Multifunctional Irrigation-Assisted Vacuum Drainage versus Traditional Drainage in the Treatment of Odontogenic Deep Fascial Infection: A Retrospective Cohort Study

Di He
Zhejiang University School of Medicine Second Affiliated Hospital
Yuanyi Qian
Zhejiang University School of Medicine Second Affiliated Hospital https://orcid.org/0000-0002-0001-4221
LiMei Zhou
Hangzhou Dental Hospital
HaoZhao Qi
Zhejiang University School of Medicine Second Affiliated Hospital
Menghua Yu
Zhejiang University School of Medicine Second Affiliated Hospital
Tian Zhang
Zhejiang University School of Medicine Second Affiliated Hospital
Qin Yan
Zhejiang University School of Medicine Second Affiliated Hospital
Xiahan Sheng
Zhejiang University School of Medicine Second Affiliated Hospital
Yanming Liu (liuyanming@zju.edu.cn)
Zhejiang University School of Medicine Second Affiliated Hospital

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Research article

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Abstract

Background: Odontogenic deep fascial space infection in the head and neck is a common clinical problem which requires emergency surgery. Traditional drainage method is considered laborious and gravity-dependent. We aimed in this study to promote a modified multifunctional irrigation-assisted vacuum drainage (MIVD) and evaluate the clinical effect of it in the treatment of odontogenic deep fascial infection.

Methods: Patients diagnosed with odontogenic deep fascial space infection in the Second Affiliated Hospital, Zhejiang University School of Medicine, China between March 2018 and March 2021 were studied. We divided the patients into two groups based on the drainage method they received: patients with the MIVD device were included in the MIVD group, patients with traditional drainage were included in the traditional group. Data was collected retrospectively including baseline characteristics and treatment outcome variables. Pearson Chi-square test and the Student t-test were used in statistical analyses. Statistical difference was considered significant when $p<0.05$.

Results: A total of 65 patients were included. All the patients were eventually cured. There were no significant differences in age, gender, systemic diseases, history of diabetes, tobacco use, number of the infected spaces, preoperative white blood cell count and C-reactive protein between the two groups ($p>0.05$). The number and frequency of manual irrigation by clinicians (MIC), time required for white blood cell count to return to normal levels (TWBC), time required for C-reactive protein to return to normal levels (TCRP), the length of hospitalization and the length and total cost of antibiotics use were significantly less in the MIVD group than those in the traditional group ($p<0.05$). There was no significant difference in the cost of hospitalization between the 2 groups ($p>0.05$).

Conclusions: The MIVD device significantly reduced the number and frequency of MIC, TWBC, TCRP, the length of hospitalization and the length and total cost of antibiotics use in comparison with the traditional drainage method. It provided a favorable treatment method for patients with odontogenic deep fascial space infection in the head and neck.

1 Background

Deep fascial space infection in the head and neck is a common problem encountered in clinics that usually requires emergency surgery. These infections mostly arise from odontogenic infections [1]. Without prompt and proper management, odontogenic deep fascial space infections may result in serious consequences such as mediastinitis, necrotizing fasciitis, sepsis and osteomyelitis [2-8]. Among the infections of all potential spaces, those located in the lower head and upper cervical region can be particularly dangerous for their close anatomy location to the trachea. As the infection progresses, the trachea can be oppressed. Airway obstruction is inclined to happen under this circumstance, thus putting the patient's life at risk [9].

Effective treatment usually includes an incision adequate for thorough exploration of the involved spaces and a drain placement to the abscess cavity. Traditional drainage method is merely gravity-dependent. Regular irrigations are often required at least once a day to guarantee effective drainage and abscess elimination [10]. The most common shortcomings we find in clinical practice of the traditional method are: (1) the workload of clinicians is relatively heavy; (2) gravity-dependent drainage with regular irrigations cannot achieve the effect of continuous purulence removal.

Recently, negative pressure irrigation has been applied to the treatment of abdominal infection, and excellent clinical effect has been received [11, 12]. Based on this idea, we proposed a modified drainage device that combined continuous vacuum drainage with internal irrigation for odontogenic deep fascial space infections three years ago. In this study, we describe the structure of this multifunctional irrigation-assisted vacuum drainage (MIVD) device and evaluate the clinical effect of it by comparing it with the traditional treatment of odontogenic deep fascial space infections in the head and neck.

2 Methods

2.1 Subjects

This was a retrospective cohort study. We included 65 patients (38 males and 27 females) admitted into the Department of Oral and Maxillofacial Surgery, the Second Affiliated Hospital, Zhejiang University School of Medicine, China, from March 2018 to March 2021. Inclusion criteria were as follows: (1) patients with a confirm diagnosis of deep fascial space infection; (2) patients whose infection was odontogenic; (3) patients who received surgical operation. Patients were excluded if (1) their infections were confined to temporal space and infraorbital space; (2) their clinical data was not complete; (3) they did not receive the surgical treatment due to nonmedical reasons. Involved spaces were buccal space, pterygomandibular space, masseteric space, sublingual space, parapharyngeal space, submandibular space and submental space. For patients with infraorbital space infection, intraoral incision and Penrose drains are generally chosen [10]. Tubular drainage device is also inapplicable for patients with temporal space infection, considering the dense anatomical structure of the temporal space [13, 14]. Therefore, suborbital space infection and temporal space infection were not included in this study. According to the drainage method, the patients were divided into 2 groups: 33 patients with MIVD device were included in the MIVD group, 32 patients with traditional drainage were included in the traditional group.

2.2 Device structure

The MIVD device consisted of three parts: a drainage tube, an external irrigation tube and an internal irrigation tube. The drainage tube was a disposable silicone catheter with the diameter of 7.33mm, manufactured by Suzhou McLean medical equipment co., Ltd., Jiangsu, China. Scale lines could be seen on the tube wall near the end which would later be placed into the abscess cavity (the free end), and the other end would be connected with a negative pressure device. Several side holes were arranged on the tube wall near the free end, each with a diameter of 4-6mm. Two small holes, both with the diameter of about 3mm, were set symmetrically on the drainage tube wall, 15-20cm away from the free end. They worked as the entrances for the irrigation tubes to extend themselves into the drainage tube. Both irrigation tubes were disposable PVC plastic catheters with a closing cap (F6, type one) manufactured by Suzhou Jingle polymer medical apparatus co., Ltd., Jiangsu, China. The end of the internal irrigation tube remained inside the drainage tube, while the external irrigation tube stretched out from either the free end of the drainage tube or one of the side holes on the drainage tube wall, according to the different locations of the abscess cavity (Fig. 1). The number of side holes, the length of the side-hole area, and the distance from the entrance holes to drainage tube's free end depended on the size and depth of the abscess cavity.

2.3 Treatment methods

Before the surgery, all patients underwent contrast-enhanced CT scan to identify the location and range of the infected abscess cavity. Incisions were designed based on the abscess cavity's location and range. A submandibular incision was mostly used, referring to the extraoral incision 2cm below and parallel to the lower edge of the mandibular body. The platysma muscle and the superficial layer of the deep fascia were incised successively, followed by a blunt separation into the abscess cavity to provide access for purulence removal. Proper amount of purulence was extracted and sent for bacterial culture and drug sensitivity testing. After thoroughly removing the purulence, we irrigated the abscess cavity with 1% hydrogen peroxide, normal saline and 0.5% iodophor. Drainage was established afterwards. Surgical procedures are shown in Fig. 2.

In the MIVD group, we achieved drainage by the MIVD device described above. After the device was assembled and successfully put into the patient's body (Fig. 3), we sutured the incision closely. Postoperative continuous vacuum drainage and internal irrigation were established as described in below: (1) the drainage tube was connected with a negative pressure device (maintained at the pressure of 150-200 kPa) to provide a vacuum drainage environment; (2) large amounts of normal saline was infused into the abscess cavity constantly (3000ml a day, 125ml an hour) through the external irrigation tube's closing cap, allowing for continuous irrigation; (3) by manually infusing 100ml normal saline once 2-3 days through the internal irrigation tube's closing cap, the drainage tube was internally irrigated and prevented from blockage by purulence and debris; (4) irrigation and drainage volume was checked every 12 hours to keep the irrigation-drainage balanced.

In the traditional group, drainage was established by a semi rubber tube and the incision was intermittently sutured. The drainage was gravity-dependent. Manual irrigation of normal saline by clinicians was required daily, usually 1-2 times a day, according to the amount and characteristics of the drainage fluid. Indications of drainage removal for both groups included: (1) no purulence was observed in the drainage fluid; (2) the patient's postoperative white blood cell count and C-reactive protein had approached normal levels.

2.4 Variables

We recorded and collected the demographic data and treatment outcome variables from all the patients involved. Baseline characteristics included age, gender, systemic diseases, history of diabetes, tobacco use, number of the infected spaces, and preoperative white blood cell count and C-reactive protein. Treatment outcome variables included number and frequency of manual irrigation by clinicians (MIC), time required for white blood cell count to return to normal levels (TWBC), time required for C-reactive protein to return to normal levels (TCRP) and length and total cost of hospitalization and antibiotics use.

2.5 Statistical analysis

Numerical variables were presented as mean ± standard deviation, while categorical variables were expressed in absolute numbers. After checking the normal distribution and the homogeneity of the variance, statistical comparisons between the MIVD group and the traditional group were carried out via the Pearson Chi-square test and the Student t-test. Statistical differences were considered significant when $p<0.05$. All the data was analyzed by software SPSS 21.0 (IBM Analytics, Armonk, NY).

3 Results

The baseline characteristics of patients in the MIVD group and traditional group are shown in Table 1. There were no significant differences in age, gender, systemic diseases, history of diabetes, tobacco use, number of the infected spaces, preoperative white blood cell count and C-reactive protein between the two groups ($p>0.05$). Patients in both groups were eventually cured.

The results of the treatment outcome variables are presented in Fig. 4. We assessed the clinician’s workload by the number and frequency of MIC. As is shown in the Fig. 4A and Fig. 4B, the number and frequency of MIC in the MIVD group (4.97±1.90 times, 0.37±0.12 times a day) were significantly lower than those in the traditional group (23.31±9.78 times, 1.76±0.78 times a day). The differences between the two groups were statistically significant ($p<0.05$).

TWBC and TCRP of the MIVD group were 6.06±2.33 days and 8.48±2.81 days, while those of the traditional group were 8.31±3.08 days and 11.06±3.58 days, as are described in Fig. 4C and Fig. 4D. The results showed that TWBC and TCRP of the MIVD group were significantly shorter than those of the traditional group ($p<0.05$).

Antibiotics use was less in the patient of the MIVD group than the traditional group (Fig. 4E and Fig. 4G). The length and total cost of antibiotics use in MIVD group were 11.45±2.62 days and 3418.85±1776.23¥, significantly less in comparison with 13.18±3.01 days and 4433.53±1936.88¥in the traditional group ($p<0.05$).

The length of hospitalization of the MIVD group was 11.97±2.66 days, shorter than 13.72±2.30 days of the traditional group ($p<0.05$) (Fig. 4F). However, there was no significant difference in the cost of hospitalization between the 2 groups (27807.17±13532.01 versus 32094.57±19307.15, $p>0.05$) (Fig. 4H).

4 Discussion

Deep fascial space infection in the head and neck is a common clinical problem which may lead to fatal outcomes. The majority of deep fascial space infections in the head and neck can be originated from odontogenic infections [15, 16]. However, patients are easily inclined to overlook the importance of seeking medical help during the early stages, resulting in severe consequences [2-8]. In scenarios where the infections are located in the lower head and upper cervical region, the patient's life could be threatened within minutes by airway obstruction [9]. Therefore, once the pus cavity is formed, prompt surgical drainage establishment is imperative to remove purulence and provide a healing environment.

Current traditional drainage method is passive and gravity-dependent. Penrose drain and its alternatives are some of the most frequently used forms of traditional drains [10, 17]. This method requires heavy workload of clinicians and lacks the ability to provide continuous purulence removal. The patient often needs relatively large amount of antibiotics and long length of hospitalization. Compared with the traditional method, our modified MIVD device provides better drainage and irrigation after surgical treatment for patients suffer from odontogenic deep fascial space infection, especially for those whose infections are located in the lower head and upper cervical region.

Negative pressure therapy has been proven to effectively remove necrotic debris and avoid reaccumulating of purulence in the wound bed [18]. Researches have also shown that negative pressure drainage can avoid contamination and cross-infection by closely suturing the incision as well as improve granulation tissue coverage and promote epithelial regeneration [19, 20]. Meanwhile, continuous irrigation of normal saline can provide a gentle way of infection cleansing and promote better wound healing[21-23]. By combining negative pressure drainage with continuous irrigation, our modified MIVD device received better clinical outcome than the traditional drainage method. Firstly, clinicians' workload was effectively reduced. Instead of manual irrigation 1-2 times a day, the MIVD device allowed for automatic continuous irrigation. Clinicians only needed to irrigate the internal irrigation tube once every 2-3 days to prevent potential tube blockage, depending on the characteristics of the drainage fluid. Furthermore, infection was better controlled. As are shown in the results, time required for inflammation-related indicators (white blood cell count and C-reactive protein) to return to normal levels was shortened. The features of patients with deep fascial space infection in the head and neck usually include swelling or asymmetry of the infected region. After being treated with the MIVD device, the swelling of the infected area was notably improved in all patients. A typical case is shown in Fig. 5. Postoperative contrast-enhanced CT scan also displayed shrinkage of the abscess cavity. Meanwhile, drainage samples were collected and sent for bacterial culture and drug sensitivity testing every 2-3 days. Negative results were obtained. All of the outcomes above indicated that the MIVD device was effective in infection elimination. Moreover, the length of antibiotics use and total hospitalization were both shortened. This reduced the possibility of bacterial resistance, on the other hand, accelerated the healing process. The cost of antibiotics use was therefore reduced. However, despite the fact that the average cost of hospitalization in the MIVD group was less than that in the traditional group, there was no significant difference between them. We believed this was because the total cost of hospitalization could be affected by many factors, such as the patient's age and systemic diseases.

Previously, negative pressure drainage with irrigation device has been applied for maxillofacial space infections by some scholars [24] and favorable effect has been achieved. However, the drainage tube and irrigation tube of their device were separated. This required more surgical incisions, thus increasing the patient's operational trauma and complexity of the surgery. As for our MIVD device, the irrigation tubes are nested within the drainage tube, requiring only one incision for each device. Due to its integrative and concise structure, the MIVD device can be used flexibly both individually or in combinations according to the number of the abscess cavity. Postoperative contrast-enhanced CT scan showed that the MIVD device extended well in abscess cavities, even in those with complex anatomical structures, for example, areas beneath the skull base (Fig. 6). Furthermore, negative pressure drainage system is prone to tube blockage. Qiu et.al [25] mentioned in their study that there was a 12.7% incidence rate of clogging about the negative pressure drainage technique. In the light of this problem, we equipped the MIVD device with an internal irrigation tube, which successfully protected the drainage tube from blockage by purulence or necrotic debris.

The main shortcoming of our device was the patient’s postoperative activity limitation, for the drainage tube was connected to a negative pressure device (usually a central negative pressure system). The patient’s activity limitation may increase the risk of thrombus of lower extremity veins. In order to prevent thrombus, we have taken active VTE (Venous Thromboembolism) preventive measures, including application of the gradient pressure band, pneumatic compression therapy and requiring the patient to do 10 minutes of moderate bedside exercise three times a day.

5 Conclusions

Compared with the traditional drainage method, the MIVD device significantly reduced the number and frequency of MIC, TWBC, TCRP, the length of hospitalization and the length and total cost antibiotics use. Thus, it is a promising treatment method for patients with odontogenic deep fascial space infections in the head and neck.

List Of Abbreviations

MIVD: Multifunctional irrigation-assisted vacuum drainage; MIC: Manual irrigation by clinicians; TWBC: Time required for white blood cell count to return to normal levels; TCRP: Time required for C-reactive protein to return to normal levels; VTE: Venous Thromboembolism

Declarations

Ethics approval and consent to participate

This study was approved by the Human Research Ethics Committee of the Second Affiliated Hospital, Zhejiang University School of Medicine (No.2021-0543). Since it was a retrospective study, informed consent was not required. All the patients' information was maintained anonymous.

Consent for publication

Not applicable.

Availability of data and materials

The datasets used and analyzed during the current study are available from the corresponding author on reasonable request.

Competing interests

The authors declare that they have no competing interests.

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Authors' contributions

D He and YM Liu conceived of the study, participated in its design and coordination, and helped to draft the manuscript. YY Qian participated in statistical analysis and was a major contributor in writing the manuscript. LM Zhou and HZ Qi participated in data collecting. MH Yu participated in the table producing and helped in data interpretation. T Zhang, Q Yan and XH Sheng participated in the photo collecting and illustration. All authors read and approved the final manuscript.

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References

[1] Topazian R G, Goldberg, M.H. and Hupp, J.R. . Oral and Maxillofacial Infections[M]. 4th Edition ed. Philadelphia: WB Saunders Company. 2002.

[2] Gaber Hassanein A, Mohamed E E H, Hazem M, et al. Assessment of Prognosis in Odontogenic Descending Necrotizing Mediastinitis: A Longitudinal Retrospective Study[J]. Surg Infect (Larchmt), 2020, 21(8): 709-715. DOI: 10.1089/sur.2019.302.

[3] Wong T J J o o, Oral m s o j o t A A o, and Surgeons M. A nationwide survey of deaths from oral and maxillofacial infections: the Taiwanese experience[J]. 1999, 57(11): 1297-9; discussion 1300. DOI: 10.1016/s0278-2391(99)90863-7.

[4] Bulut M. Fatal descending necrotising mediastinitis[J]. Emerg Med J, 2004, 21(1): 122-123. DOI: 10.1136/emj.2003.002865.

[5] Carter L, Lowis E J B d j. Death from overwhelming odontogenic sepsis: a case report[J]. 2007, 203(5): 241-2. DOI: 10.1038/bdj.2007.784.

[6] Abe M, Mori Y, Inaki R, et al. A Case of Odontogenic Infection by Streptococcus constellatus Leading to Systemic Infection in a Cogan's Syndrome Patient[J]. 2014, 2014: 793174. DOI: 10.1155/2014/793174.

[7] Bali R, Sharma P, Gaba S, et al. A review of complications of odontogenic infections[J]. 2015, 6(2): 136-43. DOI: 10.4103/0975-5950.183867.

[8] Matsumoto Y, Yokoi H, Ikeda T, et al. Odontogenic infection and antiresorptive agent-related osteonecrosis of the jaw with facial subcutaneous abscess formation: A retrospective clinical study of difficult-to-diagnose cases[J]. Auris Nasus Larynx, 2021, 48(4): 758-763. DOI: 10.1016/j.anl.2020.12.005.

[9] Lim H K, Wang J M, Hung S T, et al. A dangerous cause of airway obstruction: deep neck infection[J]. Signa Vitae, 2021, 17(2): 4-9. DOI: 10.22514/sv.2020.16.0101.

[10] Furness J. Contemporary oral and maxillofacial surgery, 6th edition[J]. Br Dent J, 2013, 215(2): 99. DOI: http://dx.doi.org/10.1038/sj.bdj.2013.731.

[11] Tong Z, Shen X, Ke L, et al. The effect of a novel minimally invasive strategy for infected necrotizing pancreatitis[J]. Surg Endosc, 2017, 31(11): 4603-4616. DOI: 10.1007/s00464-017-5522-0.

[12] Tong Z, Ke L, Li B, et al. Negative pressure irrigation and endoscopic necrosectomy through man-made sinus tract in infected necrotizing pancreatitis: a technical report[J]. BMC Surg, 2016, 16(1): DOI: 10.1186/s12893-016-0190-x.

[13] Rout S, Gautam S, and Shah A K J J o C M C. Temporal space infection secondary to recurrent buccal space infection from mandibular deciduous molar in 7-year-old child: a case report[J]. 2019, 9(1): 70-73.

[14] Bratton T, Jackson D, Nkungula-Howlett T, et al. Management of complex multi-space odontogenic infections[J]. The Journal of the Tennessee Dental Association, 2002, 82: 39-47.

[15] Weise H, Naros A, Weise C, et al. Severe odontogenic infections with septic progress - a constant and increasing challenge: a retrospective analysis[J]. 2019, 19(1): 173. DOI: 10.1186/s12903-019-0866-6.

[16] Zheng L Y, Yang C, Zhang W J, et al. Comparison of multi-space infections of the head and neck in the elderly and non-elderly: Part I the descriptive data[J]. J Cranio Maxillofac Surg, 2013, 41(8): E208-E212. DOI: 10.1016/j.jcms.2013.01.020.

[17] Mair M, Mahmood S, Fagiry R, et al. Comparative analysis of paediatric and adult surgically drained dental infections at a university teaching hospital[J]. Brit J Oral Maxillofac Surg, 2020, 58(10): E307-E311. DOI: 10.1016/j.bjoms.2020.08.043.

[18] Banasiewicz T, Borejsza-Wysocki M, Meissner W, et al. Vacuum-assisted closure therapy in patients with large postoperative wounds complicated by multiple fistulas[J]. Videosurgery And Other Miniinvasive Techniques, 2011, 3: 155-163. DOI: 10.5114/wiitm.2011.24694.

[19] Armstrong D G. Discussion: Update on Negative-Pressure Wound Therapy[J]. Plast Reconstr Surg, 2011, 127(1): 116S-116S. DOI: 10.1097/PRS.0b013e3181fb5431.

[20] Xue X, Li N, and Ren L. Effect of vacuum sealing drainage on healing time and inflammation-related indicators in patients with soft tissue wounds[J]. International Wound Journal, 2021: DOI: 10.1111/iwj.13565.

[21] Ding M-C, Lee C-Y, Wang Y-T, et al. Innovative continuous-irrigation approach for wound care after deep neck infection surgery: A case report[J]. International Journal of Surgery Case Reports, 2021, 80: 105620. DOI: 10.1016/j.ijscr.2021.02.006.

[22] Willy C, Scheuermann-Poley C, Stichling M, et al. Importance of wound irrigation solutions and fluids with antiseptic effects in therapy and prophylaxis. [J]. Der Unfallchirurg, 2017, 120(7): 549-560. DOI: 10.1007/s00113-017-0375-5.

[23] Kim P J, Attinger C E, Constantine T, et al. Negative pressure wound therapy with instillation: International consensus guidelines update[J]. International Wound Journal, 2020, 17(1): 174-186. DOI: 10.1111/iwj.13254.

[24] Zhao N, Liu Y, Yue J, et al. Negative pressure drainage-assisted irrigation for maxillofacial space infection[J]. Oral Dis, 2020: DOI: 10.1111/odi.13421.

[25] Qiu Y, Li Y, Gao B, et al. Therapeutic efficacy of vacuum sealing drainage-assisted irrigation in patients with severe multiple-space infections in the oral, maxillofacial, and cervical regions[J]. 2019, 47(5): 837-841. DOI: 10.1016/j.jcms.2019.01.031.

Tables

Table 1 Baseline characteristics of the 65 patients involved in this study

Variables	MIVD group n=33(%)	traditional group n=32(%)	P value
Age/years	50.15 ± 16.75	49.22 ± 17.33	0.747
Gender			
Male	18(54.5)	20(62.5)	0.515
Female	15(45.5)	12(37.5)	
Systemic diseases			
Yes	18(54.5)	15(46.9)	0.536
No	15(45.5)	17(53.1)	
History of diabetes			
Yes	10(30.3)	6(18.8)	0.280
No	23(69.7)	26(81.3)	
Tobacco use			
Yes	14(42.4)	14(43.8)	0.914
No	19(57.6)	18(56.3)	
Infected spaces	2.48 ± 1.00	2.16 ± 1.02	0.537
Preoperative WBC($\times 10^9$/L)	17.67 ± 4.81	15.53 ± 5.10	0.933
Preoperative CRP	106.33 ± 71.32	105.11 ± 79.30	0.580

***WBC* white blood cells, *CRP* C-reactive protein**

***P< 0.05**

Figures

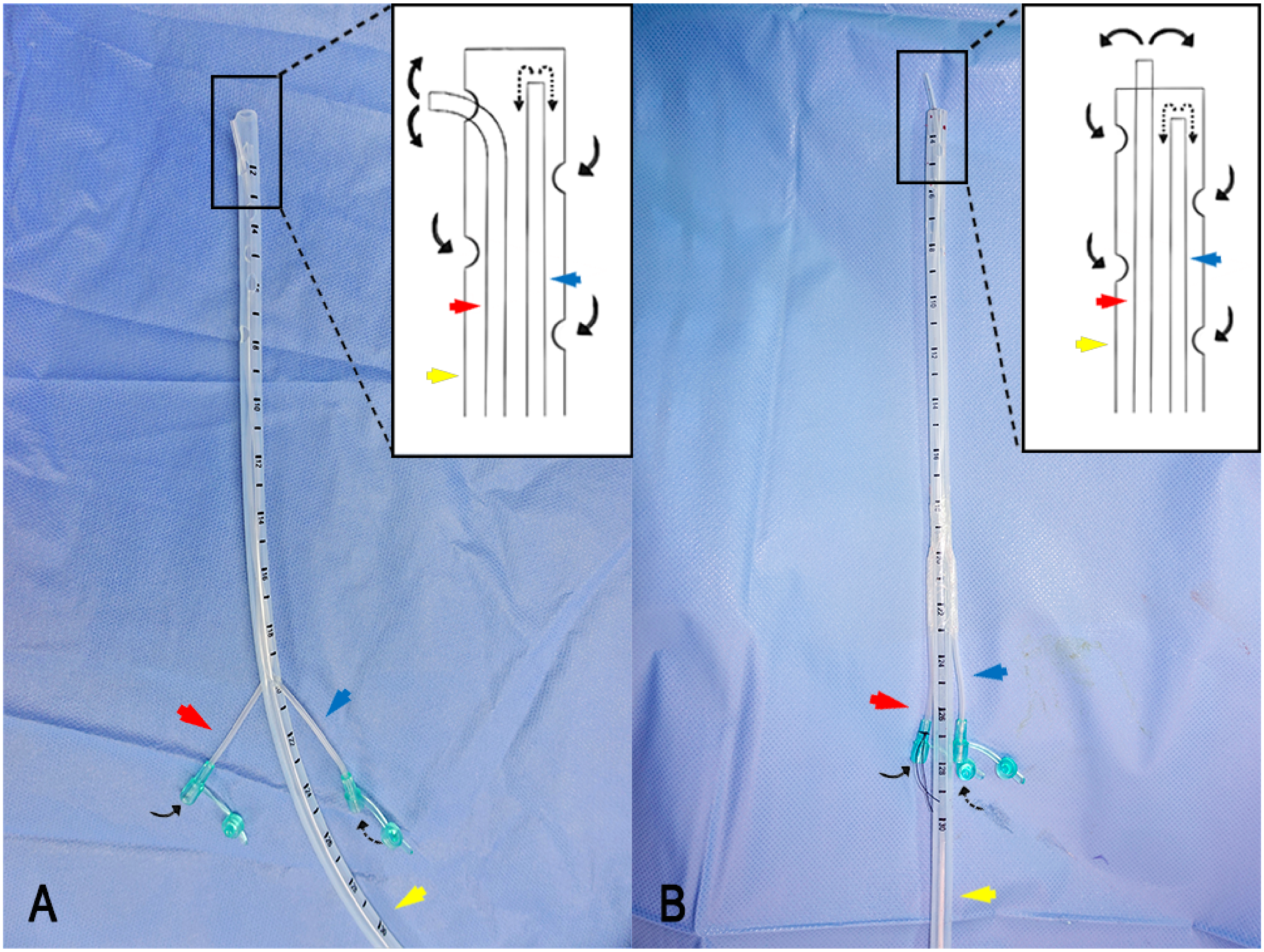

Figure 1

The structure of the MIVD device (red arrows, the external irrigation tube; blue arrows, the internal irrigation tube; yellow arrows, the drainage tube; black arrows, external irrigation fluid flow; dotted black arrows, internal irrigation fluid flow). A The external irrigation tube stretched out from one of the side holes on the drainage tube wall. B The external irrigation tube stretched out from the free end of the drainage tube

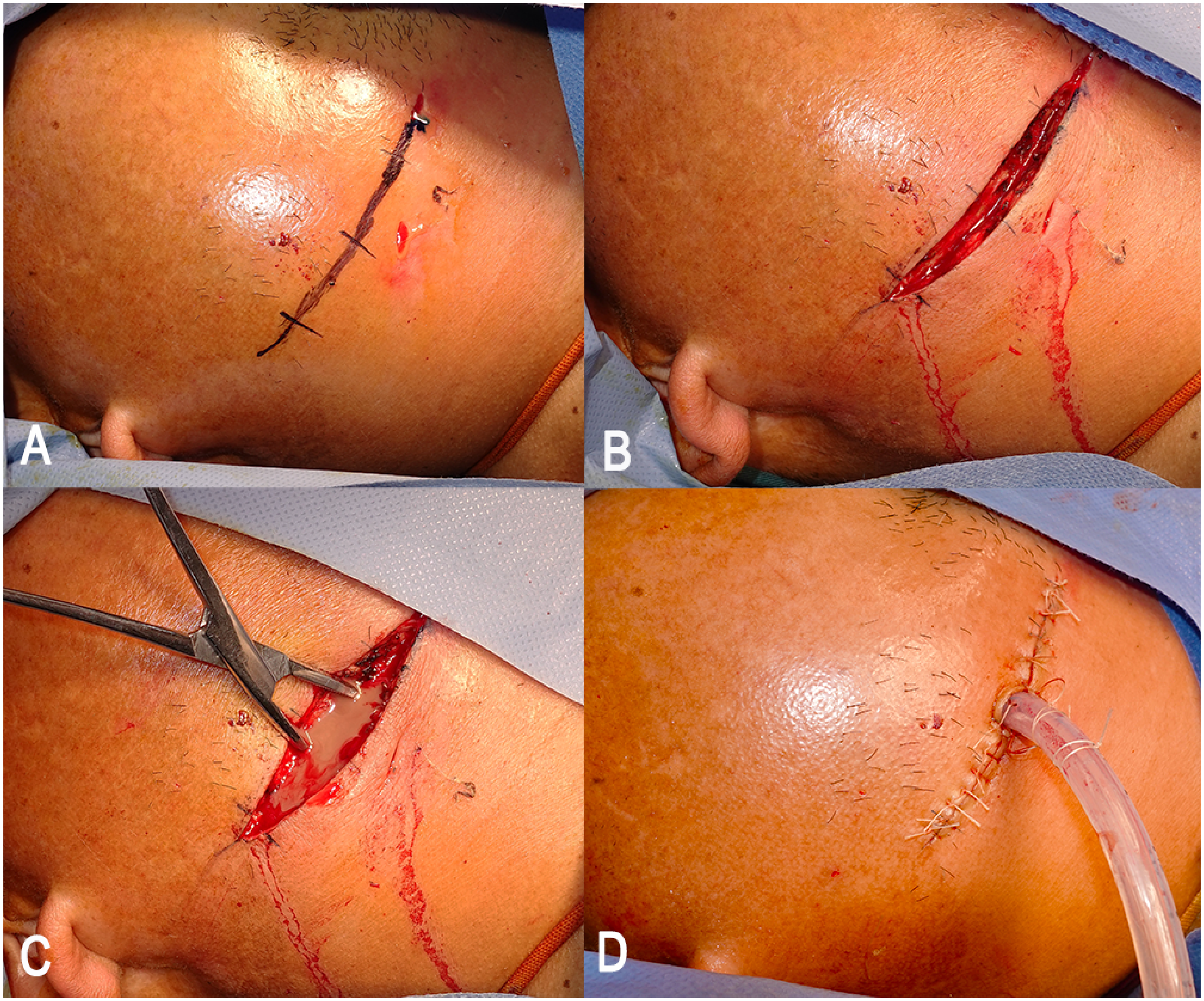

Figure 2

Surgical procedures of a patient treated with the MIVD device. A A submandibular incision was design. B The platysma muscle and the superficial layer of the deep fascia were incised successively. C A blunt separation was made into the abscess cavity to thoroughly remove purulence. D The incision was sutured closely after the MIVD device being put into the patient's body

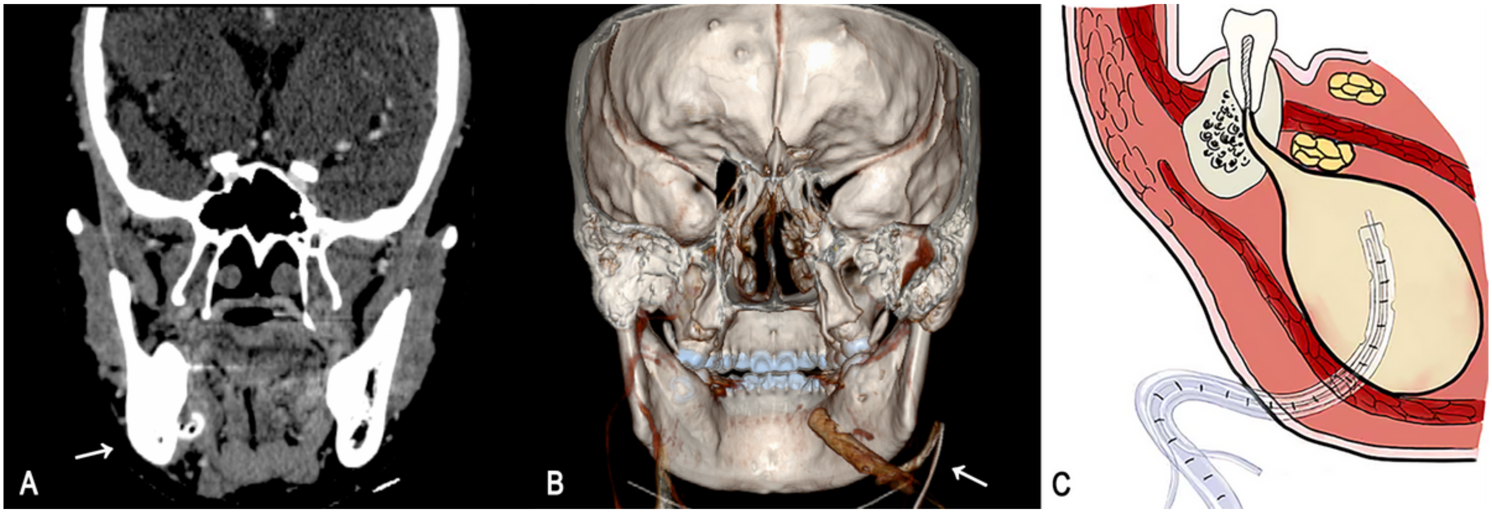

Figure 3

An example of the MIVD device in the patient's body. A Contrast-enhanced CT scan showed the location of the MIVD device in the patient body (anterior coronal position) (A, the white arrow). B Corresponding 3D reconstruction image of the patient with the MIVD device (posterior coronal position) (B, the white arrow). C An illustration of the MIVD device in the abscess cavity

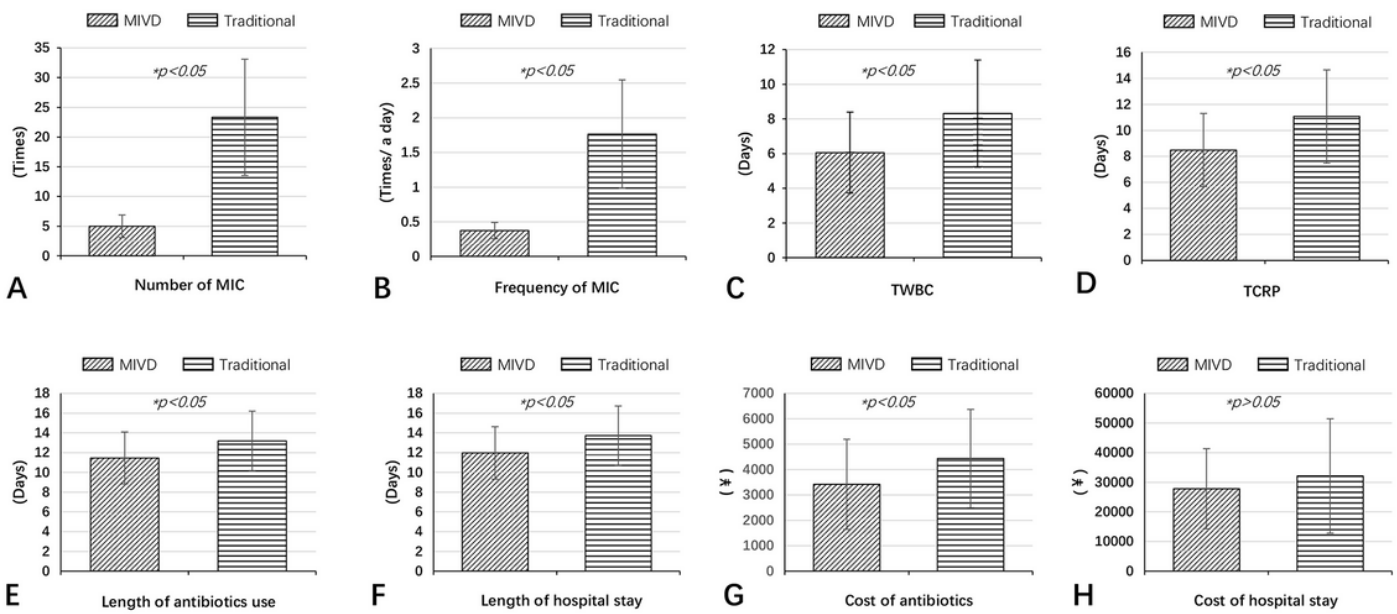

Figure 4

Comparative results of the treatment outcome variables between the 2 groups. TWBC, time required for white blood cell count to return to normal levels; TCRP, time required for C-reactive protein to return to normal levels; MIC, manual irrigation by clinicians

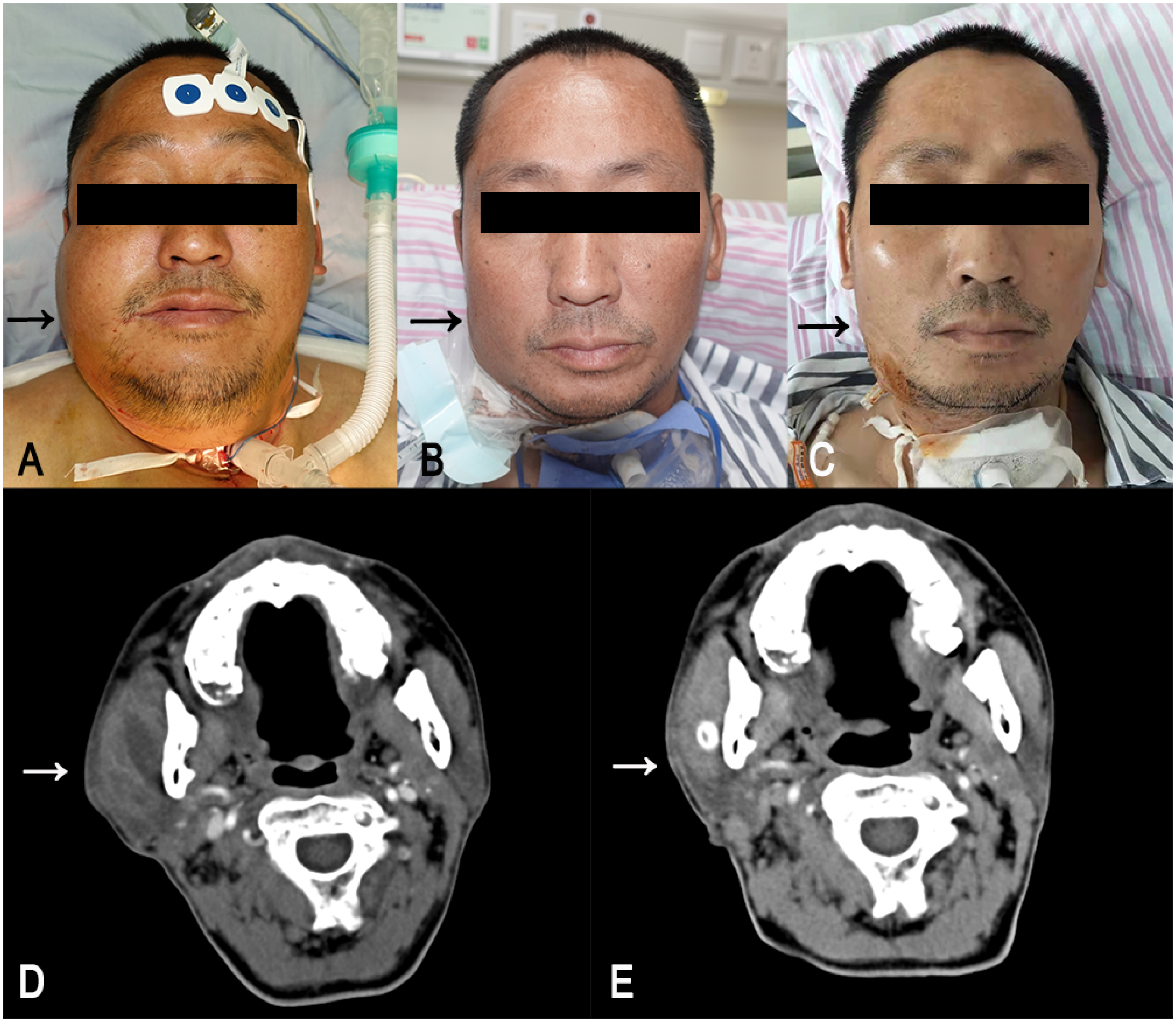

Figure 5

The swelling of the infected area was notably improved after the patient being treated with the MIVD device. A The preoperative picture of the patient. Asymmetry in the head and neck area was obvious (A, the black arrow). B The picture of the patient on the fifth day after the surgery. The swelling subsided effectively (B, the black arrow). C The picture of the patient on the seventh day after the surgery. The patient's facial appearance returned to normal (C, the black arrow). D The preoperative contrast-enhanced CT scan showed swelling of the infected area. Abscess cavities were found (D, the white arrow) E Contrast-enhanced CT scan on the fifth day after the surgery. The swelling markedly subsided and abscess cavities were controlled (E, the white arrow)

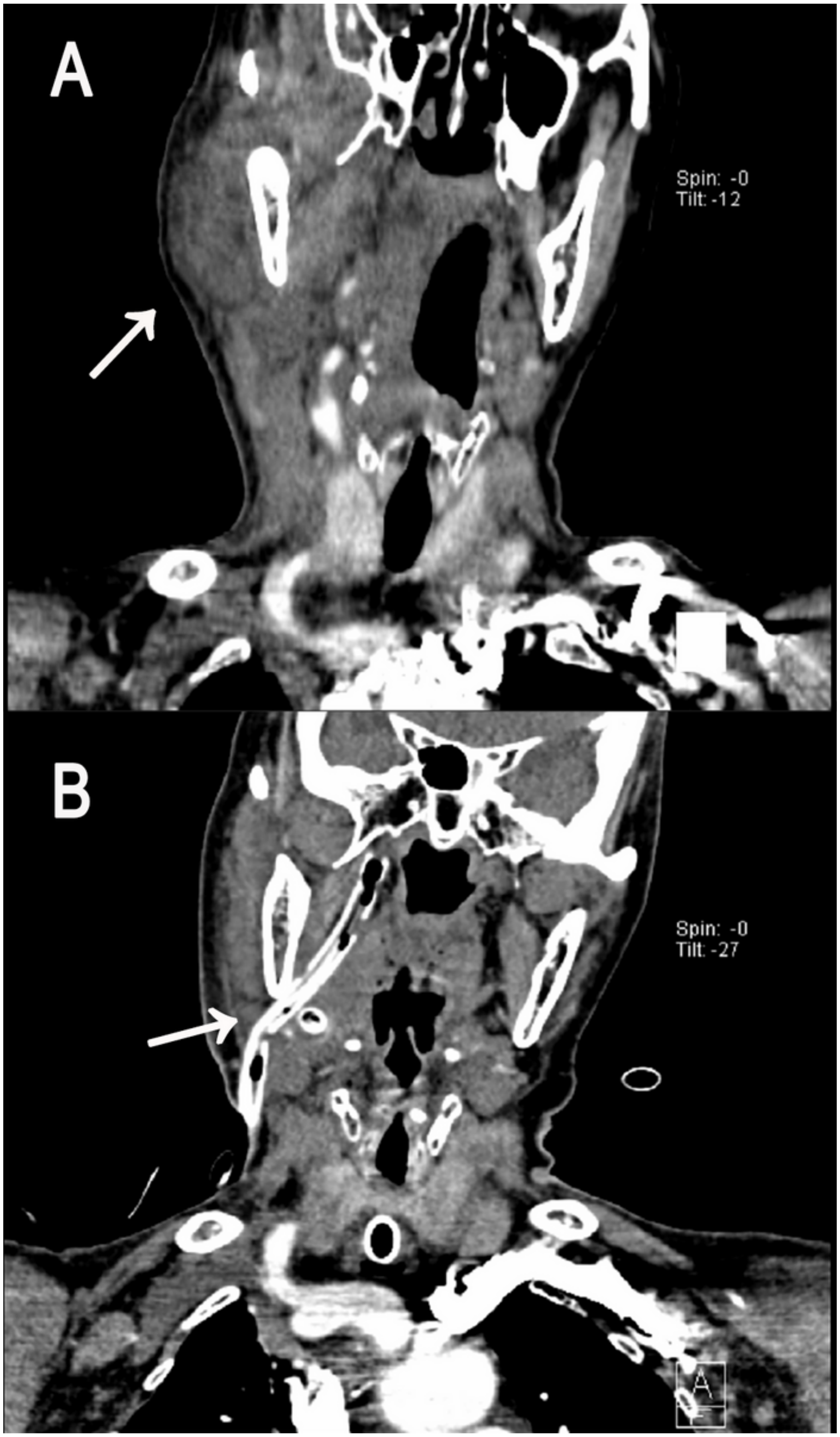

Figure 6

Contrast-enhanced CT scan of a patient treated with the MIVD device. A Preoperative contrast-enhanced CT scan of the patient. Abscess cavities can be seen (A, the white arrow). B The contrast-enhanced CT scan on the seventh day after the surgery. Abscess cavities were effectively eliminated. The MIVD device extended well in the abscess cavity beneath the skull base (B, the white arrow)