OPEN

PRS GLOBAL OPEN

CASE REPORT
Reconstructive

The Use of Hypochlorous Acid Lavage to Treat Infected Cavity Wounds

Apinut Wongkietkachorn, MD*
Palakorn Surakunprapha, MD†
Jakrapan Wittayapairoch, MD‡
Nuttapone Wongkietkachorn, MD§
Supawich Wongkietkachorn, MD¶

Summary: Managing cavity wounds that cannot be cleaned using standard irrigating solution is challenging. An immunocompromised patient with a horseshoe perianal abscess was selected to represent a heavy infection in cavity wounds. Diluted povidone-iodine was initially used to lavage the wounds, but the fever persisted and the irrigation was painful. Hypochlorous acid was then used to irrigate the wound. One day after administration of the hypochlorous acid, the fever began to subside, suggesting that this solution was able to adequately destroy the infecting microorganisms. The patient rated his pain during this procedure as 2/10. The infection had cleared within 2 weeks, and a swab culture found no microbial growth. The wound volume was reduced by more than 90% after 5 weeks, and final wound closure was achieved after 6 weeks. By comparison, another patient with a horseshoe perianal abscess who underwent traditional irrigation with diluted povidone-iodine and wet-to-dry dressing faced similar problems, but the fever in this case did not subside, and the wound became more complicated. He complained of pain during the irrigation with diluted povidone-iodine, giving the procedure a pain score of 10/10. Wound care was also difficult due to fecal contamination. As a result, the patient had to undergo colostomy to divert feces to the abdomen, thus preventing it from contaminating the wound. Time to final wound closure was 10 weeks. These cases illustrate the effectiveness of hypochlorous acid in dealing with infection in wound cavities. *(Plast Reconstr Surg Glob Open 2020;8:e2604; doi: 10.1097/GOX.0000000000002604; Published online 24 January 2020.)*

INTRODUCTION

Managing tiny cavity wounds that cannot be reached using conventional equipment is challenging. Although there has been significant development in silver-impregnated dressings, these advanced pads cannot be inserted into 1–2 mm cavities. Irrigating solution, such as normal saline or diluted povidone-iodine, is often used to overcome this hurdle,[1] but these common solutions are sometimes not sufficient, and may cause pain or delay healing.[2,3]

*From the *Division of Plastic and Reconstructive Surgery, Department of Surgery, Faculty of Medicine, Mae Fah Luang University, Chiang Rai, Thailand; †Division of Plastic and Reconstructive Surgery, Department of Surgery, Faculty of Medicine, Khon Kaen University, Khon Kaen, Thailand; ‡Department of Surgery, Faculty of Medicine, Khon Kaen University, Khon Kaen, Thailand; §Division of Plastic and Reconstructive Surgery, Department of Surgery, Q Clinic, Bangkok, Thailand; and ¶Department of Surgery, Faculty of Medicine, Thammasat University, Pathum Thani, Thailand.*

Received for publication August 3, 2019; accepted November 4, 2019.

DOI: 10.1097/GOX.0000000000002604

CASE REPORT

To represent heavy infection in tiny cavity wounds, an immunocompromised patient with a horseshoe perianal abscess was selected. A 42-year-old man came to the hospital with horseshoe perianal abscess (Fig. 1). He had underlying lymphoma and was receiving chemotherapy. After incision and drainage, the wound consisted of a large outer cavity (marked in red) and a tiny inner cavity (marked in yellow), as illustrated in Video 1. (See **Video 1** [online], which displays how hypochlorous acid is used to irrigate cavity wounds and its efficacy.) The outer cavity wounds were covered with a hydrofiber with silver (Aquacel Ag+ Extra; Convatec, UK). The secondary dressing was an adhesive sodium carboxymethylcellulose foam dressing (Adhesive Aquacel Foam; Convatec, USA), which has been found to be effective for dressing infected wounds in the perianal area.[4] Debridement and curettage of the slough and biofilm were performed weekly. A

Disclosure: *The authors have no financial interest to declare in relation to the content of this article.*

Related Digital Media are available in the full-text version of the article on www.PRSGlobalOpen.com

Fig. 1. A patient with a horseshoe perianal abscess. The fever persisted, and large amounts of exudates were found during irrigation.

polyacrylate pad with silver matrix (UrgoClean Ag; Urgo Healthcare Product, France) was applied to the wound for 1 day before curettage to ease the process.[5] The problem was the tiny cavity wound, which was first irrigated with normal saline and then with diluted povidone-iodine. A swab culture of the wound revealed *Escherichia coli*. Ceftazidime and metronidazole were administered intravenously. However, at 7 days after the operation, the fever had not yet subsided. In addition, large amounts of exudates were found during irrigation, which implied that the infection had not been adequately managed and that a different approach would be necessary.

Hypochlorous acid (Granudacyn, SastoMed GmbH, Germany) was used to irrigate the tiny cavity wound beginning on day 7 after the operation, as shown in Figure 2 and Video 1. It was in a ready-to-use form and thus did not require mixing or dilution. Dry gauze was then used to wipe the excess fluid out of the wound to prevent skin maceration. The hypochlorous acid was left inside the cavity, which was not washed with normal saline. One day after the application of hypochlorous acid (Granudacyn, SastoMed GmbH, Germany), the patient's fever began to subside, suggesting that this solution was able to adequately destroy the infecting microorganisms, even in this difficult-to-access cavity. The patient rated his pain as 2/10 using a visual analogue scale. The infection had cleared within 2 weeks, and a swab culture found no microbial growth. Wound progression was measured weekly using a three-dimensional wound measurement device (inSight, eKare, Inc., USA), which has been reported to yield high accuracy and provide both inter-rater and intra-rater reliability of >0.99.[6,7] The wound volume was reduced by more than 90% after 5 weeks, and final wound closure was achieved after 6 weeks.

Fig. 2. Hypochlorous acid (Granudacyn, SastoMed GmbH, Germany) was used to irrigate the tiny cavity wound.

A comparison is shown in a 60-year-old immunocompetent male patient with a horseshoe perianal abscess, who underwent traditional irrigation with diluted povidone-iodine and was treated using a wet-to-dry dressing. This patient faced similar problems, but his fever did not subside, and the wound became more complicated. His wound was significantly inflamed and extremely sensitive to pain. He complained of the pain caused by irrigation with diluted povidone-iodine, rating it as 10/10 using visual analogue scale. Wound care was also difficult due to feces contamination. As a result, the patient had to undergo colostomy to divert feces to the abdomen, thus preventing it from contaminating the wound. Time to final wound closure was 10 weeks.

DISCUSSION

These two difficult cases illustrate the contrast between standard treatment using diluted povidone-iodine and wet-to-dry dressing and treatment with hypochlorous acid. The standard treatment resulted in colostomy, a prolonged treatment period (10 weeks), and painful irrigation. The patient treated with hypochlorous acid, however, did not require colostomy, had a shorter treatment period (6 weeks), and experienced less pain during irrigation. This clearly illustrates the efficacy of hypochlorous acid.

Hypochlorous acid, an antimicrobial substance found in the human body, has the unique ability to kill microorganisms within 1 minute while exhibiting low cytotoxicity to healthy cells.[8,9] Once neutrophils are activated, respiratory bursts generate hydrogen peroxide (H_2O_2), which is then converted to hypochlorous acid (HOCl) in the presence of Cl– and H+.[10] It causes cell death through disruption of the cell wall, loss of intracellular contents, oxidation of respiratory components, inhibition of protein synthesis, decreased oxygen uptake, breaks in DNA, and depressed DNA synthesis.[8]

Although hypochlorous acid is comparable to sodium hypochlorite, which is used as a bleaching agent,[9] they differ in that hypochlorous acid is a weak acid and can be dissolved into hydrogen and hypochlorite ions. It remains present in environments where pH ranges from 6.5 to 8.5, but is completely converted to hypochlorite when pH is greater than 8.5.[9] This is important because the antibacterial property of hypochlorous acid (HOCl) is much higher than that of hypochlorite ions (OCl–).[8,9] Thus, the pH of the wound area should be considered when using hypochlorous acid.

In contrast to other common solutions, saline removes bacteria through the mechanical effect of rinsing and does not have any antibacterial properties. Although povidone-iodine is able to kill bacteria,[1] this ability can be hindered by

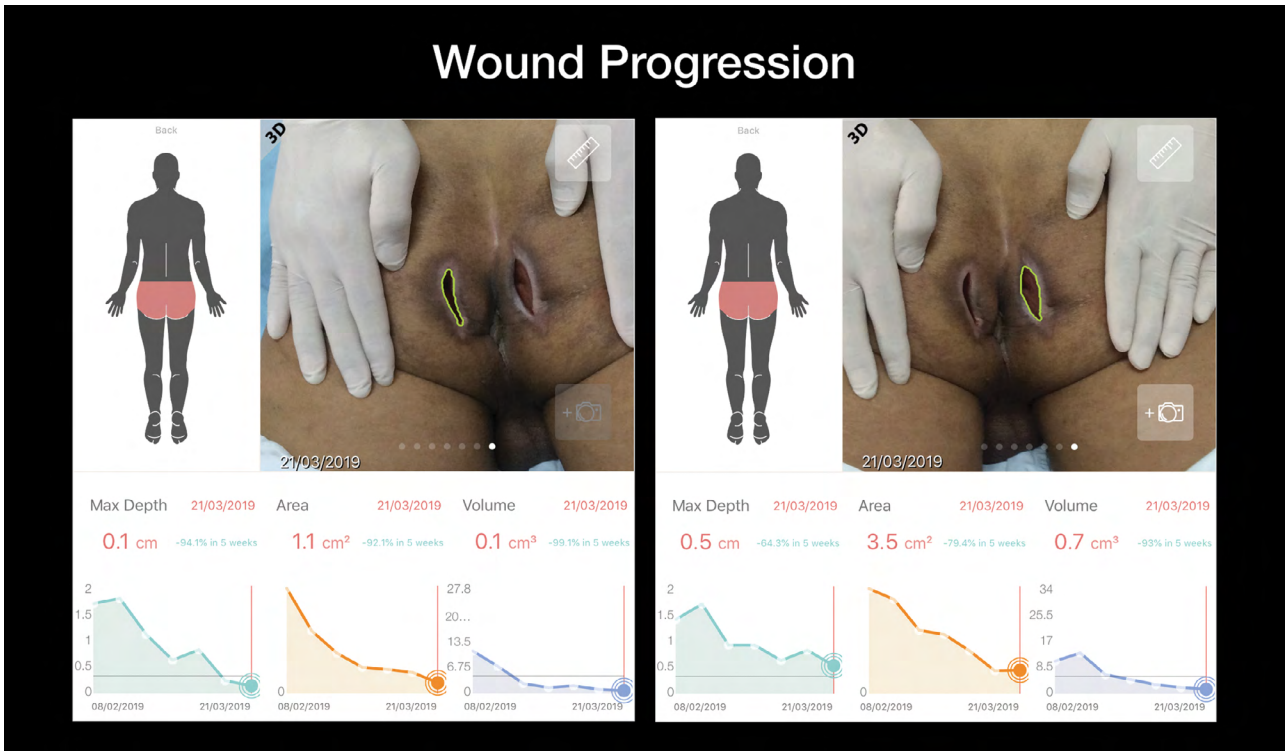

Fig. 3. The wound progression was measured weekly using a three-dimensional wound measurement device (inSight, eKare, Inc., USA). The wound volume was reduced by more than 90% after 5 weeks, and final wound closure was achieved after 6 weeks.

biofilm formation. Moreover, povidone-iodine also inhibits fibroblast growth.[2] One study that compared the effectiveness of povidone-iodine to that of hypochlorous acid in terms of wound healing found that povidone-iodine significantly delayed wound healing, while hypochlorous acid did not.[8] Betaine and 0.1% polyhexanide (Prontosan, B. Braun Medical AG, Switzerland) is another effective solution for diminishing biofilm.[11] However, it requires application with gauze for 10–15 min, which might be too long in pain-sensitive areas, and removing the gauze from the wound to disrupt the biofilm can cause the patient further pain.[11] These disadvantages of the common irrigating solutions make hypochlorous acid's unique properties of fast action within 1 min and low cytotoxicity serves the difficult cases well.[12]

CONCLUSION

Hypochlorous acid is effective in managing infection in wound cavities.

Palakorn Surakunprapha, MD
Department of Surgery, Faculty of Medicine
Khon Kaen University
123 Mittraparp Highway, Muang District
Khon Kaen 40002, Thailand
E-mail: apinutme@gmail.com

REFERENCES

1. Norman G, Atkinson RA, Smith TA, et al. Intracavity lavage and wound irrigation for prevention of surgical site infection. *Cochrane Database Syst Rev.* 2017;10:CD012234.
2. Balin AK, Pratt L. Dilute povidone-iodine solutions inhibit human skin fibroblast growth. *Dermatol Surg.* 2002;28:210–214.
3. Oakley C, Allen P, Hooshmand J, et al. Pain and antisepsis after ocular administration of povidone-iodine versus chlorhexidine. *Retina.* 2018;38:2064–2066.
4. Wongkietkachorn A, Surakunprapha P, Titapun A, et al. Periwound challenges improve patient satisfaction in wound care. *Plast Reconstr Surg Glob Open.* 2019;7:e2134.
5. Wongkietkachorn A, Surakunprapha P, Theeragul S. Easy wound bed preparation by polyacrylate pad with silver matrix and curettage. *Plast Reconstr Surg Glob Open.* 2018;6:e1954.
6. Anghel EL, Kumar A, Bigham TE, et al. The reliability of a novel mobile 3-dimensional wound measurement device. *Wounds.* 2016;28:379–386.
7. Sheng J, Li H, Jin J, et al. Application of three - dimensional wound analyzer in the small wound area measurement during the process of wound healing. *J Burn Care Res.* 2018;39:268–273.
8. Sakarya S, Gunay N, Karakulak M, et al. Hypochlorous acid: an ideal wound care agent with powerful microbicidal, antibiofilm, and wound healing potency. *Wounds.* 2014;26:342–350.
9. Severing AL, Rembe JD, Koester V, et al. Safety and efficacy profiles of different commercial sodium hypochlorite/hypochlorous acid solutions (naclo/hclo): antimicrobial efficacy, cytotoxic impact and physicochemical parameters *in vitro*. *J Antimicrob Chemother.* 2019;74:365–372.
10. Vissers MC, Winterbourn CC. Oxidation of intracellular glutathione after exposure of human red blood cells to hypochlorous acid. *Biochem J.* 1995;307 (Pt 1):57–62.
11. Bellingeri A, Falciani F, Traspedini P, et al. Effect of a wound cleansing solution on wound bed preparation and inflammation in chronic wounds: a single-blind RCT. *J Wound Care.* 2016;25:160, 2–166, 8.
12. Matthews MR, Quan AN, Weir AS, et al. Temporary abdominal closure combined with an irrigating system utilizing hypochlorous acid solution to decrease abdominal mucopurulence. *Eplasty.* 2018;18:e12.