Journal of Cranio-Maxillo-Facial Surgery 47 (2019) 837–841

Contents lists available at ScienceDirect

Journal of Cranio-Maxillo-Facial Surgery

journal homepage: www.jcmfs.com

Therapeutic efficacy of vacuum sealing drainage-assisted irrigation in patients with severe multiple-space infections in the oral, maxillofacial, and cervical regions

Yu Qiu [a, 1], Yanfen Li [b, 1], Binju Gao [a], Jun Li [a], Lizhen Pan [a], Zuo Ye [a], Yang Lin [a], LiSong Lin [a, *]

[a] Department of Oral and Maxillofacial Surgery, The First Affiliated Hospital, Fujian Medical University, Fuzhou, China
[b] School and Hospital of Stomatology, Fujian Medical University, Fuzhou, China

ARTICLE INFO

Article history:
Paper received 13 July 2018
Accepted 28 January 2019
Available online 1 February 2019

Keywords:
Vacuum sealing drainage (VSD)-Assisted irrigation technique
Oral
Maxillofacial
Cervical
Severe multiple-space infections

ABSTRACT

Objective: We compared the clinical efficacy between the vacuum sealing drainage (VSD)-assisted irrigation technique and traditional abscess incision and drainage technique in the treatment of severe multiple-space infections in the oral, maxillofacial, and cervical regions.
Methods: Data of 73 patients with severe oral, maxillofacial, and cervical infections, who were admitted to the Oral and Maxillofacial Surgery Department at the First Affiliated Hospital of Fujian Medical University between June 2014 and May 2017, were retrospectively collected. Patients were divided into two groups based on the treatments. The cure duration, incision length, physician workload (frequency of dressing-change), and treatment costs were compared between the two groups.
Results: Of 73 patients, 38 were treated with the VSD-assisted irrigation technique, and 35 with the traditional technique. All patients were cured following treatment. The cure duration, surgical scar length, and physician workload were smaller for the former group than for the latter group ($p < 0.05$). There was no difference in the treatment costs between the two groups ($p > 0.05$).
Conclusion: VSD-assisted irrigation technique used in the treatment of severe multiple-space infection in the oral and maxillofacial cervical regions shows favorable clinical effects and enables short treatment duration, lesser pain-experience, and high clinical and therapeutic efficacy.

1. Introduction

Oral, maxillofacial, and cervical infections often spread along multiple spaces, leading to complex multiple-space infections and possible serious complications. The traditional treatment requires a large incision, extensive separation, and long-duration irrigation and dressing. Moreover, obvious surgical scars are retained on the face and neck after the infection is cured. Negative-pressure wound therapy is a recently implemented method for the treatment of refractory wounds. The core technologies include the vacuum sealing drainage (VSD) technology proposed by a group of German surgeons in 1993 (Fleischmann et al., 1993) and the vacuum-assisted closure technology proposed by two American surgeons in 1997 (Argenta and Morykwas, 1997; Morykwas et al., 1997). Negative-pressure wound therapy is currently widely used for treating refractory infected wounds in orthopedics and general surgery (Plikaitis and Molnar, 2006).

However, the application of negative-pressure wound therapy in the treatment of multiple-space infections in the oral, maxillofacial, and cervical regions is rarely reported. Based on past research (Govea-Camacho et al., 2016; Zhang et al., 2015), and considering the head and neck anatomy and disease characteristics, we recently improved this method. We used dehydrated polyvinyl alcohol foams–sealed negative-pressure suction in combination with local irrigation to treat severe, multiple-space infections in the head and neck region. In this document, we elaborate on our novel method

* Corresponding author. Department of Oral and Maxillofacial Surgery, The First Affiliated Hospital, Fujian Medical University, Research Institute of Facial Restoration and Reconstruction, Fujian Medical University, Fuzhou, Fujian Province, 350005, China.
E-mail addresses: qy97@163.com (Y. Qiu), liyanfen2003@126.com (Y. Li), 244749728@qq.com (B. Gao), 1986lijun1234@163.com (J. Li), lilylilylily1234@163.com (L. Pan), 509871462@qq.com (Z. Ye), komesly@163.com (Y. Lin), drlinls@163.com (L. Lin).
[1] Yu Qiu and Yanfen Li contributed equally to the writing of this article.

https://doi.org/10.1016/j.jcms.2019.01.031
1010-5182/

and treatment results from patients with severe multiple-space infections in the oral, maxillofacial, and cervical regions.

2. Materials and methods

2.1. Subjects

This was a retrospective study. We included 73 patients (48 men and 25 women; mean age, 64 years) with severe oral, maxillofacial, and cervical infections who were admitted to the Oral and Maxillofacial Surgery Department at the First Affiliated Hospital of Fujian Medical University between June 2014 and May 2017. The surgical records of the patients were reviewed. The affected regions involved the parapharyngeal, pterygomandibular, and infratemporal spaces. The masseter muscle was affected in 45 patients, and the sublingual space, submandibular space, supraclavicular space, and floor of the mouth were affected in 28 patients. The patients were divided into two groups based on the treatment administered; negative-pressure group comprising 38 patients treated with the VSD-assisted irrigation method, and the traditional group comprising 35 patients treated with the traditional incision and drainage method. Informed consent was not required as this was a retrospective study and patient anonymity was maintained.

2.2. Materials used for treatments

The materials used for the treatments were as follows: a) VSD dressing: a wound VSD kit (Shandong Weigao Newlife Medical Devices Co., Ltd., Shandong, China), including medical sponge (specification: 15 cm × 10 cm × 1 cm), medical film (15 cm × 20 cm), irrigation tube (⌀5.3*3.5), and other parts; b) irrigation liquid: 0.9% sodium chloride (Shandong Cisen Pharmaceutical Co., Ltd., Shandong, China).

2.3. Treatment methods

Before the operation, the surgeon elaborated on the advantages and disadvantages of the two methods, and the patient selected the treatment method to be administered. The patients who were to be treated with the method of negative-pressure underwent color Doppler ultrasonography or spiral computed tomography (CT) (Fig. 1) to identify abscess sites and ranges. Their skin was incised under general anesthesia at the sites of redness and swelling or at the sites of the most intense fluctuation. The incision length was selected to be as short as possible, however long enough to allow a compressible, high vacuum material to be placed within the abscess range evaluated before surgery (Fig. 2). The length and location of the incision were recorded in the surgical records. When the abscess cavity was exposed after isolation, the pus was extracted and sent for bacterial culture and drug susceptibility test, followed by extensive isolation of the infected spaces, full drainage, and repetitive alternate irrigation with hydrogen peroxide and saline. Based on the wound morphology and the plasticity of the high vacuum material, the material was trimmed (Fig. 3). It was then placed into the wound allowing it to fully expand and drain the space, and the tension was reduced via subcutaneous isolation. Finally, an irrigation tube and a drainage tube were placed in the high vacuum material, and the wound was closed tightly (Fig. 4). After the patients returned to the ward, the irrigation end was provided with 500 mL of saline for a 4-h irrigation. During this process, the irrigation tube was connected to a pure-oxygen catheter delivering the gas at a flow rate of 5 L/min while the vacuum end was maintained at a low pressure of 40 ~ 60 kPa for 24 h for suction until the drainage fluid became clear. After the symptoms and related indicators improved, the high-vacuum drainage kit was removed, and the wound was sutured with 6-0 cosmetic sutures (Fig. 5).

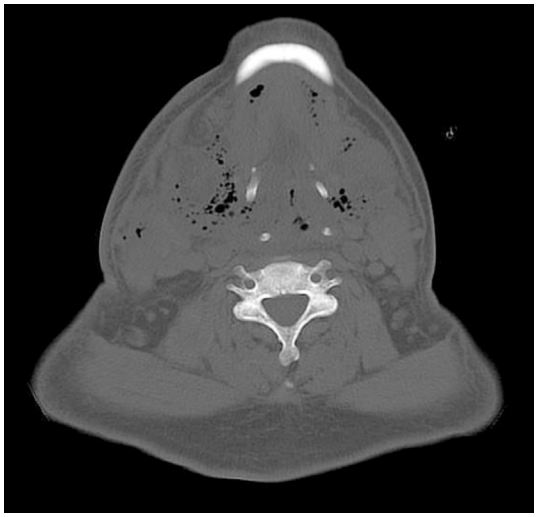

Fig. 1. Preoperative CT examination in the vacuum sealing drainage-assisted irrigation group.

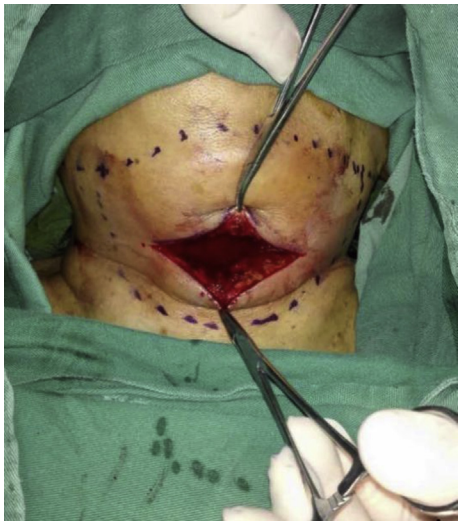

Fig. 2. Abscess draining via a small incision (dotted lines indicate the range of infection).

For patients undergoing traditional surgical procedures, according to the pre-operative color Doppler ultrasonography or CT results (Fig. 6), extensive incision and full isolation was made at the lowest site of the abscess and at the site of less obvious scars under general anesthesia. The length of the incision was determined by the depth and size of abscess to ensure smooth drainage. The length and location of the incision were recorded in the surgical records. When the incision reached the subcutaneous tissue, the abscess cavity was bluntly exposed with vascular forceps, and the infected spaces were fully isolated and thoroughly irrigated, followed by draining the spaces using a semi-latex tube and covering them with sterile gauze (Fig. 7). Dressings were changed daily, usually 1 or 2 times, according to their permeation status. The abscess cavity was irrigated with saline, 1%–3% hydrogen peroxide, or an antibiotic solution when the dressings were changed. The wound exudate samples were sent for etiological examination at intervals of 1–2 days. Based on the bacterial culture and drug susceptibility test results, the patients were treated with sensitive antibiotics. When

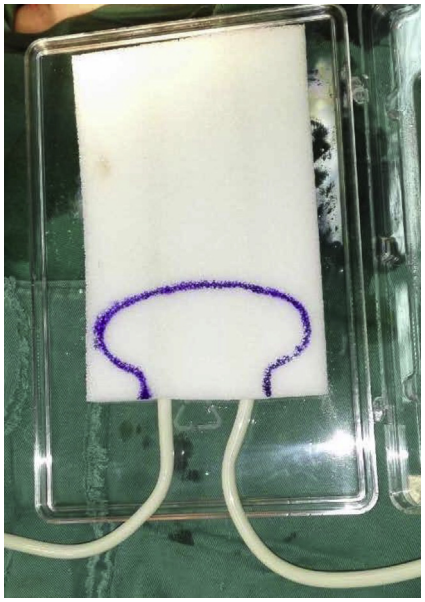

Fig. 3. Shaping of the sponge according to the size of abscess.

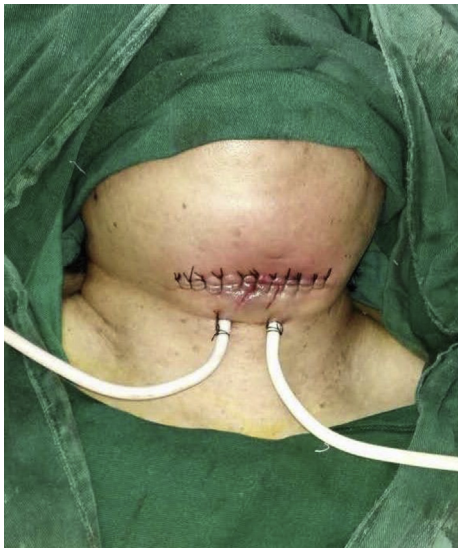

Fig. 4. Placement of sponge and tight closure of wound cavity.

the wound completely exhibited fresh granulation tissue and was free of purulent secretion, it was sutured after reducing the tension, and the patients were discharged.

2.4. Observation indicators

The cure duration, incision length, physician workload (frequency of changing the dressing), and treatment costs between the two treatment groups were compared. These data were retrieved from the medical records database of our hospital.

2.5. Statistical analysis

All data are expressed as mean ± SD. The two groups were compared using 2-sample t-tests. Statistical significance was accepted at $p < 0.05$. All data were analyzed using SPSS 22.0.

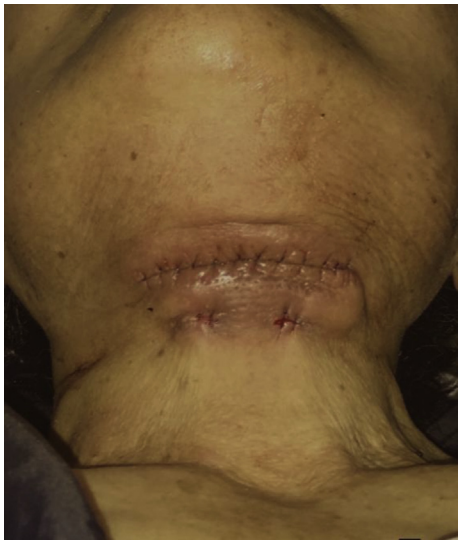

Fig. 5. Wound sutured with 6-0 prolene sutures.

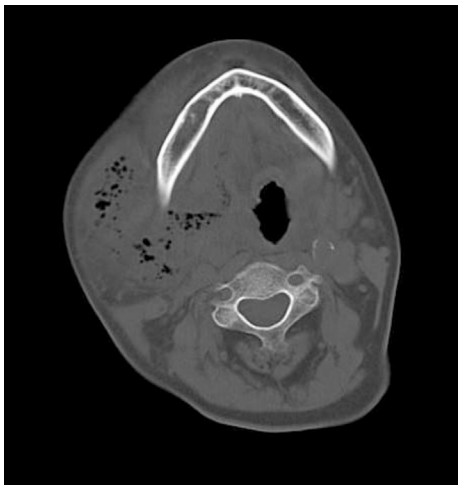

Fig. 6. Pre-operative CT examination in the traditional incision drainage group.

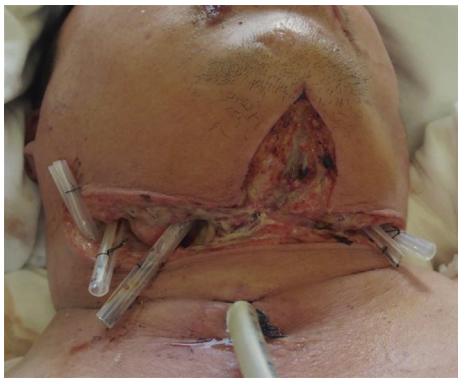

Fig. 7. Traditional incision and drainage.

3. Results

There were no statistically significant differences in sex, age, disease location, and underlying disease between the two groups ($p > 0.05$, Table 1). The patients in both groups were cured after treatment.

The cure duration was compared between the two groups; the indicator improvement period of the negative-pressure group was significantly shorter than that of the traditional group ($p < 0.05$) (Table 2). The incision length was also compared between the two groups; the incision length in the negative-pressure group was significantly shorter than that in the traditional group ($p < 0.05$) (Table 2).

We evaluated the physician's workload based on the frequency of the change of dressing. The mean frequency of the dressing-change of the negative-pressure group was significantly less than that of the traditional group ($p < 0.05$) (Table 2).

While the expenses for the materials of the VSD kit in the negative-pressure group were higher, the fee for dressing-change in the traditional group was higher because of the longer period of dressing-change; hence, there was no significant difference in the cost of treatment between the two groups ($p > 0.05$) (Table 2).

4. Discussion

Given the unique anatomy of the oral, maxillofacial, and cervical regions, a poorly controlled local infection is prone to spread rapidly, and invade multiple spaces leading to severe multiple-space infections. These infections cause serious complications such as asphyxiation, mediastinal infection, sepsis, and septic shock. Therefore, for treating these infections, the traditional therapy involves large incisions or multiple incisions to relieve local pressure and reduce the possibility of serious complications. After incision and drainage, it is necessary to conduct irrigation and dressing change 1–2 times each day. This operation takes more than half an hour each time to achieve gradual debridement. This process is lengthy, and patients are under great pain during each dressing-change. After healing, the tension at the incision and drainage sites is high, and thus, the local scar after surgery is large, leading to poor aesthetic outcomes. Whereas, after using the negative-pressure method, only the swelling of the wound and the drainage of the negative pressure needs to be observed daily. If there is no abnormality, no special dressing-change is needed. After 7–10 days, the device can be removed and the dressing only needs to be changed 2–3 times, which greatly reduces the workload of the medical personnel compared to that with the traditional method. In addition to the workload, the results show that the length of hospital stay and incision length in the negative-pressure group are significantly smaller than that in the traditional group ($P < 0.05$).

Compared to the traditional treatment method, the VSD-assisted irrigation technique not only meets the traditional requirement for incision and drainage, but also has its own characteristics. First, the high-vacuum material used has plasticity and compressibility, which allows a smaller local incision than that made during the traditional treatment. Furthermore, a trimmed, custom-shaped high-vacuum material can be placed into the incision, where the material can fully spread and expand to reach each target space. This combined with negative-pressure irrigation in the presence of a sealed wound dressing can enable full drainage via a small incision, which is consistent with the clinical results in the study by Probst et al. (2013). Thus, the VSD-assisted irrigation technique has the potential to completely replace the traditional procedures requiring large or multiple incisions and daily drainage and dressing-changes. Moreover, compared to the pain experienced in the traditional method by twice-a-day irrigation and dressing, considerably less pain is experienced with negative-pressure irrigation and drainage. In addition, negative-pressure irrigation and intermittent supply of high-concentration oxygen to the wound cavity can change the local state of wounds, and promote tissue healing. Indeed, Xu et al. (2000) and Saxena et al. (2004) found that negative pressure can reduce local edema, dilate arterioles, and increase local oxygen partial pressure. The latter combined with intermittent oxygen supply can greatly improve local hypoxic state. Moreover, continuous negative-pressure suction can promote the expression of a variety of repair signals and wound-healing genes, and increase the number of various growth factors and enzymes at the wound surface and surroundings thus promoting epithelial regeneration. Related studies have found that negative pressure can enhance the expression of calcitonin and P substance secreted by peripheral nerve endings, thereby affecting the expression of endogenous epidermal growth factor. Furthermore, negative pressure can promote a rapid increase in the content of fibronectin by regulating the activity of matrix metalloproteinase-2 and matrix metalloproteinase-9 in chronic wounds (Anasiewicz et al., 2011). In addition, long-term local negative pressure can stimulate micro-angiogenesis around the wounds, and provide more phagocytic cells and antibody components for the wounds through locally increased blood circulation. This facilitates the defense function of the immune system to improve the local anti-inflammatory capacity (Azzopardi et al., 2013). Due to the continuous negative-pressure irrigation and intermittent supply of high-concentration oxygen to the wound cavity, and the use of broad-spectrum antibiotics, the local micro-environment is altered. These collectively not only inhibit the original anaerobic bacteria, but also reduce the chance of new infections. In the clinics, we conducted bacterial

Table 1
Baseline characteristics of 73 patients with severe multiple-space infections in the oral, maxillofacial, and cervical regions.

Characteristics	Total (n = 73) (%)	Negative-pressure group (n = 38) %	Traditional group (n = 35) (%)	P value
Sex				
Male	48 (65.8)	26 (68.8)	25 (71.4)	0.80
Female	25 (34.2)	12 (31.2)	10 (28.6)	
Age (years)				
Range (median)	22-81 (62)	22-79 (61)	24-81 (62)	0.99
<60 years	47 (64.4)	25 (65.8)	23 (65.7)	
>=60 years	26 (35.6)	13 (34.2)	12 (34.3)	
Infected spaces				
masseter muscle, pterygomandibular space, temporal and infratemporal spaces	38 (52.0)	19 (50.0)	19 (54.3)	0.88
parapharyngeal space	7 (9.6)	3 (7.9)	4 (11.4)	
sublingual space, floor of mouth, submandibular space	24 (32.9)	14 (36.8)	10 (28.6)	
supraclavicular space	4 (5.5)	2 (5.3)	2 (5.7)	
Comorbidity with underlying diseases such as diabetes mellitus				
Yes	60 (82.2)	27 (71.1)	23 (65.7)	0.62
No	13 (17.8)	11 (28.9)	12 (34.3)	

Table 2
Comparison of results between the two treatment modalities.

Groups	n	Cure duration (d)	Incision length (cm)	Dressing change (frequency)	Cost of treatment (euros)
Negative-pressure	38	8.7 ± 1.1	8.8 ± 1.3	3.7 ± 0.9	3554.5 ± 253.6
Traditional	35	16.3 ± 1.6	14.7 ± 2.6	18 ± 2.1	3534.6 ± 263.2
P value	-	*<0.05*	*<0.05*	*<0.05*	*>0.5*

cultures and drug susceptibility tests for the drainage fluid multiple times. The results of these tests were negative, which confirmed that the VSD-assisted irrigation treatment was effective.

There are some shortcomings associated with the clinical application of VSD-assisted irrigation technique. First, the head and neck have irregular morphology, and do not resemble a flat trunk or limbs. Moreover, due to the wide range of motility caused by swallowing and rotation of the head, wrinkles are easily generated on the head and neck. If the negative-pressure drainage material is placed according to the conventional method, and the wound surface is covered by a specific transparent dressing, it is may cause leakage of the irrigation fluid, and thus retrograde infections. Therefore, we modified the above-mentioned method by completely embedding the high-vacuum material under the wound surface, and closing the wound tightly. This not only ensures negative pressure, but also avoids leakage. Second, the application of VSD-assisted irrigation technique is prone to poor drainage. Previous studies (Baharestani et al., 2009) have reported a 12.7% incidence rate of clogging, and attributed it to the following factors: a) the pore size of high-vacuum material is generally around 0.1 mm, and thus the pore is prone to clogging; b) continuous negative-pressure suction can greatly reduce the pore size of high-vacuum material; c) procoagulants such as platelets in local wound bleeding are likely to form large blood clots resulting in clogging; d) the collapse of the suction pipe contributes to clogging of the drainage tube. Thus, often secondary surgery is required to replace the tubes, rendering the option of surgery unacceptable to some patients. Therefore, we have drawn several conclusions for a favorable clinical practice of this method as follows: a) after the incision and drainage of the lesion, wound bleeding should be completely ceased; b) the infusion rate at the irrigation end and the negative-pressure suction force at the drainage end should be adjusted, so the countercurrent irrigation force of the negative-pressure drainage device is relatively balanced. This not only improves the irrigation efficiency to reduce the concentration of procoagulant substances and inflammatory factors, but also avoids clogging caused by excessive negative pressure; c) during VSD-assisted irrigation, we found that the exudate extracted in the early stage contained a large amount of protein. This coupled with the poor nutritional status of patients made the negative-pressure drainage more likely to result in hypoproteinemia. Therefore, we should closely monitor the nutritional status of the body, regularly re-examine relevant indicators, and if necessary, provide nutritional support to prevent the body's negative nitrogen balance; d) considering that the negative-pressure drainage device is relatively expensive, it is not the best choice for patients with non-critical maxillofacial infection or those of poor economic status; and e) because the negative-pressure drainage device is placed at the infection site, it should be removed by a second operation when the infection is controlled. Although the operation is simple and does not cause great pain, sometimes patients may experience mild discomfort. In conclusion, we think that the best indication for this technique is the severe multi-space infection of the maxillofacial region and neck that cannot be fully drained by small incisions. Based on the basic principle of this technique, we have also applied it to infectious lesions due to other causes in maxillofacial region, such as postoperative wound infection or chronic osteomyelitis, and have achieved favorable results.

There are some limitations in our study. First, this is a single-center study with a limited sample size. Secondly, bias is inevitable in this retrospective study. In order to control bias, we conducted a chi-square test between the non-research factors in the two groups, and no statistical significance was observed. However, the methods used by patients are indeed non-random, mainly based on the choice of patients and the surgeons' preferences. Surgeons may use VSD technology in more serious cases. These factors may influence our results; hence, we need to increase the number of samples and design randomized prospective clinical trials to control or correct the risk of bias.

Source of funding

The study was supported by Fujian Provincial Natural Science Foundation (2016J01452).

Conflicts of interest

No potential conflicts of interest relevant to this article.

Acknowledgement

Yu Qiu and Lisong Lin would like to thank Baochang He (Department of Epidemiology and Health Statistics, School of Public Health, Fujian Medical University, Fujian, China) for support with the analysis of the clinical data.

References

Anasiewicz T, Borejsza-Wysocki M, Meissner W, Malinger S, Szmeja J, Kościński T, et al: Vacuum-assisted closure therapy in patients with large postoperative wounds complicated by multiple fistulas. Wideochir Inne Tech Maloinwazyjne 6: 155–163, 2011

Argenta LC, Morykwas MJ: Vacuum-assisted closure: a new method for wound control and treatment: clinical experience. Ann Plast Surg 38: 563–576, 1997 discussion 577

Azzopardi EA, Boyce DE, Dickson WA, Azzopardi E, Laing JH, Whitaker IS, et al: Application of topical negative-pressure (vacuum-assisted closure) to split-thickness skin grafts: a structured evidence-based review. Ann Plast Surg 70: 23–29, 2013

Baharestani M, Amjad I, Bookout K, Fleck T, Gabriel A, Kaufman D, et al: V.A.C. Therapy in the management of paediatric wounds: clinical review and experience. Int Wound J 6(Suppl. 1): 1–26, 2009

Fleischmann W, Strecker W, Bombelli M, Kinzl L: Vacuum sealing as treatment of soft tissue damage in open fractures. Unfallchirurg 96: 488–492, 1993

Govea-Camacho LH, Astudillo-Carrera A, Hermosillo-Sandoval JM, Rodríguez-Reynoso S, González-Ojeda A, Fuentes-Orozco C: Impact of vacuum-assisted closure management in deep neck abscesses. Cir 84: 275–281, 2016

Morykwas MJ, Argenta LC, Shelton-Brown EI, McGuirt W: Vacuum-assisted closure: a new method for wound control and treatment: animal studies and basic foundation. Ann Plast Surg 38: 553–562, 1997

Plikaitis CM, Molnar JA: Subatmospheric pressure wound therapy and the vacuum-assisted closure device: basic science and current clinical successes. J Expert Rev Med Devices 3: 175–184, 2006

Probst F, Otto S, Sachse R, Cornelius CP: Minimally-invasive catheter drainage of submandibular abscesses. Br J Oral Maxillofac Surg 51: 199–200, 2013

Saxena V, Hwang CW, Huang S, Eichbaum Q, Ingber D, Orgill DP: Vacuum-assisted closure: microde formations of wounds and cell proliferation. Plast Reconstr Surg 114: 1086–1096, 2004 discussion 1097 1098

Xu N, Chen S, Qiao C: Effect of negative pressure on blood flow in wounds. J Fourth Milit Med Univ 21: 976–978, 2000

Zhang G, Chen S, Zheng M, Wu X, Yu J: Sustained negative pressure drainage for treatment of severe maxillofacial and neck space infection. Hua Xi Kou Qiang Yi Xue Za Zhi 33: 393–396, 2015