

PNEUMATIC TOURNIQUET

inflation alone activated a systemic formation of the thrombosis.⁵⁴

In another study, researchers confirmed that cellular interactions that augment blood coagulability were increased in the perioperative period for patients who underwent total knee arthroplasty. They also concluded that these responses were more prominent during tourniquet-assisted total knee procedures.⁵⁵

- II.c. The perioperative nurse should collaborate with the surgeon and anesthesia professional to address considerations related to the plan for anesthesia or ischemic preconditioning.⁵³ [2: *Moderate Evidence*]

The purpose of ischemic preconditioning is to increase the tolerance of tissue to a longer period of ischemia by initiating brief periods of ischemia⁵⁶ or influencing skeletal muscle tolerance with anesthetic regimens.⁵⁷ Several studies have investigated the correlation between various anesthesia or preconditioning techniques and oxidative stress related to ischemia and reperfusion that occurs after the release of a tourniquet.^{42-44,58-64}

To reduce oxidative stress related to tourniquet inflation, preconditioning techniques may be planned to initiate short intervals of temporary ischemia (eg, three cycles of five minutes, followed by five minutes of reperfusion just before tourniquet inflation).^{42,44,59,61} Perioperative nurses may participate in activities related to preconditioning (eg, retrieving medications, setting up equipment, coordinating the timing of skin preparation, documenting intervals of inflation). By collaborating with the surgeon and anesthesia professional, the nurse will be better prepared to assist in preconditioning-related activities.⁵³

- II.d. Before the patient enters the OR, a pneumatic tourniquet cuff should be selected using the following considerations.
- The width of the tourniquet cuff should be as wide as possible without inhibiting surgical site exposure.^{50,65}
 - Contoured tourniquet cuffs should be used for patient extremities in which there is a tapering of the extremity between the upper and lower edge of the cuff.^{23,50,65}
 - The length of the tourniquet cuff should be sufficient to provide bladder overlap on the limb and full engagement of the hook-and-loop fasteners.

[2: *Moderate Evidence*]

Confirming that a tourniquet with the appropriate cuff size and shape is available before the patient enters the OR decreases the risk of using the wrong cuff size or shape or causing a delay to search for the appropriately sized cuff while the patient is under anesthesia.

Improper tourniquet cuff application may lead to skin injuries (eg, pressure necrosis, fric-

tion burns).⁵ The risk of injury to tissue and nerves increases when more pressure is required for vessel occlusion. The ratio of the cuff width to the limb circumference has an inverse relationship with limb occlusion pressure (eg, wider cuffs require lower tourniquet pressures, narrower cuffs require higher tourniquet pressures).²⁰ Choosing the wrong cuff size or shape could lead to unnecessarily higher pressures and increase the risk for injury.

Wider cuffs minimize the risk for injury to underlying tissue by dispersing pressure over a greater surface area. In clinical trials, using a wider cuff has been found consistently to occlude blood flow at a lower pressure in adult patients.^{50,65-67} Similar results were found using wider cuffs in children.¹⁸ Contoured tourniquet cuffs have been found in clinical trials to occlude arterial flow at lower pressures than straight tourniquet cuffs of equal width. Contoured tourniquet cuffs minimize the risk of excessive pressure on one edge of the cuff, migration of the cuff, and a shearing injury to underlying tissue.^{23,50,65}

- II.e. A sterile cuff should be used when the cuff will be very close to the sterile field. A single-use cuff should be used when adequate protection of the cuff from contamination cannot be assured. [3: *Limited Evidence*]

Researchers conducted a study at two hospitals to assess microbial colonization on reusable tourniquet cuffs versus sterile single-use disposable tourniquets. They found that 23 of the 34 reusable tourniquet cuffs were contaminated before surgical application. Although they did not follow the patients to find out the incidence of surgical site infection in the 23 patients who had contaminated cuffs applied, the researchers concluded that sterile single-use tourniquet cuffs are preferred to decrease the bacterial load when the cuff is placed in close proximity to the surgical site.⁶⁸

- II.f. Potential risks for patient injuries and complications associated with dual-bladder cuffs used for intravenous regional anesthesia should be identified and safe practices should be established. [3: *Limited Evidence*]

Reports indicate that complications associated with intravenous regional anesthesia include local anesthetic toxicity, seizures, cardiac arrests, compartment syndrome, thrombophlebitis, discoloration, or widespread petechiae.⁴⁷ When using intravenous regional anesthesia, there is a risk for local anesthetic toxicity caused by accidental tourniquet failure or leakage around the tourniquet due to high venous pressure.^{49,69} Complications can also occur that are related to tubings and misconnections (eg, attaching to distal versus proximal cuffs) when using dual cuffs for intravenous regional anesthesia.^{70,71}





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- II.f.1. Based on the preoperative patient assessment, the perioperative nurse should identify medication allergies, especially sensitivities to local anesthetics, and communicate with the anesthesia professional to clarify the plan for intravenous regional anesthesia before the tourniquet is applied.
- II.f.2. The perioperative RN should confirm that
- a dual-bladder tourniquet cuff and extra connective tubing will be used,
 - the planned location on the extremity is wide enough to accommodate the additional width of the dual-bladder tourniquet cuff, and
 - a higher pressure is planned to compensate for the narrow size of each cuff bladder.¹⁷
- Although intravenous regional anesthesia is more common in upper extremities, dual tourniquet cuffs and injection of local anesthetics have been used for lower extremities.⁷² Variation in cuff sizes and the need for dual cuffs versus two separate cuffs will depend on the size of the patient's extremity and the location planned for the regional block.
- II.f.3. Members of the perioperative team should clearly communicate with each other about the inflation-deflation sequence when using a dual-bladder cuff and when using two single-bladder cuffs together for intravenous regional anesthesia.
- II.f.4. The proximal and distal cuffs and the respective tubing should be clearly identified.

Recommendation III

Patient safety should be the primary consideration when using a pneumatic tourniquet and its accessories.

Patient injury related to pneumatic tourniquet use has been reported. For example, one case report found that if the cuff that is applied to a patient's extremity has a bladder that is bent, folded, or crushed, adequate pressure may be compromised, resulting in bleeding at the surgical site.⁷³ Excessive pressure from the tourniquet may cause limb redness, bruising, swelling, or nerve injury.⁶

- III.a. The tourniquet's tubing and connectors should be incompatible with other tubing (eg, intravenous) or labeled to clearly identify that they are part of the tourniquet system.^{70,71} [3: Limited Evidence]
- Although reports of misconnections involving tourniquet tubing are not common, misconnections of other types of tubing and connectors (eg, blood pressure tubing, Luer connections) have been reported.^{70,71}
- III.b. Before each use, the perioperative nurse should verify that the entire tourniquet system is com-

plete, clean, and functioning according to the manufacturer's instructions for use.

- The pneumatic tourniquet regulator should be compatible with all associated components, and the connections should be secure.¹⁷
- The cuff, tubing, connectors, and o-rings should be inspected for cracks, leaks, and other damage.¹⁷
- The tourniquet should be tested for integrity and function.¹⁷
- The integrity of the hook-and-loop fasteners and tie ribbons should be inspected.¹⁷
- A full battery power charge should be confirmed, if applicable.¹⁷

[3: Limited Evidence]

Ensuring that the tourniquet functions properly before a procedure reduces the risk of pressure loss and patient injury.¹⁷

Unintentional pressure loss can result from loose tubing connectors, deteriorated tubing, or cuff bladder leaks and may result in patient injury.

- III.c. A pneumatic tourniquet that is not working properly or is damaged should be removed from service immediately, along with all its accessories, and reported to the designated individual responsible for equipment maintenance (eg, biomedical engineering personnel).⁷⁴ [2: Moderate Evidence]
- III.d. The perioperative RN should verify the correct surgical site before application of the tourniquet cuff and verify the tourniquet inflation pressure during the time-out process.⁷⁵ [2: Moderate Evidence]

Placing a tourniquet on the wrong limb may result in a cascade of events leading to wrong site surgery. Confirmation of the location of the tourniquet and its pressure setting during the time-out process increases communication and consistent documentation and reduces the likelihood of error.

- III.e. Safety practices should be implemented when applying tourniquet cuffs to the verified operative extremity. [2: Moderate Evidence]

When the tourniquet cuff is inflated, nerves and blood vessels are compressed. This poses a potential risk to superficial nerves that are in unprotected areas during cuff placement.^{4,23}

Proper application of the cuff decreases the risk for injury or pressure variances.^{5,17,76-80} For example, a loose fitting cuff may shift after placement, causing a friction burn on the skin.⁵ Higher pressures also may be needed if the cuff is applied too loosely.¹⁷ Patients who are obese or others who have loose skin and adipose tissue at the site of the tourniquet cuff are at risk for the skin folding or puckering beneath the tourniquet cuff. This increases the risk for uneven pressure on vessels and skin injury.¹⁷

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- III.e.1. Tourniquet cuffs should be applied snugly to the verified operative extremity⁵⁰ and in a position on the extremity that creates a minimal amount of ischemia.²⁷

In one quasi-experimental study of 50 patients undergoing surgery for carpal tunnel syndrome under local anesthesia, researchers recommended placement of the tourniquet on the upper arm. They reported that there were not significant differences for patients tolerating tourniquets placed on the upper arm versus the forearm when the tourniquet time was shorter than 20 minutes. In addition, the patient's fingers may curl up and the tourniquet cuff may interfere with the surgical incision when it is placed at the forearm.⁴¹ Researchers have found that patients undergoing foot surgery with local anesthesia have less pain when the cuff is placed at the ankle.⁸²⁻⁸⁴

- III.e.2. When applying the tourniquet cuff to the small limb of a child where space is limited, the perioperative RN should evaluate the size, shape, and fit of the tourniquet to avoid its movement during the procedure. **Sterile tourniquets should be considered for use if the tourniquet must be positioned close to the surgical site.**⁷⁶

Children's extremities can present unique challenges related to the size of the limb (eg, no space for the tourniquet, acute taper of a young child's thigh). If the tourniquet is not the right shape or is not applied tightly enough, it may slide toward the surgical wound, risking loss of compression or interference at the surgical site.⁷⁶

- III.e.3. The cuff should be applied in its final position. If at any time a cuff position change is necessary, the cuff should be removed and reapplied.

Moving a cuff after placement may cause shearing of underlying tissues and subsequent injury.

- III.e.4. A low-lint, soft padding (eg, limb protection sleeve, two layers of stockinette) should be placed around the limb according to the cuff manufacturer's instructions for use. The padding should be wrinkle-free and should not pinch the skin.

In two clinical trials, the overall skin complication rate was lower when padding was used.^{77,78} However, higher pressures may be needed if a cuff is applied over a thick layer of loose padding.¹⁷

Avoiding padding materials that may shed fibers (eg, cotton cast padding, sheet padding) will decrease linting. When lint from padding materials becomes embedded in the hook-and-loop fasteners of a tourniquet, it may reduce the effectiveness of the fasteners and potentially lead to an

unexpected release of the cuff during a procedure.

- III.e.5. The patient's skin under the tourniquet cuff should be protected to prevent fluid accumulation (eg, skin prep solutions, irrigation) under the cuff.

Underpadding and tourniquet cuffs can harbor moisture, resulting in skin breakdown if protective interventions are not taken. Two cases have been reported in which patients had to undergo burn wound excision and skin grafting because of chemical burns caused by pooling of the prep solution under a tourniquet.⁸⁰

- III.e.6. Reusable tourniquet cuffs should be protected from contamination by fluid, blood, and other potentially infectious material during surgery. Tourniquet protectors (eg, U-shaped drapes, adhesive drapes, tourniquet covers) should be used to minimize soiling.

Reusable tourniquet cuffs that are not protected from fluid, blood, and other potentially infectious material can be a source of cross contamination.

- III.e.7. The cuff tubing should be positioned on or near the lateral aspect of the extremity.

Lateral placement of the cuff tubing may help avoid pressure on nerves of the extremity and prevent kinking of the tubing.

- III.f. Procedures involving pneumatic tourniquet control on two extremities should have the tourniquet tubing labeled to clearly identify which tubing belongs to which cuff and which is associated with which components of the tourniquet system(s). The perioperative RN, surgical team members, and anesthesia professionals should confirm the respective placement of the tourniquets and plans for inflation during the time-out process.²⁵ [2: Moderate Evidence]

The risk for complications and the systemic effects of tourniquet use may increase when ischemia and reperfusion occur in two extremities. However, in one published expert opinion, the authors suggested that the delay between the sequential deflation of the first cuff and inflation of the second cuff allows time for caregivers to assess the systemic response and accommodate for the lactic acid released from the first procedure before the second cuff is inflated. If the patient does not tolerate the reperfusion or if complications occur in the first procedure, the option of aborting the second procedure may be a better choice than performing simultaneous bilateral procedures.⁸⁵

The use of two tourniquet cuffs increases the number of tubings and connections which can increase the opportunity for errors of misconnections or inflation or deflation of the wrong cuff. Labeling the tubing to each cuff

