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## Sex-Based Differences in Depth of Soft Tissue and Bone Diameter at the Sternal Intraosseous Catheter Insertion Site

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## ABSTRACT

### Background

Intraosseous (IO) catheters are commonly used to rapidly obtain vascular access for critically-ill patients in the emergency department (ED). While the sternum is a common IO insertion site for adult subjects, little is known about sex-based variation in the proper depth of insertion.

### Methods

A retrospective cohort study was performed, utilizing CT scans obtained from DMC over a ten-year period (2009-2018) to estimate soft tissue depth overlying the recommended sternal IO insertion site. Depths of soft tissue from skin surface to bone surface (Measurement A) and from skin surface to the opposite bony cortex (Measurement B) were measured using standard radiologic software.

### Results

Our data includes 32 male and 21 female subjects with a body mass index (BMI) between 18.5 and 25. Measurement A for males ( $\bar{x}=17.89$  mm,  $\sigma=8.91$ ) was significantly larger than for females ( $\bar{x}=12.98$  mm,  $\sigma=5.96$ ) ( $p=0.0308$ ). Sternal diameter (Measurement B-Measurement A) was also significantly larger in males ( $\bar{x}=17.15$  mm,  $\sigma=5.06$ ) compared to females ( $\bar{x}=13.75$  mm,  $\sigma=4.20$ ) ( $p=0.0138$ ). Measurement A was  $\leq 25$ -mm in 78% of males and 90% of females.

### Conclusions

Our results suggest that sex-based differences exist in soft tissue depth and bone diameter at the sternal site, despite similar BMI values. Since common IO needle lengths are 25-mm and 45-mm, these results suggest that 25-mm needles are sufficient for most patients in this BMI category; however, 22% of males and 10% of females studied would have required the longer 45-mm needle. Future studies with larger cohorts are needed to further validate these findings.

## INTRODUCTION

- Intraosseous (IO) catheterization is widely used to administer fluids or medications in emergencies when veins are difficult or impossible to access (1).
- The IO needle is inserted into the medullary cavity of a specified bone, where the site can then be used for infusion.
- The sternum is one site of IO insertion; however, overlying soft tissue can affect insertion depth, and thereby affect necessary IO needle length (2,3).
- This study compares the soft tissue depth overlying the sternal IO insertion site between sexes to determine if the current standard 25cm and 45cm needle lengths are appropriate for all cases.

## METHODS

- Cross-sectional computed tomography (CT) images of the torso obtained from 2009-2018 DMC electronic records (Fig. 1) were used to measure soft tissue depth overlying the standardized sternal IO insertion site (insertion site: 1.5cm inferior to the sternal notch).
  - Measurement A: soft tissue surface to cortical surface.
  - Measurement B: soft tissue surface to deep cortex.
- Images with fracture, hardware, or edema were excluded.

## METHODS

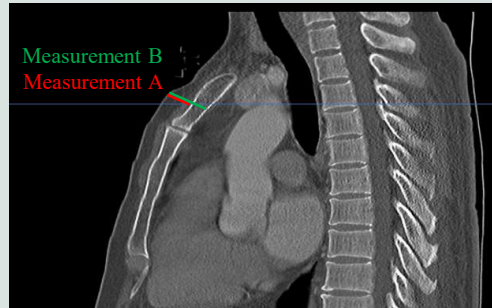


Figure 1: CT cross-sectional image of sternum.

## RESULTS

- CT images from 32 male patients and 21 female patients with BMI ranging from 18.5 to 24.9 were measured. No significant differences in BMI were noted between sexes ( $p=0.7484$ ).
- An independent-samples t-test showed Measurement A (soft tissue depth) to be significantly greater in males than females ( $t(51)=2.2207$ ,  $*p=0.0308$ ) (Fig. 2).
- An independent-samples t-test showed that sternal diameter (Measurement B – Measurement A) was significantly larger in males than females ( $t(51)=2.5492$ ,  $*p=0.0138$ ) (Fig. 3).
- A Fisher's exact test showed no significant differences in the number of males that had soft tissue measurements greater than 25mm compared to females ( $p=0.2910$ ).

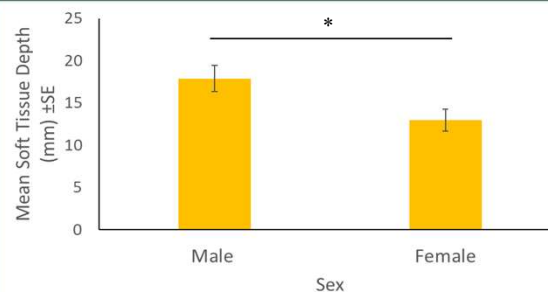


Figure 2: Comparison of mean soft tissue depth (Measurement A)

## RESULTS

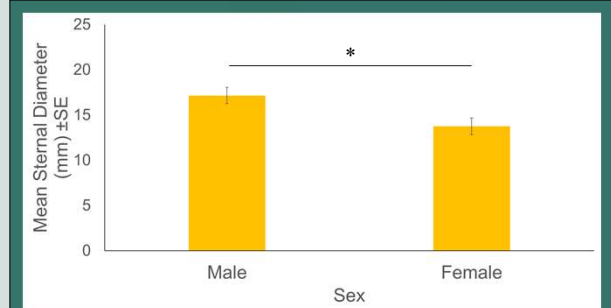


Figure 3: Comparison of mean sternal diameter between sexes (Measurement B – Measurement A)

## CONCLUSIONS

- These results showed that males had a greater thickness of soft tissue overlying the sternal IO insertion site, indicating a greater minimal threshold for IO needle length than for females.
- Measurement A was larger than 25mm in 22% of males and 10% of females, indicating the standard 25mm IO needle would not be long enough for these patients.
- These results provide evidence that BMI alone is not sufficient to guide selection of appropriate IO needle length.
- Males also showed a larger sternal diameter compared to females, indicating a larger cavity in which to successfully insert an IO needle.
- Future studies should also evaluate larger cohorts with a broader range of BMI to determine if these sex differences are found in a wider variety of patients.

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