Tourniquet release: physiologic changes

Tourniquet application is common in extremity surgery. By placing a tourniquet on a limb after exsanguination, blood loss can be minimized and surgical visualization improved. Although generally well tolerated, tourniquet inflation, and especially deflation, can be associated with substantial physiologic changes you need to be aware of.

Exsanguination of the limb with an Esmarch bandage and Inflation of the tourniquet is associated with an increase in effective blood volume, central venous pressure, and systemic vascular resistance, resulting in a rise in blood pressure. The BJA article below even references a report of cardiac arrest with tourniquet inflation due to this, but there is no reference. Blood pressure can further increase after ~45 minutes of tourniquet inflation thought to be due to tourniquet pain. Tourniquet inflation is also associated with platelet activation and hypercoagulability, although the clinical significance of this is uncertain. You may also see a rise in core temperature due to the patient having less surface area involved in circulation and therefore less heat lost to the ambient environment.

Far more consequential, are the physiologic changes that occur with tourniquet deflation. With no blood flow to the limb for minutes/hours, cells have switched over to anaerobic metabolism with a consequent fall in their PaO_2 and rise in their $PaCO_2$ and lactate. The release of the tourniquet returns circulation to the limb and returns this, inflammatory mediators, and other byproducts of ischemia and anaerobic metabolism, to the central circulation. This causes a **rise in end-tidal CO_2, lactate, and potassium** (due to the acidosis), and a **fall in pH, blood pressure, and central venous pressure**, there are a multitude of case reports regarding cardiac arrest due to this. The rise in CO_2 causes cerebral vasodilation resulting in an increase in middle cerebral artery blood velocity of up to 50%. Hyperventilation should help mitigate this rise in cerebral blood flow and end-tidal CO_2. Reintroduction of the cold limb to systemic circulation and redistribution of blood also causes a **fall in temperature**. Similarly, now that the oxygen starved limb is getting blood flow, the patient may demonstrate a **rise in O_2 consumption and CO_2 production.** Concordant with the release of the tourniquet, one can see a short period of increased fibrinolysis which resolves within 30 minutes.

Further Reading:

Kumar K, Railton C, Tawfic Q. Tourniquet application during anesthesia: "What we need to know?". J Anaesthesiol Clin Pharmacol. 2016 Oct-Dec;32(4):424-430. doi: 10.4103/0970-9185.168174. PMID: 28096570; PMCID: PMC5187604.

John L. Deloughry, FRCA, Richard Griffiths, MD FRCA, Arterial tourniquets, Continuing Education in Anaesthesia Critical Care & Pain, Volume 9, Issue 2, April 2009, Pages 56–60, https://doi.org/10.1093/bjaceaccp/mkp002