In Vivo Intramuscular pH in Tibia Fractures Is Acidic But Normalizes After Stabilization and Resuscitation

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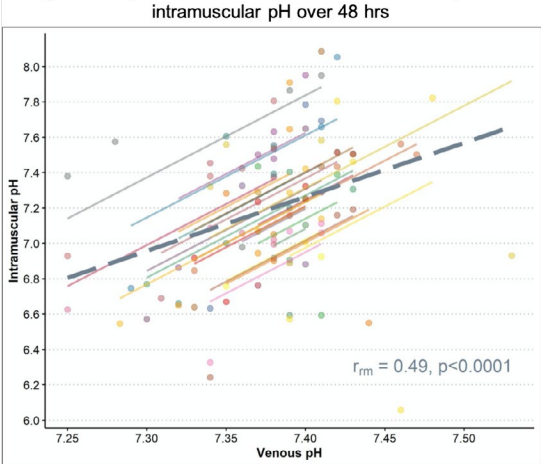
Purpose: Systemic tissue damage and resuscitation in trauma patients is evaluated via systemic pH. Little is known about intramuscular pH after tibia fracture. Our purpose was to study the in vivo intramuscular physiology adjacent to tibia fractures.

Methods: Adults with acute tibia shaft and plateau fractures (Level I, academic, 2019-2021) were offered enrollment in an observational cohort. During operative stabilization (nailing/framing) a sterile validated intramuscular pH (IpH) probe was placed into the anterior tibialis for 48 hours (<6 cm from fracture, continuous sampling) and venous pH (VpH) was drawn (0, 12, 24, 36, 48 hours). For analysis VpH and IpH were compared using a repeated measures correlation analysis; IpH values were extracted at 1-minute averages matching VpH timing. After informed consent, patients received standard of care via independent research team; no study data were available to the treating surgeon.

Results: 25 patients with tibia fractures (9 plateau, 16 shaft) were observed. Initial IpH sampling began post fracture at a mean of 38.2 hours (standard deviation [SD] 30.5). Initial IpH was universally acidic (mean 6.68, SD 0.18) and compared to initial VpH (mean 7.35, SD 0.06). Time from injury to surgery was not correlated with initial IpH (Spearmans, P = 0.56). Final IpH at 48 hours universally converged to VpH (means: 7.52, SD 0.44 vs 7.40, SD 0.03). IpH and VpH demonstrated a significant positive correlation over all 48 hours (rrm [df = 79] = 0.49, bootstrap 95% confidence interval 0.32, 0.65; P<0.0001).

Conclusion: In tibia fractures requiring operative stabilization, adjacent musculature remains nearly 1 order of magnitude more acidic than systemic circulating physiology prior to skeletal stabilization and resuscitation. After stabilization, limb IpH converged to systemic VpH within 48 hours; nearly 50% of the convergence can likely be attributed to acid-base equilibrium between extremity and systemic spaces.

Figure 1. Repeated measure correlation for venous pH and intramuscular pH over 48 hrs



[a]Each point represents a paired observation for a participant. Observations of the same color are from the same participants, with corresponding lines that indicate the repeated measures correlation fit.
[b]Measurements for venous pH were taken at the following intervals: preoperative, 12 hrs, 24 hrs, 36 hrs, and 48 hrs. Corresponding measurements for Intramuscular pH were recorded at the same interval, but starting with the first incision.

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