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Original Article

Analysis of pathogenic bacteria of oral and maxillofacial space infection and the effect of vacuum sealing drainage treatment

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Abstract: Objective: To investigate the pathogenic spectrum of oral and maxillofacial space infection and evaluate the clinical efficacy of vacuum sealing drainage (VSD) in its treatment. Methods: A retrospective analysis was performed on 118 patients with oral and maxillofacial space infection admitted to the Department of Stomatology, the Second Affiliated Hospital of Zhejiang University School of Medicine, from January 2021 to December 2023. All patients underwent pathogenic bacteria detection, and were divided into a conventional incision drainage group (n=72) and a VSD group (n=46) by treatment method. The clinical efficacy, recovery-related indicators, pain scores and serum inflammatory factor levels were compared between the two groups. Results: The most frequent infection sites were the masseteric, buccal and infraorbital spaces in turn. *Staphylococcus aureus*, *Staphylococcus epidermidis* and *Klebsiella pneumoniae* were the dominant pathogens. Compared with the conventional group, the VSD group showed a higher clinical effective rate, significantly shorter wound healing time, antibiotic course and hospital stay (all $P < 0.05$). Meanwhile, the VSD group had lower pain rating index (PRI), visual analogue scale (VAS), present pain intensity (PPI) scores, and lower serum levels of tumor necrosis factor-α (TNF-α), high-sensitivity C-reactive protein (hs-CRP) and interleukin-6 (IL-6) (all $P < 0.05$). Conclusion: Oral and maxillofacial space infection is mainly caused by Gram-positive cocci. VSD can enhance clinical efficacy, alleviate pain, reduce inflammatory response, and shorten the duration of antibiotic use and hospitalization, which is worthy of clinical promotion.

Keywords: Oral and maxillofacial space infection, pathogen analysis, negative pressure drainage, clinical therapeutic effect, inflammatory factors

Introduction

Oral and maxillofacial space infection refers to the suppurative inflammation in the fascia space of the maxillofacial region. It is one of the common acute and severe diseases in oral and maxillofacial surgery. It has the characteristics of acute onset and rapid development [1, 2]. Studies have shown that the infection mostly originates from odontogenic or glandular origin, because the maxillofacial space is connected and adjacent to the intracranial space. If the infection is not controlled timely and effectively, it can lead to multiple anatomical space infections, sepsis and even life-threatening airway obstruction and intracranial infection [3, 4]. Epidemiological investigation shows that with the application of broad-spectrum antibiotics and the change of bacterial resistance, the distribution and drug resistance spectrum of pathogenic bacteria are becoming more and more complex, which aggravates the difficulty of clinical infection treatment [5].

At present, the treatment of oral and maxillofacial space mainly relies on surgical incision and drainage combined with systemic anti-infection, which can timely and effectively relieve the pressure of the pus cavity, remove the necrotic tissue and drain the pus [6, 7]. However, scholars have found that traditional incision and drainage treatment methods have disadvantages such as large trauma, incomplete drainage, frequent dressing changes, increased patient pain, and slow wound healing [8, 9]. In recent years, vacuum sealing drainage technol-

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ogy has shown significant advantages in the treatment of various complex wounds due to its active, continuous and controllable drainage characteristics, and has achieved good therapeutic effects. However, most of them focus on clinical outcomes, and there are few studies on reducing pain response and systemic inflammation [10]. Based on this, the purpose of this study was to retrospectively analyze the cases of oral and maxillofacial space infection, explore the distribution characteristics of pathogenic bacteria, and comprehensively evaluate the clinical efficacy of vacuum sealing drainage, in order to provide more clinical evidence for improving the overall diagnosis and treatment of the disease.

General information and methods

General information

The general data of 118 patients with oral and maxillofacial space infection admitted to the Department of Stomatology of the Second Affiliated Hospital of Zhejiang University School of Medicine from January 2021 to December 2023 were retrospectively analyzed, including baseline data, pathogenic bacteria and drug sensitivity test analysis. This study was conducted in accordance with the Declaration of Helsinki and was approved by the Ethics Committee of the Second Affiliated Hospital of Zhejiang University School of Medicine (Approval No: RGSZYYLL2020013).

Inclusion criteria

1. Age greater than 18 years but less than 80 years; 2. Those with complete clinical data; 3. All patients were confirmed by imaging and serological examination as oral and maxillofacial incision and drainage; 4. Infected first-time patients; 5. Patients who completed the whole treatment cycle in our hospital.

Exclusion criteria

1. Incomplete clinical data; 2. There were disputes; 3. Pregnant and lactating women; 4. Combined infection of other tissues and organs; 5. Combined with tumor and cardiovascular disease need to deal with; 6. Infected persons in the last two weeks; 7. Patients with rheumatic immune diseases.

Treatment methods

In the conventional incision and drainage group, the abscess drainage was first incised to remove the abscess cavity. After thorough disinfection, the abscess was incised and the drainage was placed. When the drainage was placed, it was determined according to the size and location of the abscess cavity. The rubber tube was used when the abscess was deep, and the rubber strip was used as the drainage when it was limited to the surface. After the operation, the wound was cleaned 1-3 times a day according to the drainage volume, and the skin was sutured after the patient's symptoms disappeared (**Figures 1** and **2**).

For the negative pressure closed drainage group, a small incision was first used to cut the abscess, and a closed negative pressure drainage device was used to drain the wound. After the operation, the wound was rinsed with normal saline and suctioned under negative pressure. One week later, the closed negative pressure drainage device was cleaned and replaced according to the condition of the rinse. The negative pressure drainage fluid was removed after it was clear, and the wound was sutured after one week of observation [11].

Microbiological examination and antimicrobial susceptibility testing

Specimen collection and culture: Pus samples were collected aseptically during incision and drainage, immediately transported to the laboratory, and inoculated onto blood agar, chocolate agar, and MacConkey agar plates. Cultures were incubated at 35±2°C under appropriate atmospheric conditions (aerobic, 5% CO_2, or anaerobic as clinically indicated) for 24-48 hours.

Bacterial identification: Isolated pathogens were identified to species level using matrix-assisted laser desorption/ionization time-of-flight mass spectrometry (MALDI-TOF MS) or conventional biochemical tests.

Antimicrobial Susceptibility Testing (AST): AST was performed using the broth microdilution method or disk diffusion method, strictly following the current guidelines of the Clinical and Laboratory Standards Institute (CLSI). Quality control was ensured by testing reference

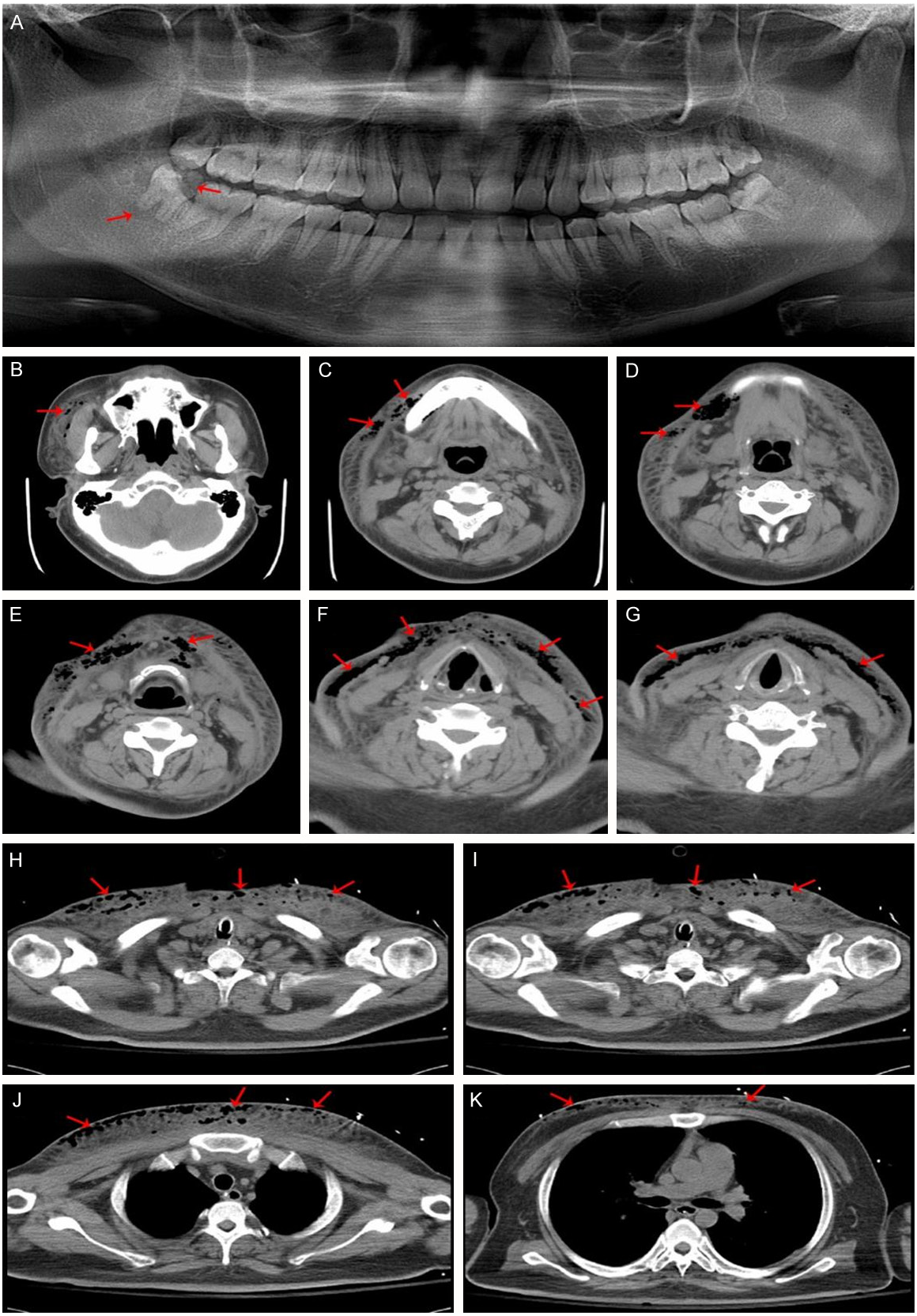

Figure 1. (A) Panoramic tomogram of the entire mouth. It can be seen that in the posterior tooth area of the left mandible (indicated by the red arrow), there is a blurred periodontal tissue, alveolar bone resorption accompanied

by increased density of surrounding tissues, suggesting the presence of a dental source infection focus in this area. (B-K) CT axial images, scanned layer by layer from top to bottom. The area indicated by the red arrow shows soft tissue swelling, uneven density, and gas shadows (B-E), suggesting infection with tissue necrosis and gas accumulation. As the scanning level moves downward (F-K), the infection range spreads to the soft tissues of the neck and upper chest, presenting as extensive soft tissue edema, blurred fat spaces, and local exudative density increase shadows, indicating that the oral infection has spread to multiple spaces in the maxillofacial and neck regions.

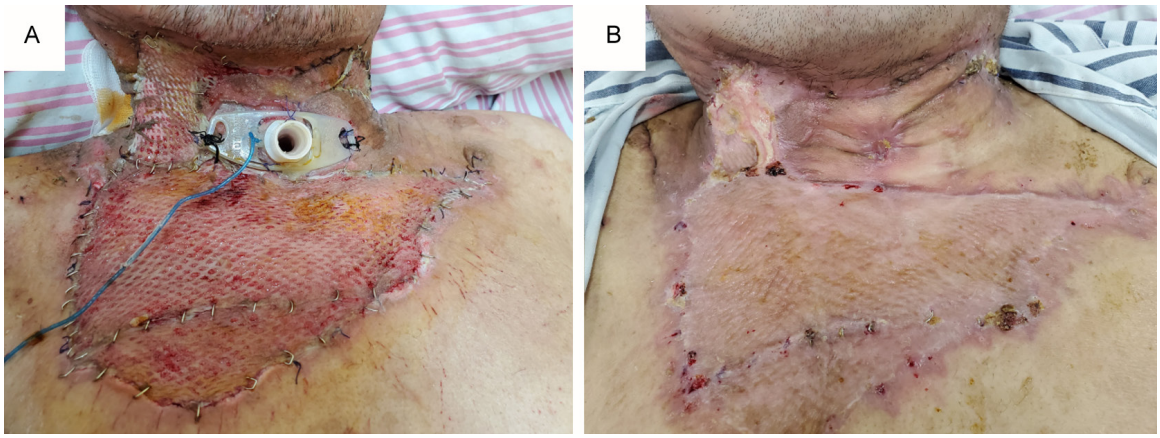

Figure 2. A. Preoperative: Manifestation of maxillofacial infection lesion. It shows the condition of the surgical area in the neck of a patient with maxillofacial infection. The surgical area shows obvious infectious redness and swelling, local exudation, and a tracheotomy tube (used for airway management) can be seen. The surface of the surgical area is covered with artificial repair materials and fixed with sutures, indicating that the infection is in the acute stage and there is a significant inflammatory response in the local tissues. B. Postoperative: Healing condition after maxillofacial infection treatment. It shows the condition of the surgical area in the neck of the same patient after treatment. The redness and exudation in the original infected area have significantly subsided. The tissue in the surgical area gradually becomes flat, the adhesion between the artificial material and the surrounding tissues improves, and only a small amount of healing crusts/exudation traces remain locally, indicating that the infection has been effectively controlled and the tissues have entered the repair and healing stage.

strains (Staphylococcus aureus ATCC 25923, Escherichia coli ATCC 25922, and Pseudomonas aeruginosa ATCC 27853) concurrently with each batch of clinical isolates.

Data collection

The general information of the patients was obtained by consulting the electronic system, including baseline data, hemoglobin content, platelet content, liver function, serum albumin index, etc. Laboratory index detection method: fasting venous blood was collected at the time of admission. Whole blood cell counts were performed using an automated hematology analyzer (model: Sysmex XN-9000) to determine white blood cell (WBC) counts. Liver and kidney function and blood lipid levels were evaluated by biochemical analyzer (instrument model: Roche Cobas c702). Specific indicators include: alanine aminotransferase (ALT), aspartate aminotransferase (AST), cholesterol level, high density lipoprotein, low density lipoprotein to evaluate liver function; serum creatinine (SCr) and blood urea nitrogen (BUN) were measured to evaluate renal function. All detection operations strictly followed the standard operating procedures provided by the reagent manufacturer. The detection time points for inflammatory factors (TNF-α, hs-CRP, IL-6) were before treatment (within 24 hours before the operation) and after treatment (on the morning of the 7th day after the operation, in an empty stomach state). Serum interleukin-6 (IL-6) levels were detected by chemiluminescence immunoassay (instrument model: Roche Cobas e801). C-reactive protein (CRP) was measured by immunoturbidimetry (instrument model: Beckman Coulter AU5800).

Efficacy evaluation criteria

Markedly effective: after treatment, the pus cavity disappeared completely, and the 24 h drainage volume was within 10 mL. There was no pain and swelling after extubation. Effective:

Table 1. Comparison of baseline data between the two groups of patients

Project	Conventional incision and drainage group (n=72)	Negative pressure closed drainage group (n=46)	Statistical value	*P* value
Age (years)	45.3 ± 12.6	43.8 ± 11.9	0.72	0.473
Gender (male/female)	40/32	26/20	0.05	0.827
Hypertension [n (%)]	18 (25.0%)	10 (21.7%)	0.18	0.674
Diabetes [n (%)]	12 (16.7%)	7 (15.2%)	0.05	0.824
Source of infection [n (%)]				
Odontogenic	38 (52.8%)	22 (47.8%)	0.30	0.584
Glandular	24 (33.3%)	18 (39.1%)		
Blood-derived	10 (13.9%)	6 (13.0%)		

after treatment, the pus cavity gradually disappeared but not completely disappeared, the 24 h drainage volume was more than 10 mL, and the white blood cell was more than 10×10^9/L; ineffective: no improvement in the pus cavity, local swelling gradually expanded, the symptoms aggravated, white blood cells above 15×10^9/L [12]. The healing time of a wound refers to the number of days from the end of the surgery until the wound surface is completely covered by epithelial tissue (i.e., without exudation and with a complete epithelial layer on the surface). This indicator is obtained by having a fixed nurse assess the wound daily and record the results in a standardized medical record form. After discharge, follow-up visits or phone calls are conducted once a week to confirm until the wound heals.

Data statistics

SPSS 23.0 statistical software was used for data analysis. The measurement data conforming to the normal distribution were expressed as mean ± standard deviation, and the count data were expressed as number of cases (percentage). Single factor analysis was performed: independent sample t test was used to compare the measurement data between groups, and chi-square test was used to compare the count data. $P < 0.05$ was considered statistically significant.

Results

Comparison of baseline data between the two groups of patients

A total of 118 patients were included in this study, including 72 patients in the conventional incision and drainage group and 46 patients in the vacuum sealing drainage group. The comparison results of the two groups of patients in terms of baseline data are shown in **Table 1**. There was no significant difference in age, gender composition, prevalence of hypertension and diabetes, and distribution of infection sources (odontogenic, glandular, and blood-borne) between the two groups (all $P > 0.05$).

Distribution of infection sites in two groups of patients

The distribution of infection sites in the two groups is shown in **Table 2**. In the conventional incision and drainage group, the masseter space was the most common site of infection, accounting for 41.67% (30/7), followed by buccal space and infraorbital space, accounting for 29.17% (21/72) and 20.83% (15/72), respectively. Submandibular, parapharyngeal and oral floor multi-space infections accounted for a relatively low proportion of 4.17% (3/72), 2.78% (2/72) and 1.39% (1/72), respectively. In the vacuum sealing drainage group, the masseter space was the most common site of infection, accounting for 39.13% (18/46), the buccal space and the infraorbital space accounted for 30.43% (14/46) and 21.74% (10/46), respectively. Submandibular, parapharyngeal and floor of mouth space accounted for 6.52% (3/46), 2.17% (1/46) and 0% (0/46), respectively. Chi-square test showed that there was no significant difference in the distribution of infection sites between the two groups ($\chi^2 = 1.14$, $P=0.966$), suggesting that the two groups were comparable in the anatomical range of infection.

Comparison of pathogenic bacteria distribution between the two groups of patients

The distribution of pathogenic bacteria in the two groups was shown in **Table 3**. In the con-

Table 2. Comparison of infection sites between the two groups of patients

Infection sites	Conventional incision and drainage group (n=72)	Negative pressure closed drainage group (n=46)	Statistical value	*P* value
Masseter gap [n (%)]	30 (41.67%)	18 (39.13%)	0.074	0.786
Buccal space [n (%)]	21 (29.17%)	14 (30.43%)	0.024	0.877
Suborbital space [n (%)]	15 (20.83%)	10 (21.74%)	0.016	0.899
Submandibular space [n (%)]	3 (4.17%)	3 (6.52%)	0.019	0.890
Parapharyngeal space [n (%)]	2 (2.78%)	1 (2.17%)	0.157	0.6920
Mouth floor multi-gap [n (%)]	1 (1.39%)	0 (0.00%)	-	-
Overall distribution comparison	72 (100.00%)	46 (100.00%)	1.140	0.966

Table 3. Distribution of pathogenic bacteria in the two groups of patients

Pathogen Category	Conventional Incision and Drainage Group (n=72)	Negative Pressure Closed Drainage Group (n=46)	χ^2 value	*P* value
Total number of strains	102	68	-	-
Gram-positive bacteria [n (%)]	55 (53.92)	36 (52.94)	0.02	0.898
Staphylococcus aureus	23 (22.55)	16 (23.53)	0.03	0.867
Streptococcus spp.	18 (17.65)	12 (17.65)	0.94	0.332
Streptococcus anginosus	8 (7.84)	5 (7.35)	0.01	0.909
Streptococcus mitis	6 (5.88)	4 (5.88)	0.073	0.945
Other Streptococcus	4 (3.92)	3 (4.41)	0.03	0.857
Staphylococcus epidermidis	7 (6.86)	3 (4.41)	0.48	0.488
Enterococcus faecalis	5 (4.90)	4 (5.88)	0.09	0.764
Other*	3 (2.94)	1 (1.47)	0.42	0.517
Gram-negative bacteria [n (%)]	44 (43.14)	30 (44.12)	0.02	0.898
Klebsiella pneumoniae	19 (18.63)	12 (17.65)	0.03	0.867
Prevotella spp.	13 (12.75)	10 (14.71)	0.15	0.699
Escherichia coli	6 (5.88)	4 (5.88)	0.073	10.787
Pseudomonas aeruginosa	4 (3.92)	3 (4.41)	0.03	0.857
Other†	2 (1.96)	1 (1.47)	0.07	0.791
Fungi [n (%)]	3 (2.94)	2 (2.94)	0.002	0.962
Overall distribution comparison	102 (100.00)	68 (100.00)	0.08	0.999

*: Staphylococcus epidermidis, staphylococcus haemolyticus & enterococcus faecalis; †: Escherichia coli & pseudomonas aeruginosa.

ventional incision and drainage group (n=72), 102 strains of pathogenic bacteria were isolated, including 55 strains of Gram-positive bacteria (53.92%), 44 strains of Gram-negative bacteria (43.14%), and 3 strains of fungi (2.94%). In the vacuum sealing drainage group (n=46), 68 strains of pathogenic bacteria were isolated, including 36 strains of Gram-positive bacteria (52.94%), 30 strains of Gram-negative bacteria (44.12%) and 2 strains of fungi (2.94%). In the composition of the main pathogenic bacteria, Staphylococcus aureus (22.55% and 23.53%, respectively) and Klebsiella pneumoniae (18.63% and 17.65%, respectively) were the main pathogens in both groups, and the distribution rates of Prevotella and other strains were similar. Chi-square test showed that there was no significant difference in the composition ratio of Gram-positive bacteria, Gram-negative bacteria and fungi between the two groups (P=0.959).

Comparison of drug sensitivity test between the two groups

The drug sensitivity results of the main pathogenic bacteria in the two groups were shown in **Tables 4** and **5**. The resistance rates of Staphylococcus aureus to penicillin (95.8% vs 93.8%) and cefotaxime (91.7% vs 90.0%), Staphylococcus epidermidis to penicillin (93.8% vs

Table 4. Comparison of drug sensitivity results of main gram-positive bacteria between the two groups [number of drug-resistant strains (drug resistance rate %)]

Anti-biotic	Conventional incision and drainage group (n=52)	Negative pressure closed drainage group (n=44)	*P* value
Staphylococcus aureus (24 strains in conventional group, 16 strains in negative pressure group)			
penicillin	23 (95.8)	15 (93.8)	0.311
cefotaxime	22 (91.7)	14 (87.5)	0.290
imipenem	5 (20.8)	3 (18.8)	0.901
Staphylococcus epidermidis (16 strains in the conventional group and 14 strains in the negative pressure group)			
penicillin	15 (93.8)	13 (92.9)	0.940
cefotaxime	15 (93.8)	13 (92.9)	0.940
Hemolytic streptococcus (12 strains in the conventional group and 14 strains in the negative pressure group)			
gentamycin	7 (58.3)	8 (57.1)	0.526
cefotaxime	9 (75.0)	10 (71.4)	0.507

Table 5. Comparison of drug sensitivity results of main gram-negative bacteria between the two groups [number of drug-resistant strains (drug resistance rate %)]

anti-biotic	Conventional incision and drainage group (n=41)	Negative pressure closed drainage group (n=27)	*P* value
Klebsiella pneumoniae (19 strains in the conventional group and 11 strains in the negative pressure group)			
chloramphenicol	14 (73.7)	8 (72.7)	0.697
Imipenem	2 (10.5)	1 (9.1)	0.984
Prevotella (15 strains in the conventional group and 11 strains in the negative pressure group)			
Levofloxacin	12 (80.0)	9 (81.8)	0.723
Pseudomonas aeruginosa (conventional group 7 strains, negative pressure group 5 strains)			
Imipenem	1 (14.3)	1 (20.0)	0.763

Table 6. Comparison of clinical treatment effects between the two groups [n (%)]

Peer group	n	Markedly effective	Effective	Invalid	Total effective
Conventional incision drainage group	72	28 (38.89)	26 (36.11)	18 (25.00)	54 (75.00)
Negative pressure closed drainage group	46	25 (54.35)	17 (36.96)	4 (8.70)	42 (91.30)
X^2 value	-	4.983	0.007	7.224	7.224
P value	-	0.026	0.933	0.007	0.007

Table 7. Comparison of treatment-related time indicators between the two groups

Peer group	n	Wound healing time (days)	Antibiotic use time (days)	Hospital stay (days)
Conventional incision drainage group	72	14.5 ± 3.2	10.8 ± 2.5	16.2 ± 4.1
Negative pressure closed drainage group	46	9.2 ± 2.8	7.3 ± 1.9	11.6 ± 3.0
t value	-	8.962	8.071	6.524
P value	-	< 0.001	< 0.001	< 0.001

92.9%), and hemolytic streptococcus to gentamicin (58.3% vs 57.1%) were similar between the two groups. Among gram-negative bacteria, the resistance rates of Klebsiella pneumoniae to imipenem (10.5% vs 9.1%) were similar to those of chloramphenicol (73.7% vs 75.0%) and prevotella to levofloxacin (80.0% vs 81.8%) (all P > 0.05).

Comparison of therapeutic effects between the two groups of patients

The results of this study showed that the total effective rate of the negative pressure closed drainage group was 91.30%, which was significantly higher than that of the conventional incision drainage group (75.00%). The difference was statistically significant (P < 0.05). The specific results are shown in **Table 6**.

Postoperative recovery and antibiotic use in the two groups of patients

The wound healing time, antibiotic use time and hospitalization time of the vacuum sealing drainage group were significantly shorter than those of the conventional incision and drainage group, and the differences were statistically significant (all P < 0.05). The specific results are shown in **Table 7**.

Comparison of pain-related scores between the two groups

There was no significant difference in pain scores (PRI, VAS, PPI) between the two groups before treatment (all P > 0.05). After treatment, the pain scores of the two groups were significantly lower than those before treatment (all P < 0.05), the reduction of the negative pressure drainage group was greater than that of the conventional incision and drainage group, and the difference between the groups was statistically significant (all P < 0.05). The specific results are shown in **Figure 3**.

Comparison of inflammatory factors between the two groups of patients

There was no significant difference in the levels of inflammatory factors between the two groups before treatment (all P > 0.05). After treatment, the levels of TNF-α, hs-CRP and IL-6 in the two groups were significantly lower than those before treatment (all P < 0.05), and the decrease in the negative pressure drainage group was greater than that in the conventional incision drainage group. The difference between the groups was statistically significant (all P < 0.05). The specific results are shown in **Table 8**.

Comparison of the incidence of adverse reactions between the two groups of patients

The results of this study showed that there was no significant difference in the incidence of adverse reactions between the two groups during treatment (P > 0.05). The specific results are shown in **Table 9**.

Discussion

Oral and maxillofacial space infection is one of the oral emergencies, which is a systemic and local tissue reactive disease. The main patho-

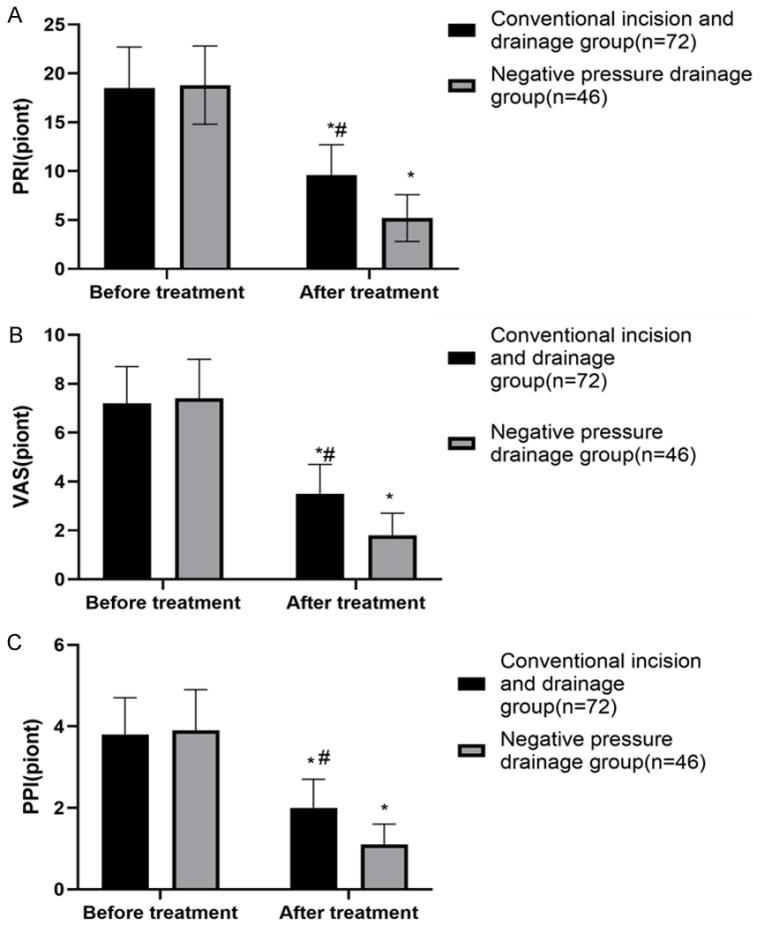

Figure 3. Comparison of pain-related scores before and after treatment between the two patient groups. Axis description: The horizontal axis represents "treatment nodes" (including "Before treatment: before treatment" and "After treatment: after treatment"). The vertical axis shows the scores of the corresponding ratings (A: PRI = Pain Rating Index score; B: VAS = Visual Analogue Scale pain score; C: PPI = Pain Intensity Grading score). Error bars explanation: The error bars in the figure represent the standard deviation (SD) of each group of data, reflecting the dispersion degree of the data within the group. Statistical significance marking: "*" indicates that there is a statistically significant difference between the negative pressure drainage group and the traditional incision drainage group at the same treatment node ($P < 0.05$); "#" indicates that there is a statistically significant difference within the same group before and after treatment ($P < 0.05$).

genic bacteria in oral and maxillofacial soft tissue grow and reproduce, leading to tissue destruction, causing suppurative inflammatory response [13, 14]. Studies have shown that it is related to inflammatory indicators, body nutrition and immune status, which can lead to poor prognosis of patients. Therefore, it is of great significance to study the pathogenic bacteria, drug sensitivity test and treatment methods to improve the prognosis of such patients [15].

Previous clinical literature has confirmed that the most common source of maxillofacial space infection is odontogenic. The results of this study show that 50.8% of the infection is odontogenic, which further confirms that oral odontogenic infection is the main source of maxillofacial infection [16, 17]. The reasons for further analysis are as follows: First, the anatomical structure of the tooth and its close relationship with the surrounding tissue are the key factors. Once caries or damages occur in the hard tissue of the tooth, the infection can spread from the enamel and dentin to the periapical tissue through the apical foramen [18]. There are a large number of loose bone marrow cavities and trabecular bone space in the jaw, which is conducive to the spread of bacteria and inflammatory mediators to the subperiosteal or interfascial space, and further invade the adjacent deep soft tissue space, such as masseter space, buccal space, infraorbital space, etc. Secondly, the complexity of the oral microbial environment increases the risk of infection. The oral cavity contains facultative anaerobic bacteria and anaerobic bacteria such as Streptococcus, Prevotella, and Fusobacterium. In the event of oral lesions or poor hygiene, the above pathogens can form biofilms and invade deep tissues through the root canal system or periodontal pocket. In addition, the oral anaerobic environment is conducive to bacterial proliferation, and produces a large number of toxins and tissue decomposition enzymes, which accelerates tissue necrosis and infection spread, and ultimately produces suppurative inflammation, supporting previous research conclusions [19, 20].

Table 8. Comparison of inflammatory factors before and after treatment in the two groups

Peer group	Point of time	TNF-α (pg/mL)	hs-CRP (mg/L)	IL-6 (pg/mL)
Conventional incision and drainage group (n=72)	before treatment	45.6 ± 8.9	18.5 ± 4.2	32.1 ± 7.3
	posttreatment	28.3 ± 6.5^*	8.6 ± 2.8^*	15.4 ± 4.1^*
Negative pressure drainage group (n=46)	before treatment	46.2 ± 9.1	18.9 ± 4.0	33.0 ± 6.8
	posttreatment	16.8 ± 5.2^Δ	4.2 ± 1.7^Δ	8.5 ± 2.6^Δ
Comparison of *P* values within the group		< 0.001	< 0.001	< 0.001
Comparison of t values between groups after treatment		10.572	9.843	10.126
Comparison between the two groups after treatment *P* value		< 0.001	< 0.001	< 0.001

Note: ^indicates a significant difference (P < 0.05) in the comparison within the same group before and after treatment. Δindicates a significant difference (P < 0.05) in the comparison between the two groups at the posttreatment time point. ^*means the value is significantly different from its corresponding pretreatment value within the same group. ^Δmeans the value is significantly different from the posttreatment value of the conventional group (intergroup comparison).

Table 9. Comparison of the incidence of adverse reactions between the two groups [n (%)]

Peer group	n	Fever	Local swelling	Drainage tube blockage	Secondary bleeding	Total incidence of adverse reactions
Conventional incision drainage group	72	6 (8.33)	5 (6.94)	4 (5.56)	2 (2.78)	17 (23.61)
Negative pressure drainage group	46	3 (6.52)	3 (6.52)	2 (4.35)	1 (2.17)	9 (19.57)
X^2	-	0.124	0.008	0.087	0.034	0.280
P	-	0.725	0.929	0.768	0.853	0.596

Previous studies have shown that the main pathogenic bacteria of oral and maxillofacial space infection are Staphylococcus aureus, Klebsiella pneumoniae and other common pathogenic bacteria [21]. In this study, the distribution of main pathogenic bacteria in the two groups was basically consistent with previous reports. The results of drug sensitivity showed that the resistance rate of Staphylococcus aureus to penicillin and cefotaxime was high (> 90%). To a certain extent, it was suggested that gentamicin (resistance rate of about 17%) or imipenem (resistance rate of about 20%) could be given priority as empirical medication when the traditional first-line drugs were ineffective. The results of this study showed that among Gram-negative bacteria, Klebsiella pneumoniae had a higher resistance rate to chloramphenicol and levofloxacin (> 70%), and Prevotella had a resistance rate of more than 80% to levofloxacin. This study further showed that imipenem maintained high sensitivity to the above two types of strains (resistance rates were about 10% and 20%, respectively), suggesting that carbapenems have important clinical application value in patients with severe or multi-drug resistance risk [22]. Previous scholars have confirmed that both conventional incision drainage and negative pressure drainage can be used to treat maxillofacial space infection, and can obtain ideal results, but there is a lack of comprehensive comparative evaluation [23, 24].

The results of this study show that vacuum sealing drainage technology has higher application value in the treatment of maxillofacial space infection, which can improve the clinical treatment efficiency, shorten the postoperative antibiotic use time and hospitalization time, and reduce the pain degree and inflammatory factor level of patients. The potential mechanism may be that continuous negative pressure suction can completely remove necrotic tissue, timely and effectively drain tissue exudate and bacterial metabolites, thereby effectively controlling infection, which is consistent with previous findings [25]. In addition, mechanical stress generated by continuous negative pressure can promote local telangiectasia, increase tissue blood perfusion, improve tissue oxygenation and nutritional status, and thus accelerate tissue repair. At the same time, the local negative pressure environment can also reduce the accumulation of interstitial fluid and relieve the pressure in the gap, thus directly relieving postoperative pain and inhibiting the

release of inflammatory mediators, which is consistent with the previous results [25].

However, when promoting negative pressure drainage technology, its applicable conditions and limitations should be fully considered. The results of this study show that this technique is mainly suitable for the limitations of drainage or single space infection. For patients with severe, diffuse multi-space infection, severe low immune function or extensive tissue necrosis, the application should be cautious, and should be combined with systemic anti-infective therapy and multidisciplinary comprehensive evaluation. In addition, in primary hospitals with limited resources, the purchase and maintenance costs of negative pressure drainage equipment, the training requirements of medical staff for standardized operation, and the compliance of patients' home care may be the limiting factors for its wide promotion. Compared with more minimally invasive techniques such as endoscopic assisted drainage, negative pressure drainage is simpler in operation and has advantages in maintaining wound cavity cleanliness and reducing dressing change frequency. However, it may still have shortcomings in achieving precise targeted drainage, avoiding important structural damage and long-term functional protection, and its long-term cost-effectiveness ratio needs further study.

In terms of the incidence of complications of negative pressure drainage in the treatment of maxillofacial infection, previous studies have confirmed that there is no statistical difference between the two treatment methods [26]. The results of this study showed that negative pressure drainage as a treatment did not increase the incidence of adverse reactions in patients with maxillofacial space infection, which once again confirmed the previous conclusion that it did not increase the incidence of complications while improving the efficacy [26, 27].

This study has the following potential deficiencies: First of all, this study is a single-center study with limited sample size, which reduces the universality of the research results and needs to be further supported by large sample multi-center prospective studies. Secondly, this study lacks the follow-up evaluation results of long-term postoperative function and quality of life of patients, which needs to be further confirmed. Finally, this study lacks the results of stratified analysis of the severity of maxillofacial infection and the type of pathogenic bacteria, which has a certain impact on the results of this study. In addition, in order to reduce the burden of patients and consider the feasibility of clinical research, inflammatory factors (such as TNF-α, hs-CRP, IL-6) were only detected at two time points before and 7 days after surgery, and the complete dynamic change curve was not depicted. Future studies can design more intensive sampling time points on the basis of full evaluation to further reveal the sequential rules of inflammatory response during infection and treatment.

In summary, oral and maxillofacial space infection is dominated by Gram-positive cocci. The clinical use of vacuum sealing drainage technology can improve the clinical treatment efficiency of maxillofacial space infection, reduce the degree of pain, reduce the level of inflammatory factors, and shorten the time of antibiotic use and hospitalization. It has certain clinical application value in eligible cases. However, its promotion and application need to comprehensively consider multiple factors such as infection type, severity, patient's general condition, access to medical resources, and cost-effectiveness. Future research needs to further clarify its best indications and explore its comparative advantages with other minimally invasive drainage techniques.

Disclosure of conflict of interest

None.

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