福岡大医紀（*Med. Bull. Fukuoka Univ.*）：46(2), 85-90, 2019

Application of Multiple Clinical Tools, qSOFA Criteria, CECT Assessment, and Flynn's Inflammatory Scoring Systems for Diagnosis and Management in a Case with Deep Neck Infection of Odontogenic Origin

Shintaro Ishida[1)], Kyoichi Narihira[2)], Ryosuke Kita[1)], Aya Yoshino[1)], Naoko Aoyagi[3)], Toshihiro Ohgawara[4)], Tomoki Shimamura[3)], Seiji Kondo[1)]

[1)] *Department of Oral and Maxillofacial Surgery, Faculty of Medicine, Fukuoka University*
[2)] *Department of Oral and Maxillofacial Surgery, School of Dentistry, Showa University*
[3)] *Department of Dentistry and Oral Surgery, Hakujyuji Hospital, Fukuoka*
[4)] *Department of Oral and Maxillofacial Surgery, Mitoyo General Hospital, Kagawa*

Abstract

Since deep neck infection（DNI）of odontogenic origin spreads through the myofascial space and/or facial planes of the neck, early diagnosis of the extent of infection（including the existence of sepsis）and appropriate treatment are crucial. Treatment of DNI arising from lower pericoronitis in a 22-year-old Japanese man required surgical revision in the absence of infection control. To evaluate definitions of sepsis, we recommended using a new bedside measure, the quick Sequential Organ Failure Assessment（qSOFA）because it does not require laboratory tests and can be assessed quickly and repeatedly. From the middle of the clinical time course, contrast-enhanced computed tomography（CECT）was used to identify the spread of pus into the supra-posterior area of the mandibular ramus and retropharyngeal space after initial treatment, assess the degree of involvement of severe infection using Flynn's inflammatory scoring systems, and for guiding extensive incision and drainage under general anesthesia to prevent systemic toxicity and subsequent multiorgan failure. Imaging features of CECT that are advantageous in the management of DNI, and treatment flow for DNI with some criteria identifying sepsis and the severity of odontogenic infection have been highlighted.

Key words：deep neck infection（DNI）, odontogenic origin, sepsis, quick Sequential Organ Failure Assessment（qSOFA）, contrast-enhanced computed tomography（CECT）

Introduction

Deep neck infection（DNI）of odontogenic origin is a potentially life-threatening disease characterised by the formation of abscess in several myofascial spaces[1)2)]. When DNI occurs in the submandibular, submental, or parapharyngeal space, the patient in the risk of effects on the respiratory tract requires incision and drainage of the infected space[3)]. If an initial assessment of general conditions by clinical criteria such as systemic inflammatory response syndrome（SIRS）criteria[4)] and/or scoring systems of the extent of inflammation based on imaging[3)] are not applied, a rapidly progressive course with fatal outcomes may be seen and the right timing for adequate treatment may be missed. Recently, a new bedside clinical measure, termed the quick Sequential Organ Failure Assessment（qSOFA）, is used to prompt clinicians to further investigate for organ dysfunction[5)6)7)]. Compared with previous SIRS crite-

Corresponding author：Seiji Kondo, Department of Oral and Maxillofacial Surgery, Faculty of Medicine, Fukuoka University, 7-45-1 Nanakuma, Jonan-ku, Fukuoka 814-0180, Japan
Tel：+81-92-801-1011 Fax：+81-92-801-1044 E-mail：kondo@fukuoka-u.ac.jp

ria, qSOFA had better discriminative value for early, accurate detection of sepsis[6)7)]. Use of these appropriate criteria for general and local conditions is thus key to determining prognosis.

Regarding the evaluation of DNI, the extent of the disease process is often difficult to detect on inspection or palpation, and sometimes occurs early and imperceptibly in the disease course. Various diagnostic tools have therefore been used in clinical practice, such as computed tomography (CT), magnetic resonance (MR) imaging, and ultrasonography[8)]. Of note, CT is the most popular and useful modality in evaluating the location of abscess in the oral vestibule or deep myofascial space, and provides good contrast resolution in the presence of gas[3)8)]. However, some cases have shown in appearing indistinct or non-enhancing soft-tissue masses, leading to overlooked and undrainable situations at surgery. Contrast-enhanced CT (CECT) was originally used as the modality of choice in neoplastic diseases. This modality clearly depicts the position and size of the lesion, as well as relationships with adjacent anatomic structures. When contrast medium is used, rim enhancement around tumor area is observed due to the newly formed, leaky vasculature in tumors, known as angiogenesis. On the other hand, since a similar phenomenon regarding vasculature (blood vessel permeability) was observed around the soft tissues surrounding abscess, CECT can in theory be applied to enhancing infectious lesions with a central, hypodense, non-enhancing area of necrosis[9)10)].

The purpose of this report was to present the case of a non-immunocompromised patient with extensive cellulitis from DNI in several myofascial spaces, who was finally successful treated by accurate diagnosis through the appropriate use of CECT.

Instead of SIRS criteria, qSOFA proved useful to evaluate sepsis easier and earlier. In addition, using the existing scoring system for radiographic images of the degree of severity of DNI, the risk of affecting the respiratory tract was assessed. We have also provided an overview of the assessment and treatment flow for odontogenic DNI to oral and maxillofacial surgeons.

Case report

A 22-year-old Japanese man visited our hospital in the evening with a chief complaint of painful swelling in the left mandibular third molar, which had begun few days earlier. Vital signs showed：body temperature, 38.4℃；heart rate, 95 beats/min；respiratory rate, 22 breaths/min；SpO_2, 96%；and blood pressure, 132/62 mmHg. Although consciousness was clear (Glasgow Coma Scale, 15), the patient showed mild dyspnea. Extraorally, marked swelling extended from the left cheek to the lower neck region. Although intraoral examination could not be performed due to severe trismus, swelling of the buccal mucosa on the left side surrounding the mandibular third molar region was evident. Laboratory examinations showed an elevated white blood cell count (WBC) of $20.2\times10^3/\mu$L, and elevated levels of liver enzymes (bilirubin, 1.2 mg/dL；alanine transaminase, 133 U/L；aspartate transaminase, 43 U/L), serum glucose (185 mg/dL), and C-reactive protein (22.5 mg/dL). Renal function (serum creatinine, 1.0 mg/dL) and platelets ($230\times10^3/\mu$L) appeared unremarkable. The presence of sepsis was assessed using SIRS criteria (examining 4 values：body temperature, heart rate, respiratory rate, and WBC), and all the criteria were met. On the other hand, according to qSOFA score (altered mention, respiratory rate≧22breaths/min, and systolic blood pressure≦100 mmHg), only one criterion (respiratory rate ＞22breaths/min) was met at baseline, indicating the free from potential sepsis. Radiographic examinations including panoramic radiography and computed tomography (CT) were performed on the day of the first visit. The panoramic radiograph revealed a horizontal impacted mandibular third molar on the left side. CT showed fluid collection in the submandibular and lateral parapharyngeal regions, and abnormal swelling in the left buccal region (Figure. 1A). On the basis of these findings, descending cellulitis of the lateral parapharyngeal and submandibular regions originating from pericoronitis of the mandibular third molar was diagnosed. The patient was immediately admitted to our hospital and empirical intravenous antibiotic therapy [ceftriaxone (CTRX) 1 g and clindamycin (CLDM) 600 mg, 3 times/day] was started.

On day 2 of hospital admission (18 h after admission), surgical incision and drainage was carried out under general anesthesia, and the buccal, submandibular, and parapharyngeal spaces were explored intra- and extra-orally, and material for cultures was taken. At a later date, day 9, cultures showed positive results for aerobic group G streptococci, followed by anaerobic Gram-negative species (*Prevotella*/*Prophyromonas*) in combination. Saline with povidone-iodine irrigation in the

drain insertion area was carried out on a daily basis. On day 4 (2 days after initial incision and drainage), blood tests for inflammatory markers were moderately improved, but no changes were seen in body temperature or respiratory rate (Figure. 2). We decided to perform CECT immediately, clearly revealing new formation of abscess in the supra-posterior area of the mandibular ramus and retropharyngeal space with abnormal air collection (Figure. 1B). Due to these findings, the patient required a second surgery (incision and drainage) on both sides of the supra-posterior ramus under general anesthesia. Multiple Penrose drains were inserted into these tissue spaces, especially the retropharyngeal spaces, and saline with povidone-iodine irrigation was continued twice a day. On day 7, the antibiotic regimen was changed to sulbactam/ampicillin (SBT/ABPC) due to hepatic impairment caused by CTRX. The cheek swelling gradually decreased, and the patient improved with temperature reaching 37℃ on day 10 of hospital admission. However, continuous pains was still present, so continuous irrigation was maintained for over 1 week. On day 22 (18 days after second surgery), another follow-up CECT was taken at the last moment because pus was still being discharged through Penrose drains from the submandibular region.

This CECT showed increased amounts of necrotic tissue around the mandibular ramus and submandibular region, although physical examination and blood tests suggested decreased inflammation. On the same day, a third surgery (debridement) was therefore performed under conscious sedation. On day 28, with these sequential treatments, all symptoms at last disappeared.

Figure. 1A

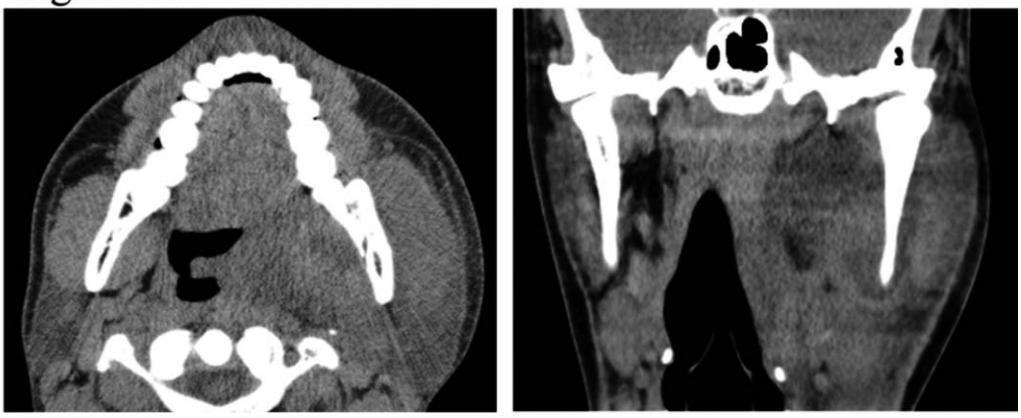

Figure.1B

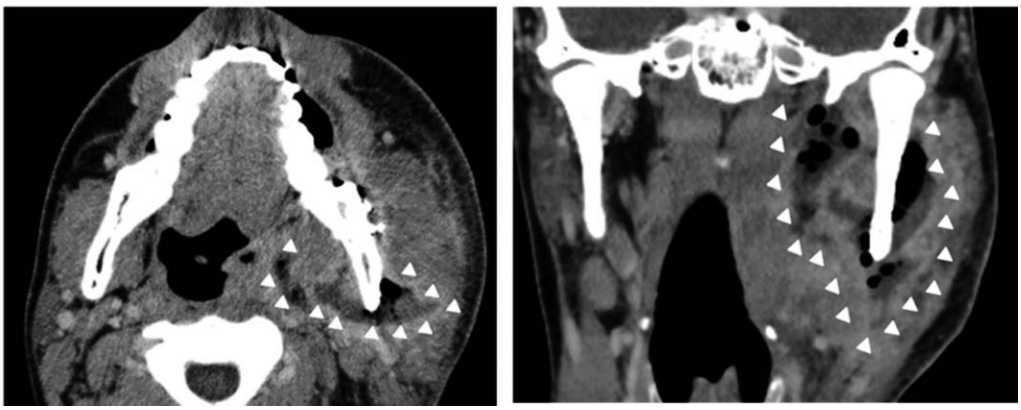

Figure. 1 Radiographic examination of deep neck infection was performed before treatment.
A, upper panel (Axial and coronal CT on the day of hospital admission. B, lower panel) Axial and coronal CECT on day 4. Formation of abscess with abnormal air collection in the supra-posterior area of the mandibular ramus and retropharyngeal space (white arrowhead).

Discussion

DNI of odontogenic origin can rapidly spread along the fascial spaces of the head and neck, risking life-threatening organ dysfunction caused by a dysregulated host response to infection, defined as sepsis. To evaluate the presence of sepsis, SIRS criteria have been used in a variety of facilities[4]. All 4 variables were satisfied in our case, indicating the presence of sepsis. However, these results in our case were accordingly overestimated with a discrepancy of a theoretical value, i.e. traditional tools such as the SIRS criteria from an actual conditions of the absence of sepsis and /or organ dysfunction. In fact, the assessment of SIRS criteria for a dysregulated, life-threatening response was not accurately reflected in the actual clinical conditions[4]. As a result, our patient with a qSOFA of only one criterion was not admitted to the ICU.

For evaluating DNI, CT represents a fundamental modality for accurately confirming the presence and extent of abscess, providing valuable information for planning the drainage procedure[3)8)9)]. The Hounsfield unit (HU) scale is a measurement of relative densities determined by CT. On plane CT images, the formation of abscess was originally observed as the attenuated area with HU between those of water and soft tissue. When a contrast medium is used, an area of low attenuation with a complete circumferential rim of enhancement is observed; that is, the hallmark of abscess. CECT therefore facilitates not only accurate and reliable diagnosis, but also the search for occult or residual collections of pus[8)9)]. In fact, Lazor et al. reported that the sensitivity of CT for detecting deep neck abscesses was very good (87.9%)[10)].

From the points observed in our case, our proposed treatment flow for DNI is shown as Figure 3. Early diagnosis and correct treatment planning can save the patient's life and prevent complications of disease extension. On the initial visit, we first identified the existence of sepsis using a SIRS criteria. However, according to qSOFA score, which is considered a bedside clinical score among non-intensive care unit (ICU) patients[5)6)], only one criterion (respiratory rate >22 breaths/min) was met at baseline, indicating the free from potential sepsis. Of note, the very low mortality rate of patients with qSOFA score less than 2 is a strong argument to replace SIRS without the risk of missing critically ill patients[7)].

After starting empiric antimicrobial therapy that primarily covered Gram-positive organisms, anaerobes and beta-lactamase-producing bacteria, CECT, not plane CT, was taken at the beginning to provide an accurate and reliable diagnosis of DNI as far as possible. Based on this radiographic examination, it is very important that the extent of odontogenic infection was scored in the affected anatomic spaces. We recommend that the degree of involvement of severe infection and the recognition of the infected space in the risk of effects on the respiratory tract be classified using the se-

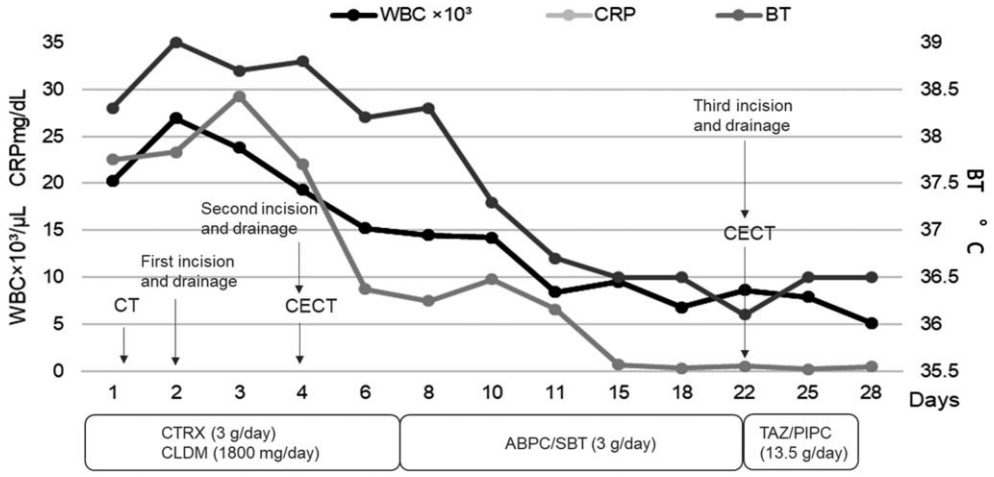

Figure. 2 Clinical timeline of a patient showing important events, imaging and intervention dates, and antibiotic treatments. WBC：white blood cell count；CT：computed tomography；CECT：contrast-enhanced computed tomography；BT：body temperature；CRP：C-reactive protein；CTRX：ceftriaxone；CLDM：clindamycin；SBT/ABPC：sulbactam/ampicillin；TAZ/PIPC：tazobactam/piperacillin.

vere scale (SS) scoring criteria described by Flynn et al[3]. In our case, the patient showed involvement of the subperiosteal space (SS=1), space of the body of the mandible (SS=1), buccal space (SS=1), submandibular space (SS=2), sublingual space (SS=2), submasseteric space (SS=2), and lateral pharyngeal space (SS=3), yielding a score of 12 from a maximum of 36 points, constituting a surgical emergency (Table. 1). According to the corresponding classification, incision and drainage should be carried out within 24 h, or within a few hours in some severe cases. When no improvements of temperature, swelling, or blood examination results were observed within 48 h from first surgical drainage, postoperative check-up CECT should be repeated as a fundamental diagnostic procedure with regard to subsequent surgical interventions (Figure. 3).

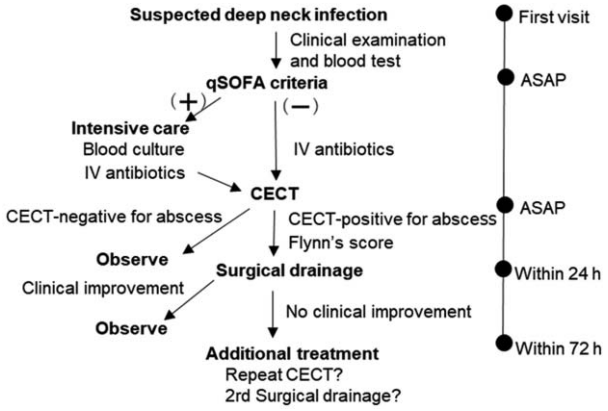

Figure. 3 Proposal algorithm for evaluation and management of DNI.
Repeated radiological investigations pre- and post-operatively as a fundamental diagnostic procedure with regard to subsequent surgical interventions. In terms of intravenous antibiotics, the most common choices for empiric therapy were second- and third-generation cephalosporins and metronidazole. qSOFA: quick sequential organ failure assessment; CECT: contrast-enhanced computed tomography; ASAP: as soon as possible.

In light of the general condition and imaging evaluation methods with the sequential treatment for DNI described above, under accurate assessment of the general condition by qSOFA, CECT should be performed. This modality could contribute to better, more rapid identification of residual collections of pus at high risk of causing complicating DNI, and enabled effective drainage of all anatomic deep fascial spaces affected by infection based on the severe scale scoring criteria. It is possible that our assessment and treatment flow for odontogenic DNI was useful guidance for oral and maxillofacial surgeons.

Conflicts of interest

The authors declare no conflict of interest.

Table 1 Severity Score For Severe Odontogenic Infections

Severity score	Anatomical space involved
Severity score=1 (Mild risk for airway and/or vital structures)	Vestibular Subperio steal Space of the body of the mandible Infraorbital Buccal
Severity score=2 (Moderate risk for airway and/or vital structures)	Submandibular Submental Sublingual Pterygomandibular Submasseteric Superficial temporal Deep temporal (or Infratemporal)
Severity score=3 (Severe risk for airway and/or vital structures)	Lateral pharyngeal or pterygopharyngeal Retropharyngeal Pretracheal
Severity score=4 (Extremely severe risk for airway and/or vital structures)	Prevertebral Mediastinum Intracranial infection

NOTE: Severity score for a given subject is the sum of severity scores for all of the spaces affected by cellulitis or withabscess, based on clinical and radiographic findings.
The souece of this table is rederence 3).

Acknowledgement

This research did not receive any specific grant from funding agencies in the public, commercial, or not-for-profit sectors

Ethical Approval

No ethics approval was required for this case. Permission was obtained from the patient to publish the details of this case.

References

1）İsmi O, Yeşilova M, Özcan C, Vayisoğlu Y, Görür K. Difficult cases of odontogenic deep neck infections：a report of three patients. Balkan Med J 34：172-179, 2017.
2）Kinzer S, Pfeiffer J, Becker S, Ridder GJ. Severe deep neck space infections and mediastinitis of odontogenic origin：clinical relevance and implications for diagnosis and treatment. J Acta Oto-Laryngologica 129：62-70, 2009.
3）Flynn TR, Shanti RM, Hayes C. Severe odontogenic infections. Part 2：Prospective outcomes study. J Oral Maxillofac Surg 64：1104-1113, 2006.
4）Kaukonen KM, Bailey M, Pilcher D, Cooper J, Bellomo R. Systemic inflammatory response syndrome criteria in defining severe sepsis. N Engl J Med 372：1629-1638, 2015.
5）Singer M, Deutschman CS, Seymour CW, Shankar-Hari M, Annane D, Bauer M, Bellomo R, Bernard GR, Chiche JD, Coopersmith CM, et al. The Third International Consensus Definitions for Sepsis and Septic Shock（Sepsis-3）. JAMA 315：801-810, 2016.
6）Seymour CW, Liu VX, Iwashyna TJ, Brunkhorst FM, Rea TD, Scherag A, Rubenfeld G, Kahn JM, Shankar-Hari M,Singer M, et al. Assessment of clinical criteria for sepsis：For the third international consensus definitions for sepsis and septic shock（sepsis-3）. JAMA 315：762-774, 2016.
7）Freund Y, Lemachatti N, Krastinova E, Van Laer M, Claessens YE, Avondo A, Occelli C, Feral-Pierssens AL, Truchot J, Ortega M, et al. Prognostic accuracy of sepsis-3 criteria for in-hospital mortality among patients with suspected infection presenting to the emergency department. JAMA 317：301-308, 2017.
8）Kim YJ, Kim JD, Ryu HI, Cho YH, Kong JH, Ohe JY, Kwon YD, Choi BJ, Kim GT. Application of radiographic images in diagnosis and treatment of deep neck infections with necrotizing fasciitis：a case report. Imaging Sci Dent 41：189-193, 2011.
9）Boscolo-Rizzo P, Marchiori C, Zanetti F, Vaglia A, Da Mosto MC. Conservative management of deep neck abscesses in adults：the importance of CECT findings. Otolaryngol Head Neck Surg 135：894-899, 2006.
10）Lazor JB, Cunningham MJ, Eavey RD, Weber AL. Comparison of computed tomography and surgical findings in deep neck infections. Otolaryngol Head Neck Surg 111：746-750, 1994.

（平成30．11．14受付，平成31．3．8受理）
「The authors declare no conflict of interest.」