Feedback to the Field: An Assessment of Sternal Intraosseous (IO) Infusion

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Disclosure: The opinions and assertions contained herein are the private views of the authors and not to be construed as official or as reflecting the views of the Departments of the Army, Air Force, or Defense.

Abstract

Intraosseous vascular infusion (IO) is a recognized alternative to peripheral intravenous infusion when access is inadequate. The sternum and proximal tibia are the preferred sites. A review of 98 cases at autopsy revealed successful sternal IO placement in 78 cases (80%). Assuming a worst case scenario for placement (pin mark and no tip in bone [17 cases] and tip present and not in the sternum [3 cases]), attempts were unsuccessful in 20 cases (20%). We draw no specific conclusions regarding sternal IO use, but hope that personnel placing these devices and those providing medical training can use the information.

Introduction

"Feedback to the Field" (FT2F) is a communication intended to provide potentially useful observational data to medical providers and medical trainers. Those in receipt decide if the information is valuable and how it is used.

These case-based observations made by the Armed Forces Medical Examiner System (AFMES) are de-identified and unlinked to occurrence. They do NOT assess effectiveness or relation to outcome. They do NOT suggest or advise on current or proposed policy.

Because the observations are derived from the autopsy procedure at the Port Mortuary, Dover Air Force Base, Delaware, the cases are Killed in Action/Died of Wounds (KIA/DOW) and do NOT reflect Wounded in Action (WIA) experience. In addition, the possible effects of handling and transportation from theater must be considered.

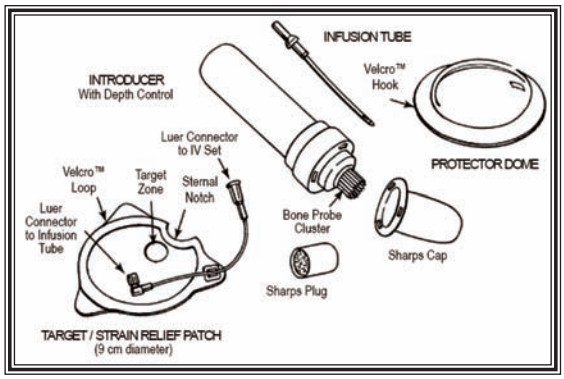
The Defense Medical Material Program Office (DMMPO), which falls under the Office of the Assistant Secretary of Defense (Health Affairs) Force Health Protection & Readiness, receives and reviews FT2F communications and then distributes them electronically. The following material on Sternal Intraosseous Intravenous Devices is taken from the 7th FT2F distribution made in December 2010. If you do not receive FT2F distributions and wish to be added to the list, contact DMMPO (Appendix I).

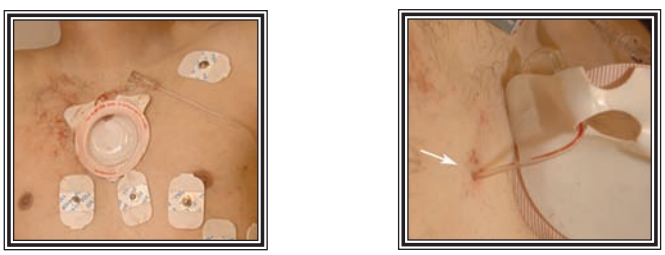
Background

Intraosseous vascular infusions (IO) are a recognized alternative to peripheral intravenous infusions when access is inadequate. Current use of IO devices is popular in emergency medicine, with focus on critically ill patients in the out-of-hospital setting.[1] In the military, the sternum and proximal tibia are the preferred sites.

The principal sternal IO device being taught and distributed by the Department of Defense (DOD) is the FAST-1 (Pyng Medical) (Figures 1-3).[2] There are three versions of this device. Device placement is guided by a template that is positioned using the sternal notch as a reference. The introducer is

Figures 1a & b. *FAST-1, second version. A. Photo. B. Schematic. (the first version requires a removal tool). Both figures courtesy of Pyng Medical, Vancouver, Canada.*





Figures 2 a & b. *A. FAST-1 in place with cover over the target patch. B. Exposed insertion site. Note the circle of pin marks around the infusion tube left by the introducer (arrow).*

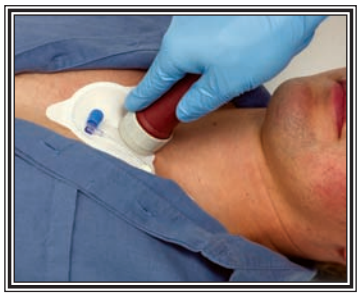
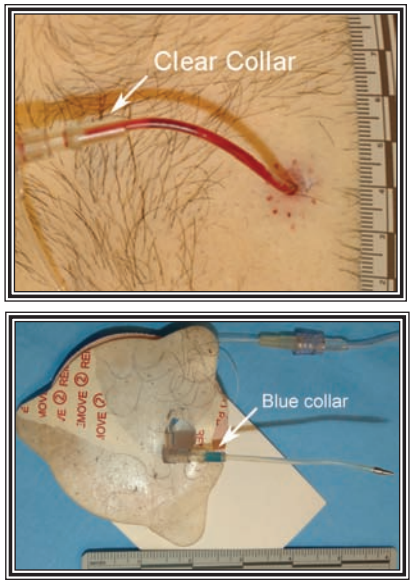
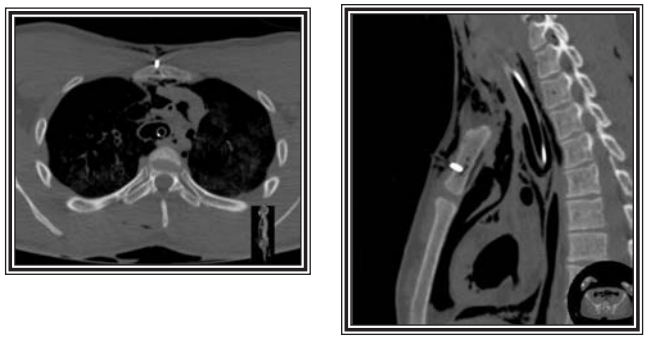


Figure 3. *Placement of the device uses an adhesive template, the sternal notch for positioning, and the introducer is placed in the circular template cutout (target zone). Figure courtesy of Pyng Medical, Vancouver, Canada.*

placed in a circular target zone (Figure 3). The first version with the clear collar requires a removal tool; the second version, which has a blue collar, can be extracted without a tool (Figures 4a & b). Retention of the metal tip after removal has been reported by users. Manufacturer's instructions direct users to grasp the infusion tube with fingers or clamp and pull perpendicular to the manubrium. This should be one continuous motion until removed. The tube, not the luer connection, is used to pull for removal. Other sternal devices are available and may appear in emergency care facilities within the DOD. One of these, the EZ-IO (Vidacare) sternal needle, can be inserted manually or with a power driver. This was the topic of a prior FT2F communication.



Figures 4a & b. *Removal issues.*
A. The first version with the clear collar (top left) requires a removal tool.
B. The second version of the FAST-1 now being fielded and not requiring the tool has a blue collar. (bottom left) The tube can be pulled out manually. Reports of tip retention in the sternum with the second version have been received.

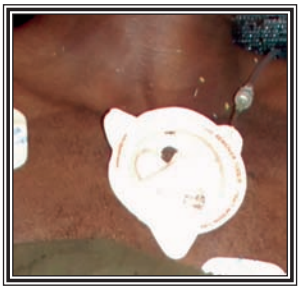


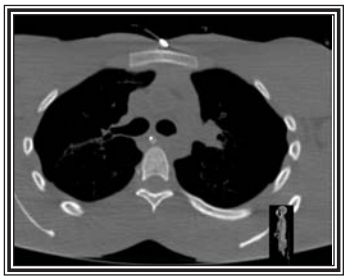
Figures 5 a & b. (*A) Axial-left and (B) sagittal-below, computed tomography show the metal tip of the infusion catheter in the manubrium of the sternum.*

Observations Of FAST-1 Use

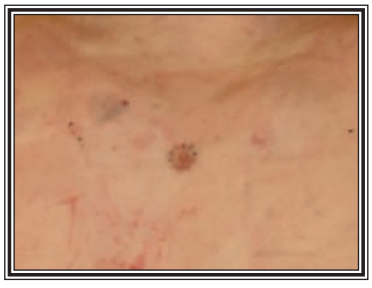
We reviewed 98 cases reported as showing evidence of sternal IO infusion at autopsy. The acquisition of full body postmortem digital radiographs and computed tomography (CT) images prior to autopsy (Figures 5a & b above) allowed retrospective analysis of these cases.

In 81 cases, the sternal IO infusion device was localized by CT identifying the metal tip of the infusion tube. The CT images enabled precise determination of position within or outside the sternum (Figures 6a & b). In 17 cases, the autopsy showed use of a sternal infusion device (the presence of a pin marking footprint), but a device was not physically present on CT. (Figures 7a & b).



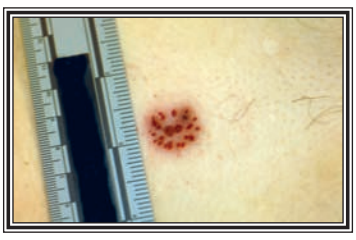


Figures 6a & b. *A. External photograph-left. B. Axial computed tomography-below shows the sternal infusion device is not in the manubrium.*



Figures 7a & b. *Two example cases (A-left and B-below) show pin marks and no device present. No retained metal tip was noted on computed tomography.*

In these cases, the radiographs and CT revealed no metal tip in the sternum or adjacent soft tissue. Our assumption is that unsuccessful attempts at



placement occurred in these pin mark cases because instructions in theater are to ship human remains without removal of devices used in emergency medical treatment (e.g., tourniquets, endotracheal tubes, chest tubes, intravenous devices). When pin marks are present without the device components, we do not know how the procedure was performed. It is possible the device was used without the template or that the template was not optimally positioned. We have observed some cases with a high pin mark pattern (e.g., marks in line with the ridge of the clavicle) (Figure 8).

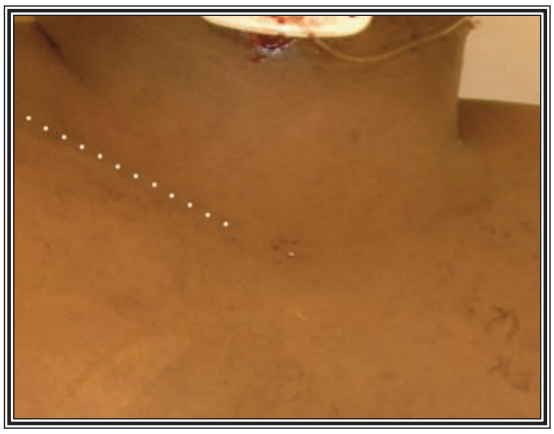


Figure 8. *High placement pattern noted in some cases with pin mark only. The marks appear in line with the ridge of the clavicle (dotted line). It is not known if the target patch was used in these cases or how it was placed if used.*

Conclusion

To estimate the success rate of sternal IO placement, we noted positive verification in 78 (80%) of the 98 cases. Assuming a worst case scenario when pin mark was found with no tip in bone (17 cases) and tip present and not in the sternum (3 cases), attempts were unsuccessful in 20 (20%) of 98 cases.

Discussion

This information is presented as "observational data" only. We have no knowledge of the echelon of care, facility, and individual(s) involved in device placement. It must be appreciated that battlefield conditions and treatment situations are highly variable and represent the most extreme circumstances for rendering emergency care. In a civilian report of FAST-1 use, a 74% success rate for first-time users and 95% success rate for experienced users gave an overall success rate of 84%.[3] Special Operations Medical personnel in a non-combat study were found to have a 94% success rate with the FAST-1 (29 of 31 attempts).[4] Using the "worst case" scenario noted above has led to estimation of an 80% success rate; this may be considered satisfactory in a battlefield environment. We know healthcare providers do not propose a success rate less than 100% as a desirable goal.

This presentation makes no association between sternal IO position and outcome of treatment. We are seeing non-survivors and have no data on wounded with sternal IO devices. This could bias our observations to the most difficult cases and environments where care was rendered. Consequently, we cannot draw specific conclusions regarding sternal IO use but hope that personnel placing these devices and providing medical training can use the information. With awareness of these findings, further questions are: (1) Can this rate be improved in the battlefield environment? And, if so, (2) How can improvement be accomplished?

DMMPO Recommendations/Actions

- Leave medical equipment and devices on Killed In Action and Died of Wounds patients
- Review training techniques & TTPs
- Report equipment issues to ensure proper resolution (Appendix I)

The following information for sternal IO devices is provided:

- FAST-1 6515-01-536-9363 and 6515-01-530-6147
- EZ IO (manual sternal needle) 6515-01-559-6311 and 6515-01-559-7489
- FAST-X Sternal NSN in processing.

The material distributed by FT2F is intended for education and training purposes. We encourage its use at all levels. If portions are extracted, they must include the following credit line: *Source: Armed Forces Medical Examiner System.*

References

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APPENDIX I

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