Adjuvant Therapy of Vacuum Assisted Closure (VAC) in Complex Odontogenic Head and Neck Infections: A Retrospective Study of 10 Patients

Leandro Díez Suárez*, Deisy Yolany Meza Enamorado, Mario Alberto Teliz Meneses and Diego Antonio Cariño Cartagena

Department of Oral and Maxillofacial Surgery, National Autonomous University of Mexico (UNAM), Mexico

Abstract

Introduction: The complex anatomy of the head and neck is a challenge in the treatment of odontogenic infections. Currently, conventional management consists of removal of the causative agent, antibiotic therapy, drainage, and surgical debridement. However, adjuvant therapies have been developed that have improved the prognosis of the patient with complex odontogenic infection.

Material and Methods: A retrospective review of 10 patients is carried out; 7 men and 3 women who presented a diagnosis of Head and Neck Deep Abscess (HNDA) and Necrotizing Fasciitis (NF) of odontogenic origin classified as complex and were treated with adjuvant Vacuum-Assisted Closure (VAC).

Results: The study consisted of 10 patients; 7 men and 3 women. The mean age was 39.9 years; the main systemic disease was diabetes mellitus followed by systemic arterial hypertension. Three patients had a diagnosis of NF and 7 patients presented HNDA. The most compromised aponeurotic space was the submandibular, followed by submental and sublingual. One patient died with a diagnosis of cervicofacial NF with extension to the mediastinum and 9 patients resolved favorably.

Conclusion: Complex odontogenic infections of the head and neck continue to be a disease with a high mortality rate. Radical and timely diagnosis and treatment are crucial for patient survival. The benefit of Vacuum assisted closure favors drainage and healing of the infected site, reduces the number of surgical washes and the patient's hospital stay.

Keywords: Necrotizing Fasciitis (NF); Head and Neck Deep Abscess (HNDA); Odontogenic infection; Head and neck infection; Vacuum Assisted Closure (VAC)

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****Correspondence:***

Leandro Díez Suárez, Department of Oral and Maxillofacial Surgery, National Autonomous University of Mexico (UNAM), Mexico,

E-mail: ledisuar@gmail.com

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Introduction

Complications related to odontogenic head and neck infections have decreased considerably due to advances in microbiology, antibiotics, diagnostic tools such as computed tomography and magnetic resonance imaging, new medical treatments and surgical techniques. However, odontogenic head and neck infections can present a difficult task for the maxillofacial surgeon. More, when the airway or deep cervicofacial spaces are involved [1].

The main complications that can arise from the progression of an odontogenic infection are Necrotizing Fasciitis (NF) and Head and Neck Deep Abscess (HNDA), both of which are potentially fatal due to airway obstruction, extension of the disease through the deep planes and systemic compromise [2-4].

Treatment of odontogenic head and neck infections requires multidisciplinary radical and timely participation. The basic principles in the treatment of odontogenic infections consist of removing the causative etiological factor, antimicrobial therapy performing surgical, drainage or debridement of the compromised anatomical structures. Occasionally is necessary an advanced management of the airway and the patient's hemodynamic status [5].

Despite a timely and aggressive treatment both systemic and surgical, some patients do not present a clinical improvement or have a poor healing process. The main systemic diseases that affect the evolutionary process of odontogenic infections include diabetes mellitus, hypertension, autoimmune diseases, kidney, liver and lung failure [6,7].

The Vacuum Assisted Closure (VAC) has recently been used on the head and neck as a complementary treatment in NF and HNDA. VAC therapy has important advantages such as reducing the number of surgical lavage, healing time, and hospital stay. In addition, it increases viable tissue, making it possible to close the wound by first or second intention [8].

The purpose of this study is to show the results of our series of cases in the treatment of the main complications of odontogenic infections of the head and neck; NF and HNDA treated concomitantly with VAC.

Materials and Methods

A retrospective review of 10 patients is carried out; 7 men and 3 women who presented a diagnosis of NF and HNDA of odontogenic origin classified as complex and who were treated at our institution between March 2018 and December 2020.

For the publication of this study, all patients had written informed consent in accordance with the Declaration of Helsinki.

Inclusion criteria for the present study and to classify them as complex included any of the following variables: Odontogenic infections that did not respond adequately to the initial treatment carried out (antimicrobial therapy, removal of the causative factor and surgical lavage or drainage), patients with underlying systemic diseases, compromise of at least 1 space classified as high risk (lateral pharynx, retropharynx, pretracheal, dangerous space, mediastinum, orbital, intracranial/cranial), 2 or more spaces classified as moderate risk (submandibular, submental, sublingual, pterygomandibular, submasseteric, superficial temporal, deep temporal, subgaleal).

Exclusion criteria included patients who presented odontogenic infections only in low-risk spaces (vestibular, subperiosteal, space of the body of the mandible, infraorbital, buccal), non-odontogenic infections and referred patients who received some initial treatment in another care center.

Hospital admission and initial treatment

After hospital admission, the patients underwent routine physical examinations and laboratory tests consisting of blood count, blood chemistry, and coagulation tests. In cases suggestive of NF, C-Reactive Protein (CRP) tests were also performed using the LRINEC scale (Laboratory Risk Indicator for Necrotizing Fasciitis Score) Table 1.

Computed Tomography (CT) examinations were performed in all patients, who were used to evaluate the severity and extension to the anatomical spaces involved Figure 1A, 1B.

The collection of samples for bacterial culture with aerobic and anaerobic analysis was carried out by means of fine needle aspiration and they were transported in a culture medium for microbiological analysis and antibiogram (BD BBLTM CultureSwab™) (BACT/ALERT® FN PLUS). In some patients, there was no bacterial growth in the samples made for microbiological culture.

Antimicrobial therapy was performed in all patients after consultation with the infectious disease service. The antibiotic was chosen according to the results of the microbiological culture, antibiogram and the general systemic state of the patient.

Surgical treatment and implementation of vacuum assisted closure (VAC)

Under balanced general anesthesia with nasotracheal, orotracheal intubation or tracheostomy as determined by the anesthesiology service, all patients were transferred to the operating room and the teeth involved were extracted. In addition, drainage with surgical debridement was performed through an anatomical dissection along the involved cranial or cervicofacial plane.

Necrotic tissue and venous thrombosis were removed as much as possible and mechanical washes were performed with a solution of 3% hydrogen peroxide, povidone iodine, and 0.9% sodium chloride. In some cases, the placement of the VAC was performed in a second surgical stage. This, in order to attend to the emergency, obtains a bed with better conditions and obtains adequate access to the involved aponeurotic spaces.

Anatomical locations where VAC therapy was implemented included the skull, facial region, and neck. In order to protect anatomical structures susceptible to damage by VAC therapy such as bone, cartilage, sense organs, oral mucosa and large vessels; we carried out the protection of the tissue with an interposition matrix that helped reduce the direct contact of the VAC system with these structures. (JELONET® - Smith & Nephew) (Gelfoam® - Pfizer). In these cases, a white Polyvinyl Alcohol (PVA) sponge with non-adhesive properties was also indicated. WhiteFoam® - Smith & Nephew).

After preparing the site, we adapt the sponges of the system keeping the skin around the wound clean and dry for the placement of the adhesives and thus achieve an airtight seal.

The VAC system (RENASYS® - Smith & Nephew) and (V.A.C

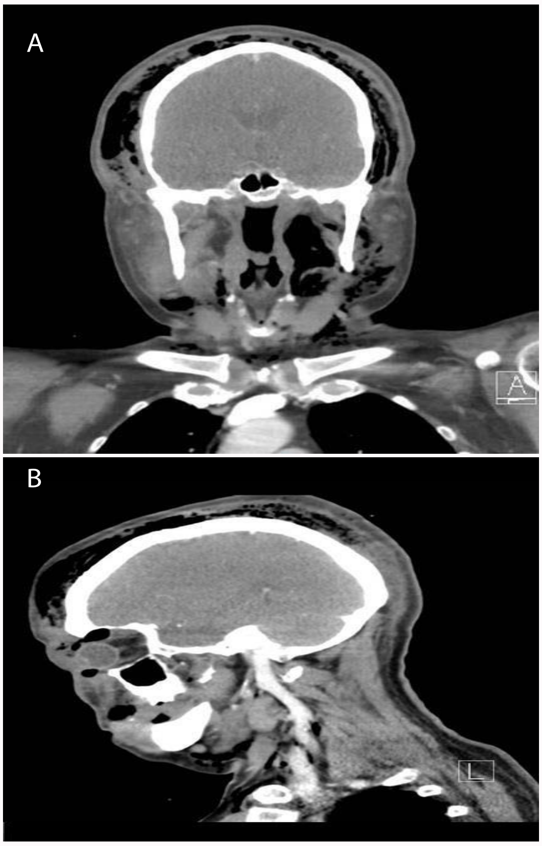

Figure 1: A: Base line tomography showing collection in subgaleal, parapharyngeal, masticatory, submandibular and bilateral supraclavicular space. **B:** look at the compromise of orbit and spread into dangerous space.

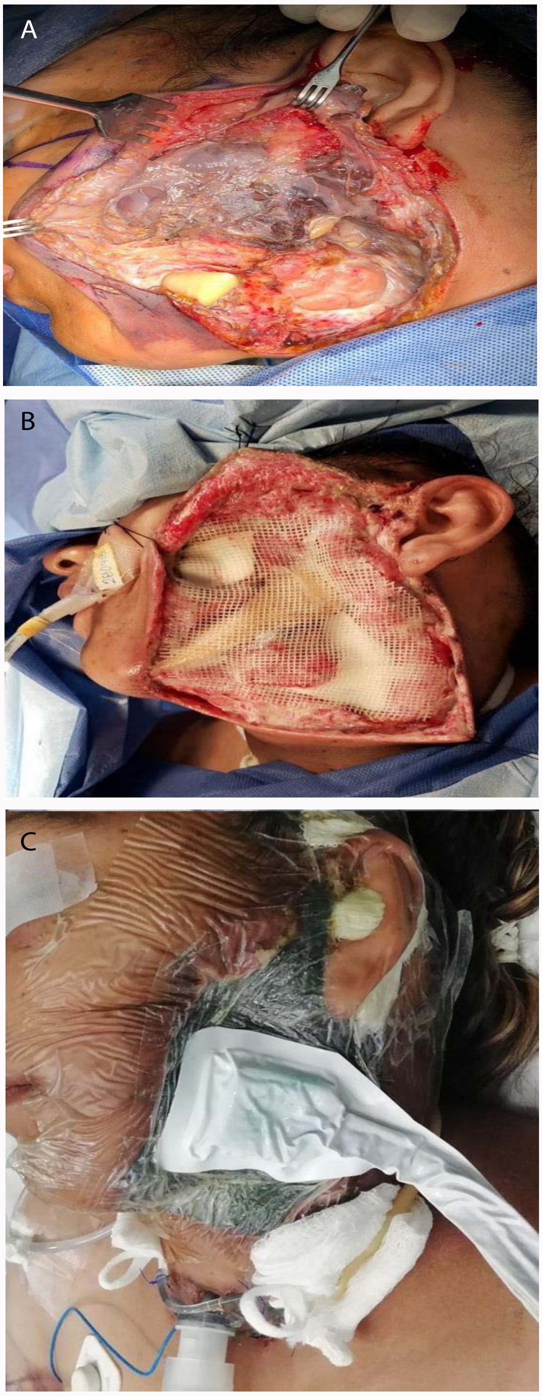

Figure 2: A: Cervicofacial necrotizing fasciitis showing necrotic tissue and venous thrombosis involving skin, fascia and left hemifacial muscles. Look at the exposure of the mandibular bone and left submandibular gland. **B:** Surgical wound after two weeks of surgical scrubs. Look at the protection of important vessels and oral mucosa covered with dressings before VAC therapy. **C:** Activated system ensuring a hermetic seal of the wound.

Ulta™ Therapy Sistem) was activated with a pressure range between 80 and 120 mmHg Figures 2A-2C.

Postoperative treatment

The VAC system was replaced every 3 or 4 days, performing superficial surgical scrubbing and conserving as much tissue as possible. Before performing the VAC removal, the patients underwent a microbiological culture test for aerobic and anaerobic organisms, which had to be negative for removal.

Primary closure was performed when there was no loss of soft tissue and the wound edges were facing without difficulty. Occasionally, dissection around the wound allowed primary closure.

In cases where there was no possibility of performing a primary closure, a local flap, skin graft or secondary intention wound closure was used. In these cases, even if the infection was controlled, the VAC therapy was prolonged to allow more granulation tissue formation Figures 3A-3D.

Results

Table 1 summarizes the demographic variables and preoperative findings for complex odontogenic head and neck infections. The clinical courses are summarized in Table 2.

The sample consisted of 10 patients; 7 men and 3 women. The age (years), mean ± SD (range) was 39.9 years ± 10.5 (54 to 22; n=10). The main related systemic disease was diabetes mellitus in 6 patients followed by systemic arterial hypertension. Other diseases such as kidney failure were observed in 1 patient, Cushing in 1 patient, rheumatoid arthritis in 1 patient, and obesity in 1 patient.

Three patients had a diagnosis of NF and 7 patients had HNDA. Of the 10 patients, six had compromise of 1 to 3 high-risk spaces. All patients had 3 or more moderate-risk spaces compromised. The most compromised aponeurotic space was the submandibular in 9 patients, followed by the submental and sublingual spaces, which were equally present in 7 patients. The initial laboratories showed hyperglycemia in all patients, 4 of them presenting ketoacidosis, 5 patients exhibiting leukocytosis, 1 patient presenting thrombocytosis and 1 patient hypoalbuminemia (Table 1).

Figure 3: A: Subgaleal abscess that later developed with frontal and parietal necrotizing fasciitis. **B,C:** After resolving the infectious phase, the VAC therapy for wound management is extended, trepan is performed in the calotte to favor the formation of granulation tissue. **D:** Subsequently a secondary closure of the wound was achieved.

Table 1: Demographic variables and preoperative findings for complex odontogenic head and neck infections.

Case #	Age	Gender	Comorbidity	Diagnosis	Low Risk Spaces	Moderate Risk Spaces	High Risk Spaces	Initial Labs	LRINEC Scale
1	22	M	Healthy	Cervicofacial HNDA		SMB, SM, SL		WBC 9.50, NEUT 83.50, BLS 122 MG/DL	
2	24	M	Healthy	Cervicofacial HNDA	Bu	SMB, SM, SL		WBC 13.40, NEUT 71.80 BSL % 110 MG/DL	
				NF				WBC 18.30, NEUT	13 High risk
3	30	F	DM, RF	Cervicofacial	Bu	SMB, PTM, SMA	M	96.10% BSL 562 MG/DL	
4	40	M	DM	HNDA Cervical		SMB, SM, SL		WBC 13.30, NEUT 86%, BSL 456 MG/DL	
5	40	M	DM. HTN	HNDA Cervical		SMB, SM, SL	LP, RP, M	WBC 6.30, NEUT 78.30%, BSL 245 MG/DL	
6	45	M	DM	NF Cervicofacial	Bu	SMB, SM, SL		WBC 16.40, NEUT 89.91%, BSL 204 MG7DL	4 Low risk
7	47	F	DM, HTN, RA	HNDA Cervical		SMB, SM, SL	LP	WBC 7.40, NEUT 69%, BSL 416 MG/DL	
8	51	F	DM	HNDA Craniocervicofacial	Bu	PTM, SMA, SMB, DT, ST	C, LP, M	WBC 8.7, NEUT 682.8% BSL 113 MG/DL	
9	54	M	SD Cushing	NF Craniocervicofacial	Bu	PTM, SMA. DT, ST	C	WBC 21.10, NEUT 86%,BSL 606 MG/DL	13 High risk
10	46	M	DM, HTN, Obesity	HNDA Cervical		SMB, SM, SL	LP, M	WBC 7.40, NEUT 68.54%, BSL 460 MG/DL	

DM: Diabetes Mellitus II; RF: Renal Failure; HTN: Hypertension; RA: Rheumatoid Arthritis; SD: Syndrome; HNDA: Head and Neck Deep Abscess; NF: Necrotizing Fasciitis; BU: Buccal; SMB: Submandibular; SM: Submental; SL: Sublingual; PTM: Pterygomandibular; SMA: Submasseteric; DT: Deep Temporal; ST: Superficial Temporal; M: Mediastinum; LP: Lateral Pharyngeal; RP: Retropharyngeal; C: Cranial; LRINEC, Laboratory Risk Indicator for Necrotizing Fasciitis; Risk stratification: <6 low; 6-7 intermediate; ≥ 8 high

Table 2: Clinical courses for complex odontogenic head and neck infections.

Case #	Debridements	Days of VAC treatment until infection resolution	Days with VAC for wound management	Days of hospital stay	Complications	Outcome
1	4	12	-	19		Cure
2	4	12	-	19	LEUCK	Cure
3	6	18	35	51	LEUKC, RF, DK, sepsis, Multiorgan Failure	Death
4	3	9	-	10	LEUCK	Cure
5	5	18	-	43	TRA, THC, RF, OF	Cure
6	5	17	-	30	LEUKC, HA, DK	Cure
7	4	17	-	24		Cure
8	5	18	-	37	TRA, OAF, DK, TBC	Cure
9	5	18	137	40	LEUKC, DK	Cure
10	5	18	-	45	TRA, THC, SS, RF	Cure

LEUKC: Leukocytosis; RF: Renal Failure; DK: Diabetic Ketoacidosis; TRA: Tracheostomy; THC: Thoracotomy; OF: Oropharyngeal Fistula; HA: Hypoalbuminemia; OAF: Oroantral Fistula; TBC: Thrombocytosis; SS: Submandibular Sialadenitis

The bacteria isolated in the microbiological cultures were multiresistant *Acinetobacter baumannii* complex n=2, *Pseudomonas aeruginosa* n=1 and *S. coli* n=1. The other patients had cultures without development n=4 or were not performed n=2.

The mean ± SD (range) number of surgical debrides was 4.6 ± 0.8 (3 to 6; n=10). The VAC therapy until the resolution of the infection in (days), mean ± SD (range) was 15.7 days ± 3.2 (18 to 9; n=10). The vacuum assisted closure therapy for wound management in (days), mean ± SD (range) was 17.2 days ± 41.3 (137 to 35; n=2).

The days of hospital stay in (days), mean ± SD (range) was 31.8 days ± 12.8 (51 to 10; n=10).

The main surgical complications were tracheostomy n=2, thoracotomy for mediastinitis n=3. Orocutaneous fistula n=2. The main metabolic complications were ketoacidosis n=2, renal failure n=3, leukocytosis n=5, thrombocytosis n=1, hypoalbuminemia n=1. One patient died with a diagnosis of cervicofacial NF with extension to the mediastinum. The cause of death was severe sepsis and multiple organ failure.

Discussion

Deep head and neck infections result from the implantation and development of pathogenic microorganisms. Thus, as the morbid action by them and their products in the host. The world literature reports dental origin as the main cause of deep neck infections in 50% of cases, secondly, respiratory tract infections with 21% of cases and to a lesser extent as a result of sialadenitis [9,10].

In odontogenic infections, microorganisms from the oral cavity invade deep spaces through closed niches such as deep caries, root infection, periodontal abscesses, or trauma exposed to the oral environment [9]. In our study, odontogenic infections originated from teeth in poor condition, root remnants, and established periodontal disease. The molar region was the main cause of odontogenic infection in our series of cases.

Odontogenic head and neck infections can be more severe and life-threatening due to airway obstruction, deep-plane disease spread, and systemic involvement of the patient. Although most odontogenic infections resolve favorably, the main complications that can arise from the progression of an odontogenic infection are Head and Neck Deep Abscess (HNDA) and Necrotizing Fasciitis (NF). The last-mentioned instance, described as the most serious form of skin and soft tissue infection, being a rapidly progressive infection that affects the skin, subcutaneous cellular tissue, superficial and deep fascia [11-13]. Both NF and HNDA present significant systemic toxicity, multiple organ failure, and a high in-hospital mortality rate. The mortality rate for HNDA is 1.7% and 25% to 35% for NF [14,15].

There are several criteria for hospital admission of a patient with severe odontogenic infection. In general, a patient with trismus, dysphagia, fever, and a systemic inflammatory response should be treated in a hospital setting [3]. In addition to clinical findings, several studies establish that the main systemic diseases related to a high rate of mortality or hospital complications are: Diabetes Mellitus, hypertension, obesity, peripheral vascular disease and renal impairment [16,17].

Laboratory studies play an important role in the timely diagnosis and treatment of the patient with severe odontogenic infection. To help diagnose NF from other soft tissue infections, Wong et al. [18] proposed the LRINEC scale (Laboratory Risk Indicator for Necrotizing Fasciitis Score). A numerical score that ranges from 0 to 13 and is calculated using six laboratory indices: C-Reactive Protein (CRP) mg/dl, white blood cell count per mm^3, Hemoglobin (Hb) g/dl, sodium mmol/l, creatinine mg/dl and blood glucose mg/dl. A score ≤ 5 indicates a <50% risk of developing NF, a score of 6 to 7 indicates a 50% to 75% risk, and a score ≥ 8 indicates a >70% risk of developing NF. Thus, laboratory studies have an important diagnostic function, predict worse hospital outcomes, and help identify high-risk patients [19]. Additionally, other biomarkers have been reported such as procalcitonin, serum lactate, neutrophil- leukocyte radius, volume erythrocyte sedimentation rate and fibrinogen as predictors of severity, increased hospital stay, and sepsis [20-23].

Christensen et al. [24] conducted a retrospective study with 223 patients to determine the risk factors for reoperation in patients hospitalized for odontogenic infections. In their study, a greater number of involved spaces and older patients were associated with greater probabilities of reoperation and longer hospital stay.

Luyao Qu et al. [25] carried out a retrospective cohort study with a total of 296 patients' about of risk factors for descending necrotizing mediastinitis caused by multispace infection in the maxillofacial region. In their study, the parapharyngeal space was a statistically significant risk factor for the development of descending necrotizing mediastinitis in multivariate analysis. This is explained because the parapharyngeal space descends through the paravisceral space and connects with the anterior tracheal space, entering the anterior mediastinum more easily. Additionally, they report that the main risk factors associated with mortality are the presence of complications and sepsis. In the presence of cervical necrotizing fasciitis, descending necrotizing mediastinitis, and sepsis, the mortality rate increases to 64% [26].

In our case series, the patients with the highest number of high-risk aponeurotic spaces and spaces such as lateral pharyngeal, retropharyngeal, pretracheal, dangerous space, mediastinum, and orbital were associated with the greatest severity and the main surgical and metabolic complications. The mortality rate in our case series was 10%, represented by a patient with a diagnosis of cervicofacial NF with extension to the mediastinum, severe sepsis and multiple organ failure.

Traditionally, the treatment of complex odontogenic head and neck infections includes removal of the causative agent, antimicrobial therapy, drainage, and surgical debridement. However, adjuvant therapies have been developed that have improved the evolution and prognosis of the patient with complex odontogenic infection [27,28].

The VAC therapy uses a negative suction system using sponges and dressings placed on or in a wound. This system allows the continuous extraction of fluids and edema from the wounds, facilitating the growth of granulation tissue, increasing local blood flow and reducing the risk of infection [29]. The VAC therapy has been implemented in various clinical situations such as traumatology and orthopedics, general surgery and in the treatment of complex wounds [30-32].

Yu Qiu y col et al. 33 conducted a retrospective study with 73 patients; 38 treated with VAC therapy and 35 with traditional incision and drainage therapy. They found with the VAC system; favorable clinical effects and enables short treatment duration, lesser pain-experience, and high clinical and therapeutic efficacy compared to the traditional therapy group.

Braakenburg et al. [34] performed a randomized controlled trial studying 65 patients treated with VAC therapy and conventional therapy. In their study, they found that the VAC group healed 33% faster than patients in the conventional group. In addition, patients and nurses reported that the VAC device was more comfortable compared to conventional healing.

An important consideration in the treatment with head and neck VAC is the protection of cavities and large vessels that are damaged during the disease and its treatment. In our experience, the erosion of the great vessels and the exposure of these structures should not be a contraindication for therapy and can be managed with interposition materials, white sponge and adequate pressure ranges through the VAC system. Similar results reported by other authors [35,36].

In our study, VAC therapy was used for two purposes. Active treatment of the infection (favoring the drainage of deep fascial spaces, reducing the number of surgical washes and the length of hospital stay) and as treatment of the surgical wound (reducing the bloody area, increasing the viable tissue and allowing a definitive closure). In both situations, VAC therapy proved to be a viable, predictable, and successful alternative.

Conclusion

Complex odontogenic head and neck infections remain a disease with a high mortality rate. Radical and timely diagnosis and treatment are crucial for patient survival. The benefits of Vacuum assisted closure as a complementary therapy, there is increasing scientific evidence showing that it is a therapeutic alternative that favors drainage and healing of the infected site, reduces the number of surgical scrubs and the patient's hospital stay. The main limitation of our study was the limited number of cases. However, considering the rarity of the disease and the presence of various comorbidities and/or complications in these patients, it is difficult to create two homogeneous groups and perform a meaningful analysis. Our management protocol could help to compare the effect of Adjuvant therapy of Vacuum Assisted Closure (VAC) in complex odontogenic head and neck infections.

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