Physiologic amputation: A case study

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Acute limb ischemia is a complication of severe peripheral arterial disease that can be a threatening limb as well as life. Multiple procedures exist today to help revascularize extremities; however, even with the latest technologies, surgical amputation of the limb may still be necessary. Cryoamputation, or physiologic amputation, is a method used to treat patients who are hemodynamically unstable for the operating room and who are in need of urgent amputation owing to arterial ischemia. This procedure is used in the rare instance where not only a persons' limb is threatened, but also their life. This is a case study regarding one patient who presented to the hospital with limb-threatening ischemia who became hemodynamically unstable owing to the rhabdomyolysis associated with the ischemia of his lower extremity. Cryoamputation was used to stabilize the patient and prevent further deterioration, so that he could safely undergo surgical amputation of the limb without an increase in mortality risk. Cryoamputation must be followed by formal surgical amputation when the patient is hemodynamically stabilized. It is not a limb salvaging, procedure but it is a life-saving procedure. This case study demonstrates the usefulness of the procedure and discusses the technique used for cryoamputation. (J Vasc Nurs 2014;32:25-28)

Acute limb ischemia is a limb- and life-threatening condition. Acute limb ischemia occurs when there is a sudden halt of blood flow to a patient's peripheral arterial system. This sudden lack of blood flow begins a process of myoglobinuria or rhabdomyolysis, which is the breakdown of muscle and represents a loss in muscle cell integrity. This can also lead to rhabdomyolysis-associated acute renal failure.[1] This process, if left untreated, can progress to systemic sepsis and ultimately be life threatening. Current treatments for acute limb ischemia include abdominal aortogram with possible angioplasty, stent placement, thrombolysis, angiojet procedures, and surgical revascularization. There are times that these procedures prove to be unsuccessful and surgical amputation of the extremity is required. Patients who have comorbidities or are exhibiting signs of sepsis are at greater risk of mortality from urgent primary surgical amputation.[2] Correction of metabolic abnormalities, control of sepsis, and hemodynamic stabilization before surgery improve patient survival.[3]

Cryoamputation, or physiologic amputation, can serve as a bridge for managing a high-risk surgical patient. Cryoamputation allows time for management of comorbidities and reversal of metabolic and hemodynamic instability before surgery by halting myonecrosis and myogloburia or rhabdomyolysis.[1,3] Dry ice is applied to the ischemic limb in a patient who is medically too unstable for surgery. The extremely cold temperature physiologically amputates the nonviable extremity and results in rapid control of sepsis with the added benefit of pain control.[2,3] Cryoamputation is irreversible and must lead to a formal amputation. Patients can be managed for up to 6 weeks using cryoamputation.

A review of the literature was performed using search engines PubMed, CINHAL, Medline, and Scirus. Our review extended to articles as far back as 1967 with the Hussain's et al[4] article discussing preoperative freezing with complicating gangrene. The most recent article regarding physical amputation was in 1993 with Winburn et al,[1] who noted that myoglobinuria could be prevented by physiologic amputation.

This is a case study discussing acute limb ischemia that resulted in cryoamputation of the affected limb in a hemodynamically unstable patient. WB is a 76-year-old white man with a history of peripheral arterial disease and chronic occlusive arterial disease of the lower extremities caused by atherosclerosis. He had previously undergone a left femoral to tibial bypass graft, which was chronically occluded with little collateral runoff noted to the left lower extremity. After the chronic occlusion occurred, he was determined to be nonreconstructable in his left lower extremity vascular system. He was being treated medically with warfarin, clopidogrel, and aspirin. Of note, the patient's medical history included atrial fibrillation, hyperlipidemia, and diabetes mellitus; he was taking amiodarone, digoxin, pravastatin, and sitagliptin. His vascular history included STEAL phenomenon status post left common carotid artery to left subclavian artery bypass graft, coronary artery bypass graft, and pacemaker placement. Before his episode of acute limb ischemia, his ankle/brachial index in his left lower extremity 0.44 and right lower extremity was noncompressible. Toe/brachial index was 0.52 in the left lower extremity and 0.70 in the right lower extremity. During a routine office visit in April 2010, the patient's claudication symptoms were stable and he showed no signs of ischemia in his left lower extremity.

WB presented to the vascular surgeon's office in May 2010 with an acutely ischemic left lower extremity. His complaints included a cold and painful left lower extremity that began

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TABLE 1

LABORATORY RESULTS

Test	*Admission*	*Day 1*	*Day 2*	*Day 3 (Cryoamputation)*	*Day 4 (Surgery)*	*Day 5*	*Day 6*	*Discharge*
White blood count	10.9	19.5	18.2	16.9	15.7	14.4	12.7	10.2
Hematocrit	28.6	25.3	33.0	31.4	32.8	30.0	29.6	30.4
Creatinine	1.55		2.19	2.56	2.19	2.23	1.81	1.02

suddenly after suffering a fall at his house. On examination in the office, he was noted to be pulseless to the left lower extremity; however, he remained positive for peroneal sensation and motor function of the limb. WB was admitted to the surgical intensive care unit (SICU) for close observation of his neurovascular status and primary management of comorbidities.

Initial therapy in the SICU consisted of a heparin infusion using a standardized protocol, intravenous hydration for his history of chronic kidney disease, pain management, and transfusions of fresh frozen plasma to reverse his warfarin. The following morning, the patient was noted to have an International Normalized Ratio of 1.9 and a hematocrit of 25.3. Two additional units of fresh frozen plasma and 2 U of packed red blood cells were transfused before being taken to the interventional radiology department (IR) for an abdominal aortogram with bilateral lower extremity runoff. The aortogram revealed a chronically occluded left femoral to tibial bypass graft and superficial femoral artery with an acute thrombus at the origin of the left profunda. An arterial sheath was placed into the femoral artery for direct administration of tissue plasminogen activator (TPA) at 1 mg/min. Intravenous heparin, intravenous hydration, and pain management were continued. The patient returned to the SICU for management.

On hospital day 2, physical assessment continued to demonstrate a cold, mottled left foot with capillary refill of greater than 5 seconds. The patient returned to IR for a follow-up aortogram. Thrombolysis of the left profunda thrombus was achieved, but no flow was noted past the ankle. Only a two-vessel runoff was noted, the peroneal and posterior tibial, which did not extend past the ankle. TPA via the arterial sheath and peripheral heparin were continued with planned reevaluation in IR the next day. Several hours after returning to the SICU, the patient began to experience sinus tachycardia with a labile blood pressure, decreased urinary output, and intermittent confusion. Physical assessment revealed left thigh enlargement. The vascular surgeon and the interventionalist were notified. Orders were received to administer volume resuscitation, hold narcotics, send stat labs, and obtain computed tomography (CT) of the brain. Laboratory results demonstrated a decrease in the hematocrit from 33.7% to 24.6%, and the hemoglobin from 11.5 to 8.8 in 9 hours. Other results included a fibrinogen of 266 and partial thromboplastin time of 37.4. WB's creatinine increased from 2.19 to 2.66 in 8 hours (Table 1). CT of the brain ruled out a hemorrhage in his brain. Upon these results, the TPA infusion and heparin were discontinued and 2 units of packed red blood cells transfused owing to concerns of blood loss anemia associated with TPA administration.

On hospital day 3, the patient continued to demonstrate intermittent confusion. His creatinine was elevated and he continued to experience decreased urinary output. A nephrology consult was obtained; recommendations included administration of a furosemide infusion and additional fluid boluses. Arteriogram showed recurrent thrombus of the left profunda with essentially no flow below the knee. Attempts at anjiojet, a percutaneous procedure for thrombectomy, and angioplasty were performed with no success (Figure 1). CT of the abdomen, pelvis, and lower extremity showed a hematoma associated with the left femoropopliteal graft without extension into the retroperitoneum. There was some air noted within the hematoma; there was also abnormal enlargement of the muscle compartment of the left posterior thigh. At this time, the patient's extremity was determined to be unsalvageable; tentative plans were made for surgical amputation. A temporary dialysis catheter was placed owing to the acute on chronic kidney disease related to rhabdomyolysis from his ischemic leg. Fortunately, the patient did not require dialysis on this admission.

That afternoon, the patient began to experience anuria, and a labile blood pressure requiring phenylephrine hydrochloride support. His neurologic status declined from confused to obtunded. The vascular surgeon was paged to the SICU to evaluate the patient. It was felt at that time the patient was experiencing septic shock related to myoglobulin released from the ischemic leg. Cryogenic amputation of the left lower extremity was initiated.

Operative consent was obtained before the initiation of cryoamputation because this procedure is irreversible and always leads to formal surgical amputation. Perioperative teaching was performed with the patient and family, who stated understanding of the procedure. Operative consent contained both procedures: Cryoamputation and surgical amputation of the left lower extremity. The patient was medicated for pain before the application of the dry ice. The physician determined the level of amputation and placed two Penrose tourniquets 6 inches below the proposed level of surgical amputation. The physician determined the level of amputation with the goal that the selected level of amputation would reliably heal and also yield a stump that would readily be fitted with prosthesis.[5] WB's left lower extremity was then layered in plastic and blankets to prevent direct exposure of dry ice to the patient's leg (Figure 2). A large Styrofoam cooler was crafted for insertion of the patient's leg