Introduction

Negative pressure wound therapy (NPWT) has emerged as a popular wound management technique. NPWT with instillation (NPWTi) and NPWT with instillation and dwelling time (NPWTid) have been devised to control infections. On the other hand, in wounds with a complicated structure, commercialized NPWTi and NPWTid may not clean the contaminated area sufficiently and may fail to control infection. In the present case, intra-wound continuous negative pressure and irrigation treatment (IW-CONPIT) and wound management were performed on open contaminated wounds with a partial defect in the shoulder joint. The infection was controlled, and the wound shrank, allowing wound closure with a muscle flap.

Case Report

A Case of an Open Contaminated Shoulder Wound Managed by Intra-wound Continuous Negative Pressure and Irrigation Treatment

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ABSTRACT

To close a highly contaminated wound, the wound environment should be controlled to suppress the infection. Early debridement and early wound closure are essential. However, it is difficult to remove residual foreign matter and manage the infection immediately in some cases. We encountered a case of an open, contaminated shoulder wound managed with intra-wound continuous negative pressure and irrigation treatment. Debridement was performed on the day of injury. However, the fine foreign substances were insufficiently removed, and a superficial infection occurred. Intra-wound continuous negative pressure and irrigation treatment were performed for wound management. The infection was controlled, and the wound was covered with a latissimus dorsi muscle flap. This study showed that intra-wound continuous negative pressure and irrigation treatment were viable wound management options for superficial infections and complex structures.

Key words: contaminated wound, intra-wound continuous negative pressure and irrigation treatment, negative pressure wound therapy, negative pressure wound therapy with instillation, negative pressure wound therapy with instillation and dwelling time

Patient

A 55-year-old man worked using a machine that shattered wood into chips. His right shoulder was pinched by the mechanical roller, and he was taken to the emergency department of our hospital. The wound was contaminated with wood chips and soil, and the shoulder joint was opened. Partial defects in the deltoid and humerus nodules were observed (Fig. 1A-C).

Method

To introduce IW-CONPIT, surrounding materials were used. A hand-washing brush sponge (Fig. 2A, B) was used to cover the exposed tissue. To induce negative pressure to the wound, continuous suction was performed at −40 cmH₂O using a suction tube (Blake™ silicone drain, Ethicon, 24Fr. Fig. 2C).
and a continuous suction device (MERA continuous suction unit, Senko Medical Instrument, Fig. 2D). Saline was infused into the shoulder joint at a rate of 40 mL/h using a nasogastric tube (Salem Sump™ Tube, Covidien, 18Fr. Fig. 2E) to irrigate the wound continuously. An antimicrobial incise drape (Ioban™2, 3M) was used to cover the system (Fig. 2F).
Debridement was performed under general anesthesia on the day of injury. The time of admission to the operating room from the emergency room was 1 h 28 min. A hydraulic scalpel (Versajet™, Smith & Nephew) was used for debridement. The wound was washed with a large amount of tap water. After debridement, it was washed with 8000 mL of saline, but the fine foreign matter remained (Fig. 3). The next day, the sedated patient's wound was normally treated and washed with saline in the ward. However, the superficial infection and necrosis of the wound surface progressed. On the fifth day after the injury, debridement was performed again under general anesthesia. The IW-CONPIT was introduced at this time (Fig. 4). Dressing and sponges were changed 7, 10, 12, 15, and 18 days after the injury, with sedation. Trace amounts of wood chips remained between the sponge and muscle, and the muscle surface was slightly infected during the first two times. These fine objects were removed, and the infected or necrotic tissues were excised. Initially, the extract of the irrigation saline was sero-bloody, and this gradually changed to clear. Almost no debris was observed. The saline bottle was hung at the same height as the wound to maintain constant pressure. The patient underwent walking rehabilitation the day after the surgery. The bottle was kept at the same height as the wound. The irrigation saline did not leak, and the amount of injected and irrigated saline remained equal. Granulation tissue growth was observed with infection control, and wound closure was performed on the 21st day after injury using a latissimus dorsi muscle flap and split-thickness skin grafting (Fig. 5). The flap and skin graft survived completely, there were no complications of the flap.
NPWT was proven to be clinically effective since its initial report in 1997\textsuperscript{1–3}. The mechanism of action includes the effect of cleaning the wound by absorbing exudate, the effect of improving edema, the effect of increasing blood flow, the effect of shrinking the wound due to the contraction of the foam, and the effect of microdeformation at the part where the small holes of the foam contact\textsuperscript{3}. It has a direct positive effect on the wound (shortening the treatment period) and reduces the number of treatments. This ultimately reduces the stress of the patient and the burden of the healthcare workers. The effects of NPWT on contaminated wounds have been reported\textsuperscript{4–6}. The development of NPWTi and NPWTid has led to their application in contaminated and infected wound management\textsuperscript{7,8}. In NPWTi and NPWTid, the cleaning liquid is injected above the foam and collected from above the foam. The cleaning liquid flows

and graft beside movement deficiency of right shoulder joint three years after the injury (Fig. 6).

**Discussion**

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around the wound’s surface, and in a wound with a complicated structure or a wound with a blind end, a space with inefficient perfusion is created. To compensate for this, a method of adding ingenuity to the existing products\(^{6}\) or IW-CONPIT can be used\(^{10-12}\). In these methods, effective cleaning is performed by positioning the tube for continuous cleaning directly on the region of interest. In this case, it was expected that the fine wood fragments would not be effectively collected by the drainage tube, and the foreign matter would remain inside the shoulder joint. Thus, the cleaning tube was placed inside the joint, leading to effective and continuous wound cleaning. A continuous suction unit that generated a maximum of -50 cmH\(_2\)O of negative pressure was selected. The maximum negative pressure caused pain, so the pressure was adjusted accordingly. Isago et al. reported a significant difference in efficacy between the negative pressures of -25 mmHg and -50 mmHg\(^{13}\). The negative pressure of -40 cmH\(_2\)O, which was approximately 29 mmHg, was likely insufficient. Meanwhile, a negative pressure of < 50 mmHg was sufficient. A higher irrigation flow rate increased the cleaning efficiency\(^{14}\). Clinically, high flow rates are not preferred because they cause leaks and generate a large amount of liquid waste. In a study by Kiyokawa et al., a flow rate of 1000–7000 mL/day (40–290 mL/h) was used, depending on the degree of wound contamination\(^{15}\). In this study, a flow rate of 40 mL/h was used. Since the signs of infection disappeared within one week, this rate was maintained.

**Conclusion**

NPWT, NPWTi, and NPWTid were effective and convenient wound management methods. However, they may be insufficient in the management of contaminated wounds with intricate structures. This study recommends IW-CONPIT as a treatment option for wound management.

**Acknowledgments**

None.

**Conflicts of interest**

None.

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