



Original Contribution

Negative pressure wound therapy for serious dog bites of extremities: a prospective randomized trial[☆]



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ABSTRACT

Objectives: The objectives were to investigate the emergency treatment of serious dog bite lacerations on limbs and to identify whether negative pressure wound therapy (NPWT) was beneficial in these instances.

Methods: A total of 580 cases with serious limb lacerations due to dog bites were randomly divided into 2 groups. After thorough debridement, the limb lacerations of group A (n = 329) were left open. The remaining cases (n = 251) were randomly divided into 2 subgroups, group B and group C, which were treated with 125 and 75 mm Hg of continuous negative pressure, respectively. Antibiotics were only used in cases where there were systemic signs of wound infection, and were not given prophylactically. The infection rate, infection time, and healing time were analyzed.

Results: The wound infection rates of groups A, B, and C were 9.1%, 4.1%, and 3.9%, respectively. The infection times of the 3 groups were 26.3 ± 11.6 , 159.8 ± 13.4 , and 166.4 ± 16.2 hours, respectively. The recovery times of the infection patients in the 3 groups were 19.2 ± 4.6 , 13.2 ± 2.1 , and 12.7 ± 2.3 days, respectively, and in the noninfection patients, the recovery times were 15.6 ± 2.7 , 10.1 ± 2.3 , and 10.5 ± 1.9 days, respectively. In groups B (–125 mm Hg) and C (–75 mm Hg), the infection rate, infection time, and healing time showed no significant differences.

Conclusion: Patients with serious dog bite laceration on limbs could benefit from NPWT. Compared with the traditional treatment of leaving the wounds open, NPWT reduced the infection rate and shortened recovery time. When NPWT was performed, low negative pressure (–75 mm Hg) had the same positive effects as high pressure (–125 mm Hg). Prophylactic antibiotics administration is not recommended for treating this kind of laceration.

Level of evidence: Therapeutic/care management, level II.

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1. Introduction

In recent years, the incidence of dog bites has increased markedly. According to data from the Centers for Disease Control and Prevention of Beijing, more than 150,000 people were attacked by dogs in 2006 in Beijing, which increased to more than 220,000 in 2012. Approximately 88.6% of dog bite cases involved the upper or lower extremity, and approximately 12% were serious lacerations. Some pertinent literature has been published about the surgical treatment of dog bite lacerations; however, prospective studies have rarely been performed. Dog bite wounds are a special kind of wound, with high infection rates and prolonged healing times, and their surgical treatment is controversial. Negative pressure wound therapy (NPWT) is a simple and efficient way to promote healing in a variety of complicated wounds.

After packing or covering the wound with alginate foam containing polyvinyl alcohol and packing a layer of biological membrane at the surface of the foam and wound, the drainage tubes from the foam are connected to a negative pressure aspirator and the treatment is initiated. NPWT has emerged over the last 20 years and is widely used in surgical fields. NPWT has achieved good results, especially in the treatment of complex wounds, and is widely recognized by surgeons. However, very few studies have examined the use of NPWT in serious dog bites lacerations. This prospective study aimed to assess whether NPWT has a positive effect on wound healing in serious dog bite lacerations.

2. Patients and methods

Male or female patients older than 18 years, who presented at our Rabies Prophylaxis and Immunity Clinic of Beijing with dog bites to the limbs were enrolled in this prospective randomized trial. Patients with lacerated limb wounds demanding surgical treatment (lacerations with lengths of at least 5 cm, multiple penetrating lacerations of soft tissues, or lacerations accompanied by damage to at least one of the following: muscles, tendons, ligaments, nerves, articular capsules,

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fractures, important blood vessels, acra amputation) were enrolled. Exclusion criteria were puncture wounds (less than 2 mm); medium or small lacerations (less than 5 cm); infected wounds at presentation; having visited a physician's office more than 8 hours after the injury; wounds with skin loss requiring plastic surgery; or patients with immune deficiency, using immunosuppressive agents, or with autoimmune disorders or diabetes. All patients were subjected to block randomization and were assigned to a control group (group A) and an NPWT group. Those in the NPWT group were randomly assigned to group B (NPWT – 125 mm Hg pressure group) and group C (NPWT – 75 mm Hg pressure group) using a block random digits table. The therapeutic schedules were explained to the patients in each group, and their signatures were obtained on consent forms. Patients who refused the therapeutic strategy were excluded from the trial. Before the clinical trial started, we obtained approval for the clinical trial from our hospital ethics committee (IEC Navy General Hospital, permit no.: HZQX-PJ-2006-12).

2.1. Debridement procedure

All of the limbs with dog bite lacerations underwent thorough debridement as follows.

2.1.1. Cleaning and disinfection

To relieve the pain of the patients, local anesthetic was administered before wound cleaning and disinfection. After covering the wounds with sterilized dressing, a sterile cotton ball was used to scrub the area around the wounds 2–3 times with 20% liquid soap under running water. Subsequently, the wounds were alternately cleaned with ample 20% liquid soap and physiological saline, and with 3% hydrogen peroxide and physiological saline. The total cleaning time was at least 15 minutes for each wound. A large amount of 0.05% isoosmia iodophors was used to disinfect the wounds for not less than 5 minutes.

2.1.2. Debridement

All devitalized tissue, coagulated blood, foreign material, and markedly contaminated tissue were carefully removed to expose the surrounding healthy tissue. It was essential to retain the integrity of this tissue as much as possible to repair them later and to prevent osteofascial compartment syndrome. The final procedure of debridement involved cleaning of the inside part of the laceration with 0.05% iodophors again. Sterile gloves, aseptic covers, and surgical instruments were then prepared for tissue repair. At this time, passive immunity, if necessary, was administered.

2.1.3. Important tissue repair

All of the important impaired organs or tissues (such as muscles, tendons, ligaments, important nerves, articular capsules, fractures, important blood vessels, and acra amputation) were repaired with suitable operations after debridement, and these surgical procedures were performed at least 2 hours after rabies immunoprophylaxis therapy.

2.1.4. Wound cover

After thorough cleaning and debridement, the lacerations in group A were left open and covered with sterilized dressings. The lacerations in groups B and C were covered with a polyvinyl alcohol shrink formaldehyde bubble dressing (VSD Medical Science and Technology Co Ltd, Wuhan, China) for NPWT. We used a hospital central vacuum aspiration system as a continuous negative pressure source, and negative pressure was set at 2 levels: 125 and 75 mm Hg, respectively, in groups B and C.

All of the patients were administered rabies prophylactic active immunity and/or passive immunity. Tetanus antitoxin was also administered, if necessary. Drainage was performed according to the actual condition of the lacerations. A drain was placed in the innermost part of the wound and was replaced or removed according to the drainage quantity, usually 24–48 hours after surgery. All of the wounds in groups

A were covered with sterilized dressings, which were changed 24–48 hours after surgery. The NPWT was removed 4–5 days after surgery in groups B and C. The stitches in all sutured lacerations were removed 10–14 days after surgery, according to the state of wound healing. Antibiotics were administered only after wound infection occurred.

2.2. Observation indices

2.2.1. Infection rate

Infection was defined as the satisfaction of 1 of the following 3 major criteria: fever (body temperature $\geq 38^{\circ}\text{C}$), abscess, and lymphangitis, or 4 of 5 minor criteria: wound-associated erythema that extended more than 3 cm from the edge of the wound, tenderness at the wound site, swelling at the site, purulent drainage, and a white blood cell count in the peripheral blood of 12,000/mL.

2.2.2. Infection time

The *infection time* was the interval from being bitten to emerging infection indications (calculated as the time in hours).

2.2.3. Recovery time

The *recovery time* was the interval from being bitten to the wound achieving clinical healing (calculated as the time in days).

2.3. Statistical analysis

Statistical analysis was performed with SPSS software, version 13.0 (Chicago, IL), to compare the 2 groups. The χ^2 test and *t* test were applied. Statistical significance was set at $\alpha = .05$.

3. Results

Between January 2007 and September 2015, 653 patients were enrolled in this study. After assessment, 42 were excluded and 25 were not willing to participate in our study. A total of 586 patients were included in this study. After randomization, 335 patients were in group A and 251 were included in the NPWT group. All the patients in NPWT group and most of the patients in group A (90%, 296/329) were hospitalized. In addition, 6 patients in the group A were lost to follow-up (Figure). Among the 580 valid patients, 265 were male and 315 were female. The age range was 18–94 years. The average length of the largest wounds was 9.32 ± 3.27 cm, and the average wound number was 4.6 ± 1.7 . Some patients lost or suffered serious damage to their organs from dog bites: 24 cases lost parts of fingers; 75 cases were accompanied by open fractures; and 76% of the cases were accompanied by damaged muscles, ligaments, or tendons.

After randomization, 141 male (42.9%) and 188 female (57.1%) patients were enrolled in control group A (average age, 45.36 ± 12.38 years), 57 male (46.3%) and 66 female patients (53.7%) were enrolled in group B (average age, 44.79 ± 14.26 years), and 67 male (52.3%) and 61 female patients (47.7%) were enrolled in group C (average age, 49.17 ± 11.67 years).

None of the enrolled patients contracted rabies or died. The wound infection rates in the 3 groups (A, B, and C) were 9.1%, 4.1% and 3.9%, respectively. The infection times in the 3 groups were 26.3 ± 11.6 , 159.8 ± 13.4 , and 166.4 ± 16.2 hours, respectively. The recovery times of infection of the patients in the 3 groups were 19.2 ± 4.6 , 13.2 ± 2.1 , and 12.7 ± 2.3 days, respectively, and those of the noninfection patients were 15.6 ± 2.7 , 10.1 ± 2.3 , and 10.5 ± 1.9 days, respectively (Table).

4. Discussion

Dog bites pose a serious public health problem in China. Every year, more than 10 million people are attacked by mammals in China, most of which are dog bites. Dog bites can induce rabies, which is a fatal communicable disease [1,2], as well as serious lacerations and important

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