Acute Limb Ischemia After Self-Injection of Crushed Morphine Tablets into the Radial Artery: Role of Infrared Thermography in the Assessment of Tissue Perfusion

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Patient: Male, 51-year-old
Final Diagnosis: Acute right limb ischemia after self-injection of crushed morphine tablets
Symptoms: Cyanosis • necrosis • pain
Medication: —
Clinical Procedure: Amputation • Dialysis • Fasciotomy • Ultrasonography
Specialty: Surgery
Objective: Management of emergency care

Background: This article presents a case involving complications after intentional injection of crushed tablets into the arterial circulation, its diagnosis, and the treatment adopted. The diagnosis process illustrates the potential of techniques based on thermal imaging as tools to assess tissue perfusion. Inadvertent intravenous injection of crushed tablets is more common, but there are few reports on arterial circulation, and no studies were found on the self-injection of crushed morphine tablets, particularly into the radial artery.

Case Report: A 51-year-old man with alcoholism and a history of illegal drug usage intentionally self-injected 3 crushed morphine tablets into his right radial artery. The patient progressed with compartment syndrome, requiring decompressive fasciotomy of the right forearm and ischemia of the right fingers, which were amputated. He presented with rhabdomyolysis and required dialysis. The patient agreed to full heparinization, corticotherapy, and the use of nitroglycerin and prostaglandin E1. Due to the progression of the necrotic area, the patient underwent proximal phalanx excision and surgical reconstruction of the right-hand remnant.

Conclusions: The injection of morphine tablets into circulation caused severe complications, which led to the excision of the proximal phalanx and the surgical reconstruction of the remnant of the right hand. In the present case, infrared thermography proved to be an effective method in assessing tissue perfusion.

Keywords: Infusions, Intra-Arterial • Ischemia • Microcrystalline Cellulose • Thermography

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Background

The literature on complications after inadvertent or intentional injection of crushed tablets into the arterial circulation is scarce, and no effective medical treatment against lesion progression has been reported to date. The factor with the most significant potential to modify outcomes is the time between injection and treatment by a specialized vascular team [1]. The risk of necrosis appears to be even more remarkable following intra-arterial injection of benzodiazepines when compared with other drugs [1]. The incidence of iatrogenic inadvertent intra-arterial injection has been estimated to be between 1: 3440 and 1: 56 000, based primarily upon decades-old data, and during the more common use of thiopental [2]. Cases of intentional venous or arterial injection are rare and therefore it is difficult to estimate their incidence.

A systematic review by Devulapalli et al showed that the most common site for inadvertent arterial injections was the brachial artery (40%), followed by the radial artery (24%), and most patients presented with a combination of severe pain (78%), and cyanosis and spots (46%). Motor impairment at presentation was reported in 37%, sensory deficit in 34%, and decreased temperature in 26% of patients [3]. Whether intentionally or inadvertently, lesions caused by intra-arterial injection of tablets have a similar pattern of symptoms.

Infrared thermography is a diagnostic tool that has gained relevance in several areas of medicine. This technique employs devices that detect infrared radiation emitted by the surface of the body, which allows for fast and accurate non-contact measurement of temperature changes in the skin and, unlike contact probes, imaging thermography does not influence the region where the temperature is measured as the probe does not absorb heat from the skin. Different factors can cause temperature changes in the skin. For example, increased metabolic activity in the muscles and increased blood perfusion in the region can cause the skin to heat up. On the other hand, a decrease in blood perfusion can lead to skin cooling. Thus, in many cases, changes in temperature patterns can be due to changes in blood flow, thus potentially allowing the assessment of tissue perfusion in situations of acute ischemia.

Furthermore, when the temperature measuring device can provide a temperature map of a skin region, as in imaging thermography, the physician can obtain even richer information. In addition, there are cases in which large vessels have normal flow, but this flow does not reach a subset of small vessels, causing perfusion deficiencies. In some of these cases, thermography could, in principle, be more effective than ultrasound-based techniques.

Case Report

A 51-year-old man with alcoholism and illicit drug usage history presented to our hospital after self-injection of 3 crushed morphine tablets (10 mg) into the right radial artery during an abstinence crisis. He was admitted approximately 1 h after the event with severe pain that showed no improvement with opioids, and he ultimately required a brachial plexus blockade. Upon admission, physical examination showed that his right upper limb (RUL) was cold and cyanotic (Figure 1). Brachial, axillary, radial, and ulnar pulses were palpable with preserved amplitudes. RUL arterial Doppler ultrasound was normal; however, his fingers were cold and cyanotic.

A thermal image of the right hand was obtained using a Flir C3 portable thermal camera configured to display a color palette (FLIR Systems AB, Danderyd, Sweden) (Figure 2). Figure 2 shows a progression of hot-to-cold in the right hand, consistent with the lower temperatures initially observed in the fingers. Thus, the thermal imaging device was a valuable tool that allowed a more precise assessment of the initial tactile observation that the fingers felt colder than they should be, suggesting perfusion problems in some regions of the right hand.

Full heparinization was started with enoxaparin, nitroglycerin, alprostadil (prostaglandin E1), and corticotherapy (to reduce
inflammatory response), and the entire RUL was heated with orthopedic cotton. After rapid worsening of cyanosis in his right hand and significant edema of the entire RUL, the patient progressed with compartment syndrome and underwent decompressive fasciotomy of the right forearm 23 h after admission. He was referred to the Intensive Care Unit (ICU), where he experienced rhabdomyolysis and renal failure and was treated with dialysis. His right arm and forearm perfusion improved. However, there was a critical worsening of the right-hand perfusion with extensive necrosis (Figure 3).

On the tenth day of admission, the patient underwent debridement of dead tissue from a previous fasciotomy in the anterior and posterior regions of the forearm and amputation of the distal phalanx of all 5 fingers (Figure 4). The patient was discharged from the ICU 14 days after admission with recovered renal function and was followed up by the vascular and plastic surgery team. Owing to the progression of the necrotic area, the patient later underwent proximal phalangeal excision and surgical reconstruction of the right-hand remnant (Figure 5).
Discussion

In addition to the active ingredient, tablets are composed of several other substances called excipients, such as microcrystalline cellulose (MCC), which can potentially cause or aggravate lesions when injected intra-arterially; these substances can lead to adverse effects on blood flow and vascular endothelium [4]. Furthermore, illegally acquired pills are often contaminated with impurities [4]. Détriché et al reported a case of ischemia due to arterial injection of crushed zolpidem tablets and highlighted the effect of MCC, a substance with embolic potential as the predominant mechanism of injury [1]. Due to its low reactivity with active ingredients, MCC is the primary excipient in oral pharmaceutical formulations. Morphine tablets contain MCC as an excipient. In addition, it is insoluble in water and most organic solvents, resistant to degradation in water, and water absorbent, resulting in lower particle agglomeration [1]. Goldberg et al reported that injecting pure codeine into the femoral arteries of dogs was harmless; however, adding MCC produced immediate ischemic symptoms and gangrene [5].

MCC is a natural substance obtained from purified and partially depolymerized cellulose [6]. It is currently produced from various sources, with wood and cotton being the essential raw materials used in its manufacture [6]. Neuss and Holland reported the presence of MCC incorporated in remote and subacute thrombus in the radial artery biopsy of a 62-year-old patient with a history of intra-arterial opiate injection [7].

Additionally, Amass et al described a case of rapidly progressive pulmonary arterial hypertension, right ventricular failure, and death in a young patient who received crushed tablets of illicit drugs through a peripherally inserted central catheter [8]. Postmortem analysis revealed extensive pulmonary foreign body embolism involving small-to-medium-sized arteries with segmental intraluminal and occasional subsegmental involvement. The material was Congo red positive, suggestive of MCC [8]. Although fatal pulmonary hypertension due to intravascular foreign body embolism has been described previously [9], most cases take many years to develop because of the large number of crushed tablets needed to obliterate pulmonary microcirculation. As a rule, the infusion of crushed tablets into arteries is much more harmful than into veins. Moreover, the more distal the infusion, the greater is the risk of serious complications, such as amputation.

In the present case, in addition to the sizeable volume included in a single injection (3 morphine tablets), the injection occurred in the distal portion of the radial artery, with practically no time and blood volume for dilution, causing massive obliteration of the entire palmar arch of the right hand, ischemia, necrosis, and amputation.

All objects with temperatures above zero Kelvin emit electromagnetic radiation [10], and there is a precise mathematical equation that relates the radiation’s physical characteristics (such as intensity and wavelength) with the temperature of the object [11]. A small range of this radiation is referred to as the thermal infrared range (8-15 µm) and is used in thermal imaging [12,13]. Infrared thermography is a safe methodology that does not use ionizing radiation, allowing a wide range of applications in medicine.

In other applications of infrared thermography, inflammation or increased vascularization leads to the increase of the temperature of the body segment or area under study. On the other hand, in situations of acute ischemia, obstruction of arterial blood flow causes a decrease in temperature. Thermal cameras are usually set to color palette mode, where red and blue represent the hottest and coldest areas, respectively.

Furthermore, the thermal image produced by a portable camera (Flir C3) showed a large temperature discrepancy between the proximal dorsal portion of the hand (in red) and the fingers (in blue), reinforcing that the flow measured on the arterial Doppler ultrasound, especially in the radial and ulnar arteries, was not, in this particular case, a good estimator for finger perfusion.

Conclusions

As there is no substance capable of removing MCC mainly from microcirculation, the treatment of accidental or intentional injection of crushed tablets into the arterial circulation is still based on analgesia, vigorous hydration, corticotherapy, vasodilators, and anticoagulants and surgical procedures such as debridement, fasciotomy, or amputation. This case report suggests that infrared thermography may be a promising method to provide additional information to aid in the diagnosis and monitoring of acute arterial ischemia, as well as in the delimitation of the ischemic area.

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Declaration of Figures’ Authenticity

All figures submitted have been created by the authors who confirm that the images are original with no duplication and have not been previously published in whole or in part.
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