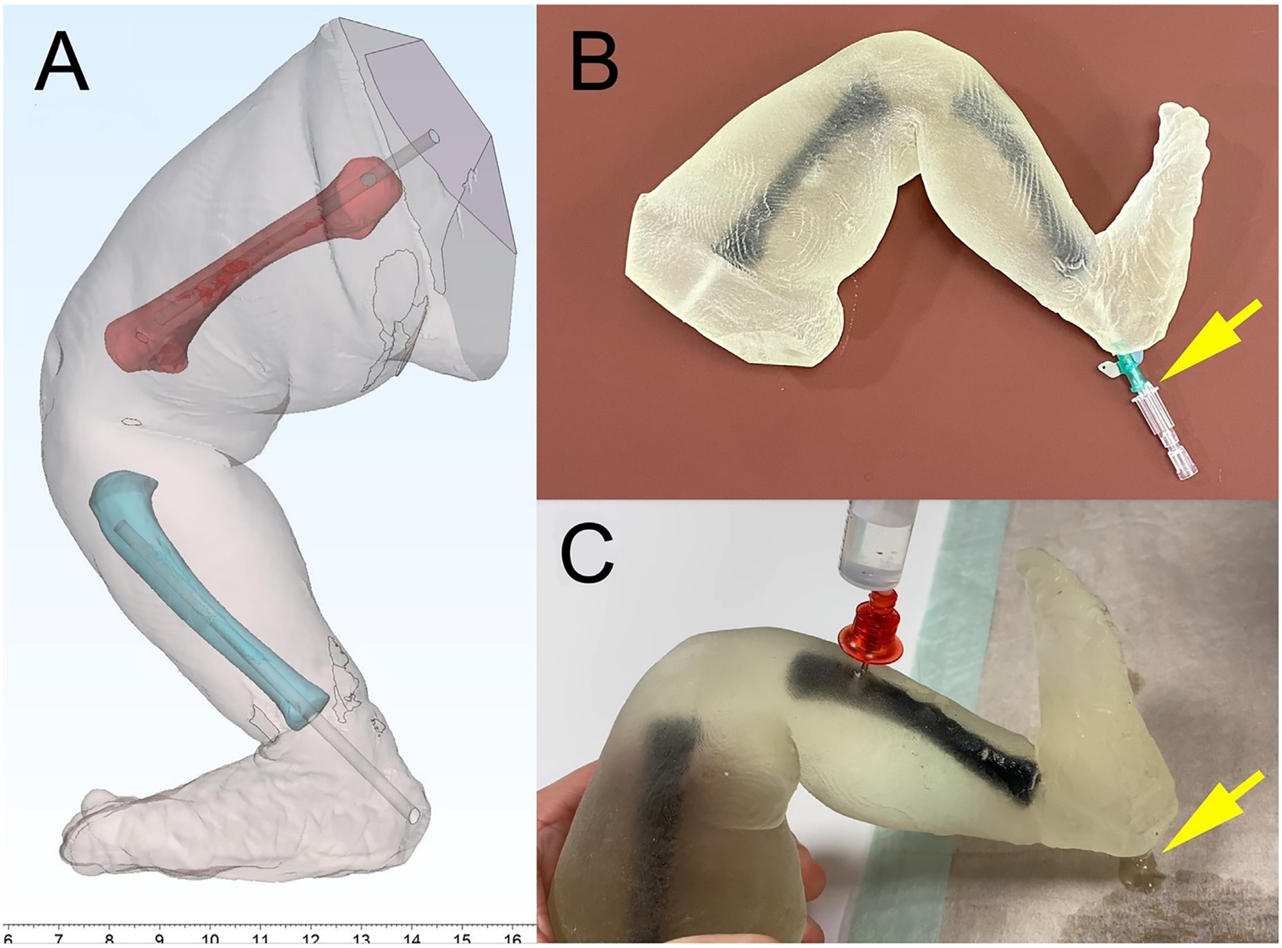

Fig. 1 – (A) 3D-Model of an infant leg derived from a CT scan of the body of a stillborn infant segmented with the Mimics Innovation Suite® software and generated using the 3-Matic® module. (B) Insertion of a infusion cannula into the monitoring canal of the 3D-printed model demonstrating its patency. (C) Proof of correct placement of the EZ-IO® needle PD 15G into the tibia by flushing it with saline, which exits through the monitoring canal at the heel of the model.

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Frank Eifinger *

Department of Pediatric Critical Care Medicine and Neonatology, Faculty of Medicine and University Hospital Cologne, University of Cologne, Cologne, Germany

Bernhard Dorweiler

Department of Vascular and Endovascular Surgery, Faculty of Medicine and University Hospital Cologne, University of Cologne, Cologne, Germany

Moritz Wegner

Department of Vascular and Endovascular Surgery, Faculty of Medicine and University Hospital Cologne, University of Cologne, Cologne, Germany

* Corresponding author at: Department of Pediatric Critical Care Medicine and Neonatology, University Children's Hospital, Kerpener Strasse 62, 50937 Cologne, Germany.
E-mail address: Frank.Eifinger1@uk-koeln.de (F. Eifinger)

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