

Reperfusion injury after Vandenbos procedure in the primary care office

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Reperfusion injury is a potential complication of minor surgical procedures involving tourniquets performed in the family physician's office. It can be difficult to distinguish reperfusion injury from other complications that require immediate intervention, such as cellulitis, allergic reaction, critical ischemia, or necrotizing fasciitis. However, timely and accurate diagnosis can avoid inappropriate use of antimicrobial medications. We report the case of a healthy 21-year-old man who presented to the family medicine office after periungual skin was excised from his toe in a primary care setting. The patient showed clinical signs and symptoms suggestive of reperfusion injury.

Case

A 21-year-old man presented to the family medicine office with a 4-month history of recurrent infection in the right great toe (**Figure 1A**). He had been treated with multiple courses of cephalexin for "ingrown toenails." He tolerated a previous Vandenbos procedure¹ to the same area on his left toe. He had no relevant past medical history, including no personal history of peripheral vascular disease, diabetes, immunocompromise, or allergies to anesthetics. He was taking no medications and had no allergies.

The patient elected for the Vandenbos procedure, which was performed in an academic family physician's office. Informed consent was obtained. Periungual skin and soft tissue were excised from both sides of the right great toenail in a sterile fashion. A tourniquet was applied for approximately 15 minutes in total. The patient was given a written set of discharge instructions for pain management and wound care¹ (**Figure 1B**) and he returned for follow-up on postoperative day 4 (**Figure 1C**), when he presented with progressive swelling, redness, discoloration, and decreased sensation in his right toe. The patient denied fevers, chills, fatigue, or pain out of proportion to the lesion on his toe. A small amount of serosanguinous drainage was seen. There was substantial edema, blistering, and ecchymosis over the dorsal and plantar surfaces of the great toe, and well-demarcated erythema at the base of the toe where the tourniquet had been applied. However, active flexion and capillary refill remained normal. Given the changed appearance, a provisional diagnosis of postoperative infection was made. The patient was empirically treated with a 7-day course of clindamycin.

During the next week, the patient continued to have decreased sensation in the distal toe but denied severe pain, fever, or malaise. The affected area remained well demarcated and had not spread proximally. No purulent drainage was seen, active flexion at the interphalangeal joint remained intact, and the patient remained afebrile. No bony destructive lesion or substantial joint space narrowing were identified on an x-ray scan. However, given the evolving appearance of the lesion, there remained concern about necrosis secondary to infection. Thus, the antimicrobial regimen was switched to a 10-day course of 500 mg of oral cephalexin 4 times a day. Additionally, an infectious disease specialist and an orthopedic surgeon were consulted. Both agreed that the appearance was worrisome. Although culture and sensitivity analyses showed light growth of *Staphylococcus aureus*, his white blood cell count ($5 \times 10^9/L$) and C-reactive protein level ($< 10 \text{ nmol/L}$) were both normal.

Editor's key points

- ▶ Reperfusion injury is a potential complication of surgical procedures that use tourniquets. It can be distinguished from infection by the absence of clinical markers of infection. Antibiotics are unnecessary unless there are other signs and symptoms to suggest infection, such as severe pain or fever.
- ▶ While tourniquets can be applied safely for a maximum of 3 hours, they should be applied for the minimum amount of time possible.
- ▶ If the diagnosis is unclear, it is important to reach out for expert opinion on management.

Points de repère du rédacteur

- ▶ Les lésions de reperfusion sont une possible complication des interventions chirurgicales à l'aide de tourniquets. Elles se distinguent d'une infection par l'absence des marqueurs cliniques d'infection. Les antibiotiques sont inutiles, à moins qu'il y ait d'autres signes et symptômes laissant présager une infection, comme une douleur intense ou de la fièvre.
- ▶ Des tourniquets peuvent être appliqués en toute sécurité pendant un maximum de 3 heures, mais ils devraient l'être le moins longtemps possible.
- ▶ Si le diagnostic est incertain, il importe de faire appel à un expert pour des conseils sur la prise en charge.

A family physician with expertise in the Vandembos procedure was also consulted.¹ He proposed an alternative diagnosis of reperfusion injury—a paradoxical inflammatory response that occurs after rapid return of blood to ischemic tissue. This diagnosis was consistent with the presentation and quite plausible. The infectious disease specialist and orthopedic surgeon agreed. Antimicrobial therapy was thus discontinued. The patient was encouraged to continue strict adherence to the prescribed wound care regimen.

During the postoperative course, the violaceous discoloration resolved and areas of erythema became pink. Vesicles on the plantar aspect of the toe began to resolve. There was granulation tissue on the medial and lateral aspects of the nail at the sites of excision (Figures 1D to 1F). The patient remained systemically well.

Discussion

Reperfusion injury is the paradoxical destruction of ischemic tissue after blood flow is restored. It is also known as *ischemic perfusion-reperfusion injury* and is a well-documented complication of myocardial and cerebral infarction following percutaneous coronary intervention or thrombolysis.^{2,3} It has also been documented in organ transplantation, cardiopulmonary bypass, and vascular surgery, and in orthopedic procedures that involve tourniquet use.⁴ In the office setting of a family medicine practice in southern Ontario, the rate of reperfusion injury after Vandembos procedure was estimated to be 1 in 500 cases (Dr Henry Chapeskie, written communication, 2018).

Prolonged use of a tourniquet promotes the inciting damage from ischemia. The pathophysiology of reperfusion injury is not fully understood (Table 1).³⁻⁷ Proposed theories include oxidative stress,^{3,5,6} intracellular calcium overload,^{3,5} inflammation,^{3,7} and complement activation.³⁻⁵

There is no documentation on clinical presentation, management, and prognosis of reperfusion injury in extremities after minor surgical procedures performed in a primary care setting.

In this case, several key features of an infectious cause were absent: there was no proximal migration of the lesion, pain on passive stretch, fever, leukocytosis, elevation in serum inflammatory biomarkers, or bony changes on x-ray imaging. The patient was systemically well throughout the postoperative course, and there was stark demarcation from the tourniquet.

The literature suggests that tourniquets should be applied for the minimum amount of time possible; however, they can be applied safely for up to 3 hours.^{8,9} In this case, the tourniquet was not applied for an unusually long period of time. However, some patients might be predisposed to reperfusion injury. Exposure to brief periods of ischemia is known as *ischemic preconditioning* and, interestingly, has been shown to confer protection against reperfusion injury.¹⁰ The exact mechanism of ischemic preconditioning is unknown.¹⁰

Figure 1. Appearance and course of resolution of reperfusion injury to the right great toe before and after the Vandembos procedure: A) Before the procedure, B) postoperative day 2, C) postoperative day 4, D) postoperative day 19, E) postoperative day 28, and F) postoperative day 37.



A limitation in this case is that antibiotics could have treated a concomitant infection. However, when sterile technique is used, there is no evidence to suggest giving prophylactic antibiotics improves outcomes in outpatient surgical procedures.¹ Antibiotics were therefore not appropriate for this patient.

Table 1. Proposed theories for the pathophysiology of reperfusion injury

PROPOSED THEORY	DESCRIPTION
Oxidative stress ^{3,5,6}	During ischemia, there is increased production of free radicals by local tissues and damaged mitochondria. On reperfusion, free radicals accumulate and destroy tissue because cellular antioxidants have been depleted
Intracellular calcium overload ^{3,5}	ATP is depleted during ischemia. Consequently, function of membrane sodium-potassium ATPase pumps is compromised, leading to electrolyte disturbances and cell swelling. Intracellular hypercalcemia triggers pro-apoptotic signaling pathways that are further exacerbated when ATP supply is restored during reperfusion
Inflammation ^{3,7}	Macrophages and damaged tissue secrete cytokines that promote neutrophilic recruitment. During reperfusion, this leads to accelerated neutrophilic extravasation of healthy tissue
Complement activation therapy ³⁻⁵	When ischemic tissue is reperfused, immunoglobulin M antibodies that were deposited onto ischemic tissues bind to complement proteins, upregulating local inflammation. Organ dysfunction and systemic inflammatory response syndrome have been reported in cases of major surgery or traumatic injury ⁴

ATP = adenosine triphosphate, ATPase—adenosine triphosphatase.

Conclusion

This case was challenging, as the differential diagnosis for the lesion included both dangerous and self-limiting conditions. The management plan could have been inappropriately escalated had the patient's benign general appearance, vital signs, and markers of systemic inflammation not been considered. It is crucial to recognize reperfusion injury in the primary care setting to avoid inappropriate use of antimicrobial medications and to ensure judicious use of finite health care resources.

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Acknowledgment

We thank **Dr Henry Chapeskie** and the Sunnybrook Health Sciences Centre Peer Support Writing Group for their assistance.

Competing interests

None declared

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This article has been peer reviewed.

Cet article a fait l'objet d'une révision par des pairs.
Can Fam Physician 2018;64:903-5