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ORIGINAL ARTICLE

Results of Vacuum Assisted Wound Closure Application

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Abstract In recent past, various methods have been used for wound treatment purpose. In this study, we aimed to compare our results established from the vacuum-assisted wound closure method, which has gained popularity day by day, with the literature. A total of 48 patients, who received vacuum-assisted wound closure treatment in our clinic between 2007and 2010, were included in this study. Etiological distribution of the patients was as follows: 32 traumatic, 6 pressure sore, 9 diabetic, and 1 iliac disarticulation. All cases were evaluated in terms of age, gender, etiology, period of treatment, and size of the wound. In the patients studied, 42 were men (87.5 %) and 6 were women (12.5 %). Mean age of the patients was 39.6 years (11–61 years). All of our traumatic patients suffered from open fracture. After the vacuum-assisted wound closure application, wound size reduced by 28.8 %, while the mean area of the surface of the wound was 94.7 cm^2 (13.7–216.3 cm^2) on average. After the wounds became ready for surgery, 15 of them were treated with split-thickness grafting, 9 of them were treated with secondary suture, 18 of them were treated with full-thickness grafting, and 6 of them were treated with flap. Average period of the application of vacuum-assisted wound closure was 11.6 days (7–15 days). Results of vacuum-assisted wound closure can be regarded as satisfactory when cases are selected properly. This system has three different effect mechanisms. Firstly, it increases local blood flow on the wound bed. Secondly, cell proliferation is triggered following the mechanic stress. Thirdly, vacuum removes the proteases from the environment which obstructs healing. Therefore, it is intended to prepare alive wound bed which is required for subsequent soft tissue reconstructions.

Keywords Wound healing · Negative-pressure wound treatment

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Introduction

Acute and chronic wounds affect 1 % of the general population [1]. Regardless of the etiology, treatment is generally more complicated when the patient also suffers from infection, diabetes, or other diseases. Such wounds may result in various conditions including hospitalization, amputation, sepsis, and even death. Today, wound treatment may take very long time, and it may cause painful and repetitive hospitalization and surgical procedures.

Several treatment methods have been utilized for improving the healing process of the wound until today, including various medical dressings, topical applications, surgical debridement, and antiseptic medicines [2–4]. Great efforts were achieved to develop new products to improve wound healing. The vacuum-assisted wound closure method, which was developed in the late 1980s, is the most recent method in this regard [5].

The vacuum-assisted wound closure system consists of a sterilized open-cell foam covering, which is covered with transparent, adhesive cover and its attached pump. The

Fig. 1 After the application of vacuum assisted wound closure treatment, situation of the wound bed of the pressure sore caused by orthesis used by the patient who were previously treated with below-knee amputation because of diabetic foot

pump applies intermittent or continuous negative pressure on the foam cover by means of a nonbended discharge tube. Vacuum pressure is usually kept between 50 and 125 mm Hg, and it can be applied intermittently or continuously [6].

The purpose of vacuum-assisted wound closure treatment is to remove the edema fluid (seroma or hematoma) from the wound area by applying negative pressure on the wound bed, to improve local blood flow, to stimulate cellular proliferation/granulation, and to control bacterial colonization [7].

Vacuum-assisted wound closure treatment is a noninvasive method which more popularly day by day can remain. The aim of the study was to share our experience and results obtained from the cases treated with the vacuum-assisted wound closure method.

Patients and Method

We retrospectively examined the data of 48 patients, who were treated with vacuum-assisted wound closure between 2007 and 2010 at our department of Orthopedics and Traumatology of the Suleyman Demirel University School of Medicine. The inclusion criteria were based on the existence of primarily unclosed wounds and surgically untreated patients.

We used the vacuum-assisted wound closure system (Kinetic Concept Inc. USA) in this study. Polyurethane sponges and polyvinyl alcohol were used to fill the wound during application. Adhesive and semi-permeable closure films were used to cover the wound. Negative pressure of 100–125 mm Hg was applied on the wound (continuously for the first 2 days and intermittently for the subsequent days). Medical dressing was changed every 48 h. Size of the wound was measured during medical dressing and wound surface was cleaned. Longest horizontal and vertical lengths were multiplied to measure the approximate wound size. All wound size values measured before and after the application were recorded. Vacuum-assisted wound closure treatment was finalized when the wound area became suitable for surgical operation following the formation of sufficient granulation tissue on wound surface. All these cases which we have investigated retrospectively were evaluated with regard to the factors of age, gender, etiology, treatment period, and wound size.

Findings

Of the 48 participants, 42 were men (87.5 %) and 6 were women (12.5 %). Average age was 39.6 years (11–58 years), and average period of the application of vacuum-assisted wound closure was 11.6 days (7–15 days). Etiological distribution of the patients was as follows: 32 traumatic (66.6 %), 6 pressure sore (12.5 %), 9 diabetic (18.75 %),

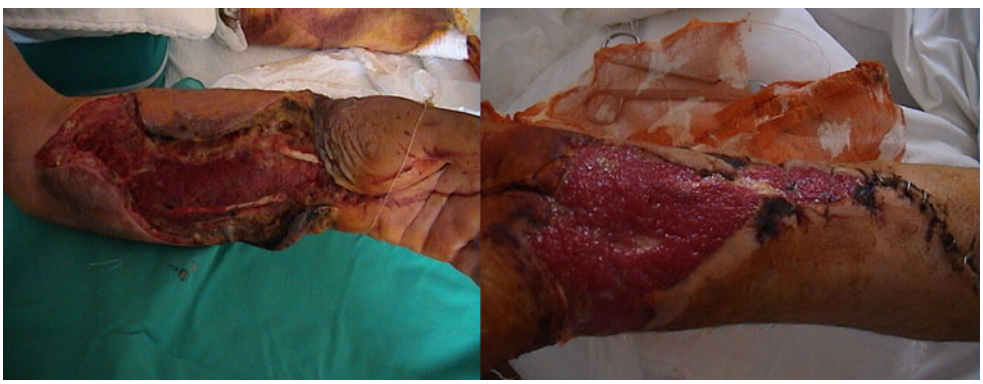

Fig. 2 Before and after vacuum assisted wound closure treatment on the wound of the patient, which wound could not be primarily closed and who were treated with faciotomy because of compartment syndrome

and 1 iliac disarticulation (2.08 %). One patient with iliac disarticulation was operated because of osteosarcoma on the left femur. Vacuum-assisted wound closure treatment was applied to primarily unclosed limb stump that exhibited necrosis after the surgery. Vacuum-assisted wound closure treatment was finalized when sufficient granulation tissue occurred on the wound surface. After the treatment, wound surface was covered with split-thickness grafting.

All of our traumatic patients have had open fracture. Following vacuum-assisted wound closure treatment, it is observed that wound surfaces have significantly narrowed, development of granulation tissues have improved, and wound secretion has decreased. While the mean wound surface measurement value was 94.7 cm^2 (13.7–216.3 cm^2) prior to the application, it was narrowed nearly 28.8 % (6.8–146.7 cm^2) after the application. Once the wounds became ready for surgery, the following treatment methods were applied to the participants: split-thickness grafting (15 patients, 31.25 %), secondary suture (9 patients, 18.75 %), full-thickness grafting (18 patients, 37.5 %), and flap (6 patients, 12.5 %) (Figs. 1, 2 and 3). None of the patients suffered from vacuum-assisted wound closure treatment-related infection and hematoma.

Discussion

Satisfactory results established from vacuum-assisted wound closure method have proved that cases were selected properly. In particular, success rate is high in traumatic cases. The vacuum-assisted treatment method has been used especially in open fracture cases as reported in the literature [8, 9]. Some problems related to blood supply can be encountered in diabetic wound cases. Success rate may be affected by some factors such as appropriate case selection and suitable treatment plan [10, 11].

Fig. 3 Vacuum assisted wound closure treatment was applied on the patient before flap, who was treated because of Type III tibia open fracture

Even though effective mechanism of the vacuum-assisted wound closure system is not definitely known, there are some theories. The first assumption is that increase in local blood flow in the wound bed as a result of negative pressure results in removal of the excessive fluid, which in turn contributes to the improvement of the local capillary circulation and oxygenization. According to the second theory, it is estimated that angiogenesis and tissue growth are stimulated and these processes give rise to cell proliferation as a result of mechanical tissue stress. The final theory is that vacuum effect removes the protease molecules which constitute an important negative factor against wound healing and bacterial load decreases following this event [12–15]. Therefore, it is intended to produce an alive wound bed which is suitable for subsequent soft tissue reconstructions.

After 11.6 days on average, it was observed that wound surfaces of the patients were narrowed prominently. Rate of such narrowing was 28.8 %. There are some studies with similar results in the literature [16, 17]. The study performed by Kılıç et al. [16] showed that 17 patient treated with vacuum-assisted wound closure were followed for average 16 days and approximately 30 % wound size reduction was achieved. Demir et al. [17] demonstrated that average duration of treatment was 12.4 days and average wound size reduction following treatment of 50 cases was 23 %. We were able to close the wounds of only three patients (18.75 %) with secondary suture following vacuum-assisted wound closure treatment. With regard to the other patients, we had to perform a surgery for wound closure. In the literature, this rate is 88.2 % and it has also been reported that no additional surgery is required following the application [16]. We believe that this rate was lower in our study, as wound surfaces of the patients were relatively large.

Average period of vacuum-assisted wound closure treatment was 11.6 days and yet the period of the hospitalization was more than 1 month, considering the second surgeries after application. Although this treatment method is more expensive and restricts daily lives of the patients, it reduces the costs caused by staying in the hospital for a long time, when compared to traditional medical dressing and surgical debridement methods. Flack et al. [18] created a Markov model to compare costs. They demonstrated an overall lower cost of care (US$52,830 versus US$61,757 per person) for patients treated with vacuum-assisted wound closure therapy compared with advanced dressings.

No complication such as infection or hematoma was observed during our study. Only four patients (8.3 %) suffered from high pressure-related pain during the process and these patients were given analgesic medicines.

As a result, it can be concluded that vacuum-assisted wound closure method offers a faster and comfortable treatment option for wounds which cannot be closed on primary basis because of their size, as well as wounds of which

blood supply is insufficient. This treatment has more advantages compared to traditional debridement and irrigation methods. We believe that the outcomes of vacuum-assisted wound closure treatment can be satisfactory with regard to careful patient and case selection.

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