

Tourniquet Release and Systemic Metabolic Acidosis

Tourniquets stop arterial blood flow to a limb, causing local tissue hypoxia and anaerobic metabolism. In the ischemic muscle, lactate and H^+ accumulate, lowering local pH. When the tourniquet is released, this acid-laden blood “cold and acidotic” flows back into the circulation ¹. The washout of lactic acid and CO_2 causes a **transient systemic metabolic acidosis**. In anesthesiology texts this is well recognized: “*Tourniquet deflation causes release of anaerobic metabolites into the systemic circulation causing ... metabolic acidosis, hyperkalemia...*” ². Likewise, one review notes that limb occlusion increases lactate and decreases pH in the cuffed limb, and that toxic metabolites produce pathophysiological changes when they are released systemically ³. In other words, ischemic metabolites built up under the tourniquet inevitably enter the bloodstream on release, lowering systemic pH.

Systemic “reperfusion syndrome” effects. In practice, tourniquet release can produce a characteristic set of systemic changes. These include:

- **Metabolic acidosis:** A surge in blood lactate and CO_2 causes a drop in arterial pH ² ³.
- **Hypotension:** Return of blood into the limb and vasodilatory metabolites can suddenly drop blood pressure ¹ ².
- **Hyperkalemia and myoglobinuria:** Ischemic muscle releases K^+ and myoglobin, risking arrhythmia and renal injury ² ⁴.

These are often grouped under “tourniquet release” or **reperfusion syndrome**. For example, a Saudi anesthesia report describes a patient who developed “*sudden hypotension, metabolic acidosis and hyperkalemia*” about five minutes after deflation of a 105-min tourniquet ⁴. Similarly, military guidelines explicitly warn that venous return from a reperfused limb is “*acidotic with ... high concentrations of potassium and myoglobin,*” and that hypotension and acidosis should be anticipated ¹. In short, the literature consistently notes that deflating a prolonged tourniquet causes a **flush of anaerobic metabolites** into the circulation, producing a transient metabolic acidosis (sometimes called *myonephropathic metabolic syndrome*).

Evidence from studies and cases. Clinical studies and case reports confirm these effects, especially after longer tourniquet times. For example, a classic anesthesiology study in children found that systemic pH fell after release of long or simultaneous tourniquets – “*systemic acidosis from release of lactate and $PaCO_2$ after tourniquet deflation*” was observed, though healthy children tolerated it ⁵. In adults, surgical studies show clear metabolic changes on deflation. One trial of ankle fracture repair found that a single full release led to higher serum lactate and CO_2 spikes than a staged (staggered) release; the authors concluded that staggered deflation “*reduced the rate of acute systemic metabolic changes associated with limb reperfusion*” ⁶. In a reported case of tibia fracture surgery, tourniquet release (after ~105 min inflation) precipitated cardiac arrest – laboratory data showed pH 7.23 and K^+ 5.9 mmol/L immediately post-release, attributable to reperfusion of acidotic muscle ⁷. Although in many patients the acidosis is transient and self-correcting, these examples illustrate that a **direct cause-effect is established** in the literature: quick deflation after prolonged ischemia can induce a systemic metabolic acidosis.

Guidelines and precautions. Both civilian and military sources emphasize anticipating these metabolic effects. Advanced care protocols recommend proactive resuscitation before deflating a long-standing tourniquet. For instance, an Australian military medical review advises treating the patient to “*minimise the systemic metabolic impact of tourniquet release*” – noting that reperfusion blood is cold, acidotic and potassium-rich ¹. Tactical Combat Casualty Care guidelines similarly caution that tourniquets in place >6 hours should not be removed without advanced monitoring (to manage sudden acidosis, hyperkalemia, etc.) ⁸. These sources recommend controlled or staged deflation and correcting acidosis (e.g. IV fluids, bicarbonate) to blunt the impact. In short, the **established literature and guidelines repeatedly link tourniquet removal to a transient metabolic acidosis**, and advise clinicians to anticipate and mitigate it ⁹ ².

In conclusion, there **is** a direct, documented relationship between tourniquet removal and systemic metabolic acidosis. Prolonged limb ischemia causes anaerobic metabolite buildup, and their sudden washout on deflation acutely lowers blood pH ³ ⁷. This reperfusion-induced acidosis is typically short-lived, but it can be clinically significant (especially after lengthy occlusion) and is explicitly discussed in peer-reviewed and military sources. Clinicians are advised to prepare for and treat this transient acidosis when removing tourniquets after prolonged use.

Sources: Recent reviews and studies of tourniquet physiology and trauma care ² ³ ⁷ ⁶ ⁵ ⁹ ¹ ⁸.

¹ The Reperfusion Toolbox: How to Resuscitate a Casualty in Preparation for Tourniquet Removal after an Extended Duration of Application | The Cove

<https://cove.army.gov.au/article/reperfusion-toolbox>

² ³ Tourniquet application during anesthesia: “What we need to know?” - PMC

<https://pmc.ncbi.nlm.nih.gov/articles/PMC5187604/>

⁴ ⁷ Saudi Journal of Anaesthesia

https://journals.lww.com/sjan/fulltext/2015/09040/cardiac_arrest_following_tourniquet_release_needs.32.aspx

⁵ Systemic responses to tourniquet release in children - PubMed

<https://pubmed.ncbi.nlm.nih.gov/3089065/>

⁶ European Journal of Emergency Medicine

https://journals.lww.com/euro-emergencymed/Fulltext/2013/12000/Reducing_the_potential_for_tourniquet_associated.5.aspx?generateEpub=Article%7Ceuro-emergencymed:2013:12000:00005%7C10.1097/mej.0b013e3283591668%7C

⁸ fmtbneast.marines.mil

<https://www.fmtbneast.marines.mil/Portals/237/Docs/Student%20Materials/TCCC%20Guidelines.pdf>

⁹ A Tourniquet De-Escalation Framework for the Australian Defence Force | The Cove

<https://cove.army.gov.au/article/tourniquet-de-escalation-framework-australian-defence-force>