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Research Abstracts

A Simple Engineering Alteration to IO Access Device Electronics Can Lead to Improved Placement Accuracy Confirmation

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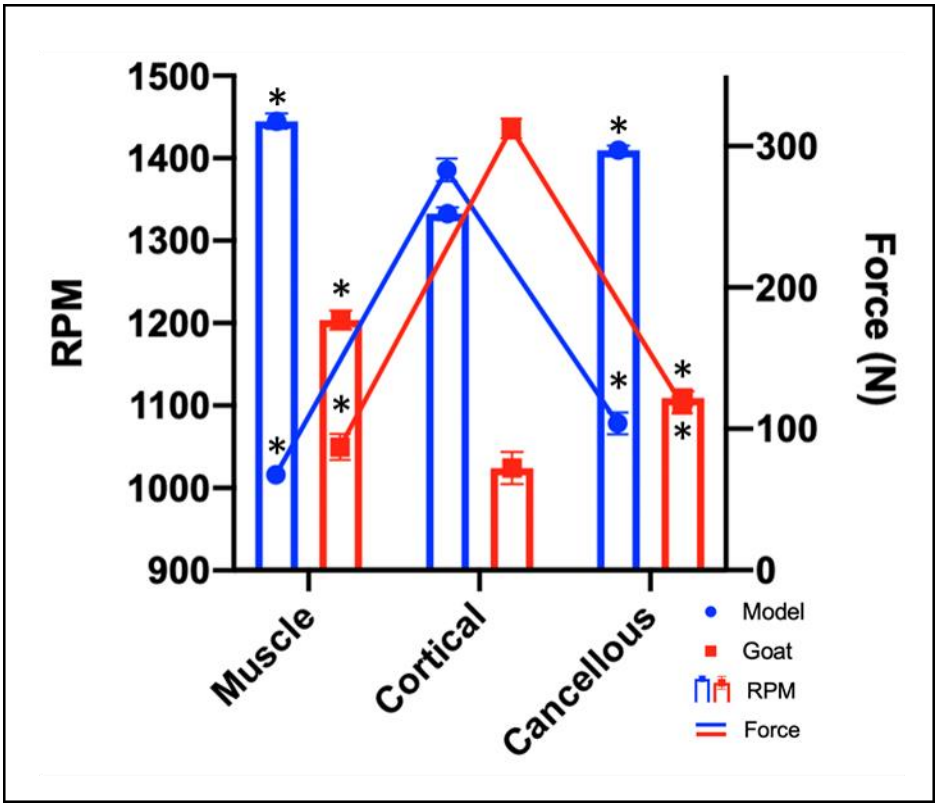
Introduction: Intraosseous (IO) catheterization is the ideal emergency access for patients when intravenous cannulation fails. Optimal IO fluid delivery requires placement in cancellous bone which can be challenging in pediatric, muscular, and obese patients. We hypothesized that commercial Arrow® EZ-IO (EZIO) device electronics can be readily altered to provide confirmation of appropriate cancellous bone placement, thereby removing IO placement subjectivity.

Methods: After deconstructing the casing and contents of an EZIO, we reorganized the battery compartment and added a Raspberry Pi microcontroller and LED light indicator discriminating changes in rotational force (Newtons, N) and drill bit rotations per minute (RPMs). The LED was programmed to illuminate only when the needle tip passed from high to low RPMs and low to high force readings. Using USB connection of the microcontroller to an external monitor we verified drill force and RPM readings in IO placement in fresh goat tibia bones (n=25) and commercial bone models (n=50) wrapped in bovine muscle. Mean ± SEM readings obtained while directly visualizing cross section drill tip entry from soft tissue to cortical bone, to cancellous bone were compared with Tukey-Kramer testing. Correlation of LED illumination with needle entry into cancellous bone was assessed with direct observation.

Results: Both RPM and force varied significantly with penetration of different tissues in bone models and goat tibias (Figure, *$p<0.05$ vs cortical, respectively). Insertion accuracy (LED lighting) in model and goat bones were 94.0% (47/50) & 92.0% (23/25), respectively.

Conclusions: A readily deployable engineering modification of commercial IO devices reproducibly signals cancellous bone access using integrated changes in drill RPM and force. Such modifications may be incorporated in future IO devices to improve insertion accuracy and safety.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RPM
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Force (N)
Muscle
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Model
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RPM
Force