

Chemical Burn From Povidone-Iodine: Case and Review

Adam Rees MD, Quyn Sherrod MD, Lorraine Young MD

Division of Dermatology, David Geffen School of Medicine at the University of California, Los Angeles, Los Angeles, CA

ABSTRACT

Chemical burn is a rare complication of topical polyvinylpyrrolidone-iodine (PVP-I), commonly called povidone-iodine (trade name Betadine, Purdue, Stamford, NJ). This adverse reaction occurred on the buttocks of an eight-year-old male after undergoing a laparoscopic appendectomy involving antiseptic skin preparation using a 10% PVP-I solution. This case is consistent with previous reports in which a chemical burn develops when PVP-I does not adequately dry, pools beneath a dependent body part during surgery, or is placed under an occlusive device. Symptoms develop immediately to one day after surgery. The proposed mechanism is irritation from iodine coupled with maceration, pressure and friction. While patients typically heal without significant scarring, the burn subjects the patient to unnecessary pain, prolongs hospitalization and increases the risk for infection. Physicians should be aware of this complication and therefore take preventative measures. These include allowing PVP-I to completely dry, preventing dripping and pooling and avoiding occlusion.

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INTRODUCTION

Povidone-iodine (trade name Betadine, Purdue, Stamford, NJ) is a widely used antiseptic regarded for its broad antimicrobial spectrum, fast onset of action and favorable safety profile. It consists of polyvinylpyrrolidone (PVP) complexed to iodine. Its antiseptic mechanism of action is due to the iodination and oxidation by free iodine of various microbial chemical structures.¹ While rare, chemical burn is a recognized complication of povidone-iodine use.^{3,5-12}

CASE REPORT

An eight-year-old male was admitted to our institution for a two-day history of abdominal pain, vomiting and fever. An abdominal CT confirmed the diagnosis of acute appendicitis. The patient was taken to the operating room for a laparoscopic appendectomy. Antibiotic prophylaxis with intravenous cefoxitin (1 gram) was administered preoperatively. The patient was placed in a supine position, the abdominal and suprapubic skin was sterilized using a 10% povidone-iodine (PVP-I) solution and the patient was draped with a sterile and nonabsorbent fabric. The procedure lasted two hours. Immediately after surgery, the patient complained of burning pain on his buttocks. The nursing staff noted a brown stain consistent with PVP-I in the area of discomfort. Noted on exam were well-demarcated patches of dusky and blanching erythema on the bilateral buttocks, inguinal region and scrotum with superimposed vesicles and bullae (Figure 1). The patient had neither significant personal or family history of dermatologic diseases nor prior history of exposure or sensitization to PVP-I. Wound cultures were negative

for bacteria and viruses. The diagnosis of partial thickness burn secondary to irritant contact dermatitis from povidone-iodine was made on the basis of the rapid appearance of the lesions following surgery, the distinct geographic pattern of involvement and the history of PVP-I staining in the affected areas. The patient received topical supportive treatment with silver sulfadiazine and AQUACEL hydrocolloid dressing (ConvaTec, Skillman, NJ). During his five-day hospitalization, the patient remained afebrile without progression of the lesions or involvement of mucosal membranes. The patient was discharged with a supportive home care regimen of Xeroform petrolatum impregnated gauze (Kendall Healthcare, Mansfield, MA) for the burn, as well as acetaminophen for pain. The patient subsequently failed to show for follow up.

DISCUSSION

Polyvinylpyrrolidone-iodine (PVP-I)—commonly called povidone-iodine (trade name Betadine)—is a widely used antiseptic regarded for its broad antimicrobial spectrum and rapid onset of action. It comes in several commercial preparations of which the most commonly used are a 10% solution and a 7.5% scrub. PVP-I consists of iodine (I₂) complexed to polyvinylpyrrolidone (PVP) and iodide (I⁻). A 10% PVP-I solution contains 90% water, 8.5% PVP, 1% iodine and 0.5% iodide. PVP is a hydrophilic polymer that lacks intrinsic antimicrobial properties but rather acts as a carrier for the iodine.¹ The true microbicidal action of the PVP-I solution comes from the free (i.e., not complexed to PVP) iodine in the solution. In aqueous solutions, free iodine is present as seven different species, including elemental iodine

(I₂), hypoiodic acid (HOI), iodine cation ([H₂OI]⁺), triiodide ion (I₃⁻), iodide ion (I⁻), hypoiodite ion (OI⁻) and iodate ion (IO₃⁻). Elemental iodine, hypoiodic acid and iodine cation account for the majority of the antimicrobial activity of PVP-I. Together, they are highly viricidal, bactericidal, fungicidal, cysticidal, protozoacidal and moderately sporicidal. The microbicidal mechanism of action involves iodination and oxidation of various microbial chemical structures, which results in rapid microbial killing.² A 10% PVP-I solution contains only 0.0001% free iodine. The gross majority of the iodine is complexed to PVP and therefore unavailable for antimicrobial activity. However, as free iodine is consumed in microbicidal activity, additional iodine is continually released from PVP, thus maintaining a constant concentration of free iodine.^{1,3} Free iodine is a well known irritant, and thus the low concentration of free iodine in PVP-I contributes to its favorable side effect profile as compared with other iodine preparations. For example, tincture of iodine contains 2% free iodine and causes a greater degree and frequency of irritant reactions.^{2,4}

While patients typically heal without significant scarring, the burn subjects the patient to unnecessary pain, prolongs hospitalization, increases the risk for infection and can jeopardize a healthy doctor-patient relationship.⁵

Chemical burn is a rare but recognized adverse effect of PVP-I with 34 previously reported individual cases.^{3,5-12} The injury develops when PVP-I is not allowed to adequately dry, pools beneath a dependent body part during surgery, or is placed under an occlusive device. Examples from the literature include a 76-year-old man who developed a burn on his upper back after thyroid surgery,³ a 38-year-old woman who developed a burn from her mid-back to buttocks after a laparoscopic gynecologic procedure,⁶ a 24-year-old male undergoing a flexor tendon repair who developed a burn on his arm where PVP-I solution had soaked into the wool padding beneath a tourniquet,⁵ a 45-year-old patient requiring epidural anesthesia who developed a burn at the epidural cannula site where gauze soaked in PVP-I was placed under a waterproof dressing,⁵ and two critically-ill patients who developed burns on their faces in areas where the cotton-tape securing the endotracheal tube was contaminated with PVP-I.¹² The offending agent was either PVP-I 10% solution or PVP-I in alcohol. Table 1 lists the common characteristics of PVP-I burns. While patients typically heal without significant scarring, the burn subjects the patient to unnecessary pain, prolongs hospitalization, increases the risk for infection and can jeopardize a healthy doctor-patient relationship.⁵

TABLE 1.**Characteristics of PVP-I Chemical Burns**

The injury occurs immediately to 24 hours after surgery.

The injury is a partial thickness burn consisting of well-demarcated erythematous patches with overlying bullae and vesicles on skin that was in direct contact with PVP-I.

The injury occurs either in dependent areas such as the back or buttocks that are in direct contact with a PVP-I soaked surgical sheet or mattress; or the injury occurs where PVP-I is purposely or inadvertently placed under an occlusive device, such as a tourniquet or dressing.

The lesions clear completely with minimal to no scarring within a period of several weeks.

The proposed mechanism of injury involves the chemical irritant iodine coupled with occlusion, maceration, pressure and friction. The injury may be exacerbated by the concomitant use of alcohol washings which de-esterify the skin thereby decreasing the epidermal barrier.^{5,13} The injury is largely regarded to be an irritant contact dermatitis and not an immunologically-mediated allergic reaction.^{3,14-17} In cases where allergic sensitization is suspected, patch testing can be considered. However, several studies have demonstrated that PVP-I in solution and under occlusion is intrinsically irritating which complicates patch-testing.^{3,7,17} In one such study, 17,500 consecutive patients were patch tested with a 10% PVP-I solution diluted 10 times in water. Of the initial 500 patients, 14 showed a positive patch test, but when these 14 patients were subsequently subjected to a repeated open application test (ROAT), only two patients had a positive ROAT. Thus the authors concluded that the majority of the initial positive patch tests were actually false positives due to irritation and not sensitization. In a similar study,³ 19 patients with a history of a rash from PVP-I and a group of healthy controls were subjected to both a patch test and a subsequent ROAT with 10% PVP-I. All of the patients and healthy controls developed a significant reaction with the patch test, yet no subjects developed a reaction with the ROAT, thus again confirming that the injury is most likely irritation and not allergy. While other authors have reported a significant amount of allergic contact dermatitis from PVP-I,¹⁸ these authors did not include a ROAT trial and thereby failed to exclude false positive irritant reactions, as argued by Lachapelle.¹⁷ Despite these caveats, there are cases in the literature where true contact sensitization appears likely.^{19,20} When patch testing is indicated, several recommendations have been proposed to exclude false positive irritant reactions. These include using a ROAT as previously described, using a dilute PVP-I preparation¹⁴ and using either dried PVP-I¹⁵ or PVP-I in a gel polymer¹⁶ instead of PVP-I in an aqueous solution.

FIGURE 1. Povidone-iodine burn on buttocks after laparoscopic appendectomy.**TABLE 2.****Preventing PVP-I Chemical Burns**

Ensure that the PVP-I solution is completely dry prior to draping the patient before surgery.

Avoid pooling of PVP-I under dependent body surfaces.

Promptly remove or change linens, absorbent padding, and adhesive tape contaminated with PVP-I.

Promptly wash residual PVP-I off of all body surface areas after surgery.

Avoid placing PVP-I under an occlusive device such as a tourniquet or dressing.

Of particular clinical relevance from the above-cited cases and studies is the suggestion that both moisture and occlusion are critical contributors to the irritant reactions caused by PVP-I. This implies that health care personnel can take specific measures to prevent chemical burns from PVP-I. These measures are listed in Table 2.

The treatment of PVP-I burn is supportive and consistent with the standard of care for a partial thickness burn and includes antimicrobial prophylaxis with a topical agent such as silver sulfadiazine and dressings that promote healing such as petrolatum impregnated gauze or hydrocolloidal dressings such as AQUACEL or DuoDERM (Convatec, Skillman, NJ).²¹ As this eruption is primarily considered to be an irritant rather than allergic contact dermatitis, patients should be aware that they do not universally need to avoid PVP-I. However, in cases where sensitization is suspected, patch testing may be performed.

DISCLOSURES

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ADDRESS FOR CORRESPONDENCE

Lorraine Young, MD

Associate Clinical Professor

UCLA Division of Dermatology

200 Medical Plaza, Suite 370-6

Los Angeles, CA 90095

Phone.....(310) 204-9554

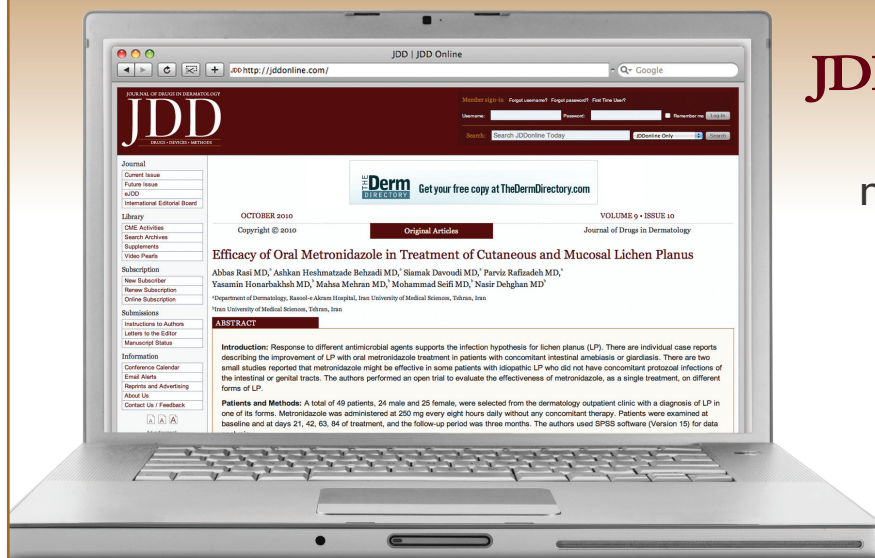
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