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HEAD AND NECK

Deep neck abscesses: the Singapore experience

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Abstract This study aims to review our experience with deep neck abscesses, identify key trends, and improve the management of this condition. This is a retrospective chart review of patients diagnosed with deep neck abscesses in the Department of ENT (Otorhinolaryngology) at Tan Tock Seng Hospital, Singapore between 2004 and 2009. Patient demographics, etiology, bacteriology, systemic disease, radiology, treatment, complications, duration of hospitalization, and outcomes were reviewed. 131 patients were included (64.9% male, 35.1% female) with a median age of 51.0 years. 54 (41.2%) patients had diabetes mellitus. The parapharyngeal space (23.7%) was the most commonly involved space. Odontogenic and upper airway infections were the leading causes of deep neck abscesses (28.0% each). *Klebsiella pneumoniae* (27.1%) was the most commonly cultured organism in this study and among the diabetic patients (50.0%). 108 (82.4%) patients underwent surgical drainage. 42 patients suffered complications. All 19 patients, who had upper airway obstruction, had either a tracheostomy or intubation. Patients with multi-space abscesses, diabetes mellitus, and complications had prolonged hospitalizations. Old age and diabetes are risk factors for developing deep neck abscesses and their sequelae. The empiric choice of antibiotics should recognize that a dental source is likely, and that *Klebsiella* is most common in diabetics. Surgical drainage and adequate antibiotic coverage remains the cornerstone of treatment of deep neck abscesses. Therapeutic needle aspiration may successfully replace surgical drainage, if the abscesses are small and no complications are imminent. Airway obstruction should be anticipated in multi-space and floor of mouth abscesses.

Keywords Neck abscesses · Diabetes mellitus · *Klebsiella pneumoniae* · Odontogenic infections · Upper airway infections

Introduction

Deep neck abscesses are defined as collections of pus contained within the fascial planes and spaces of the head and neck. The widespread availability of antibiotics has reduced the incidence of deep neck abscesses drastically [1, 2]. However, it remains an important condition as it may potentially lead to life-threatening complications such as airway compromise, jugular vein thrombosis, mediastinal involvement, pericarditis, pneumonia, and arterial erosion [2, 3]. This is especially so when there is a delay in diagnosis and treatment, and immunosuppression. The widespread and inappropriate use of antibiotics may change the clinical presentation and course of these infections, making them more elusive and less predictable [3]. Changes in the sites of deep neck infections, etiology, bacteriology, presenting signs and symptoms, and associated systemic diseases have also been recently described [1, 4]. The advent of modern imaging techniques has made it possible

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to diagnose these complications earlier and localize them more precisely.

The aim of this study was to present our experience of the clinical course and management of deep neck abscesses encountered in our department in the last 6 years and compare it to the experiences in the available literature. As an affluent modern Asian city, our population has a high prevalence of diabetes, but easy access to good primary health and dental care, and antibiotics.

Materials and methods

A retrospective chart review of patients diagnosed with deep neck abscesses in the Department of ENT (Otorhinolaryngology) at Tan Tock Seng Hospital between 2004 and 2009 was performed. The hospital's electronic database of emergency admission was used to identify cases. The admission criterion was based on clinical suspicion (fluctuant neck swelling, odynophagia, trimus, dysphagia, etc.) of patients suffering deep neck abscesses. The operation theatre log books were also examined to identify all cases of neck abscesses. Superficial infections, limited intraoral abscesses, peri-tonsillar abscesses, cervical necrotizing fasciitis, deep neck space cellulitis alone, and infections due to penetrating or surgical neck trauma were excluded from this study. Patients who did not complete the treatment were also excluded. Ultimately, 131 patients were included in this study. Their demographics, etiology, bacteriology, underlying systemic diseases, radiology, treatments, duration of hospital stay, complications, and outcomes were reviewed and analyzed. The involved spaces were classified according to previously published literature [5, 6], which included the following spaces in our series: submandibular, parapharyngeal, carotid, retropharyngeal, anterior cervical, posterior cervical, parotid, prevertebral, masticatory, and pre-tracheal space. If two or more spaces were concurrently involved in a significant way, they were classified as multi-space. The diagnosis of deep neck abscess was confirmed by computed tomography scans (CT scans) with contrast enhancement, needle aspiration, or surgery. The clinical patterns and outcomes of the patients were compared and analyzed.

Results

There were 85 men and 46 women in the study group. The median age was 51.0 years (range 17–90 years). The age distribution curve peaked in the sixth decade (see Fig. 1), with 52.7% being 50 years old or older. CT scans with contrast enhancement was performed on all patients to identify the sites and size of deep neck space abscesses. If

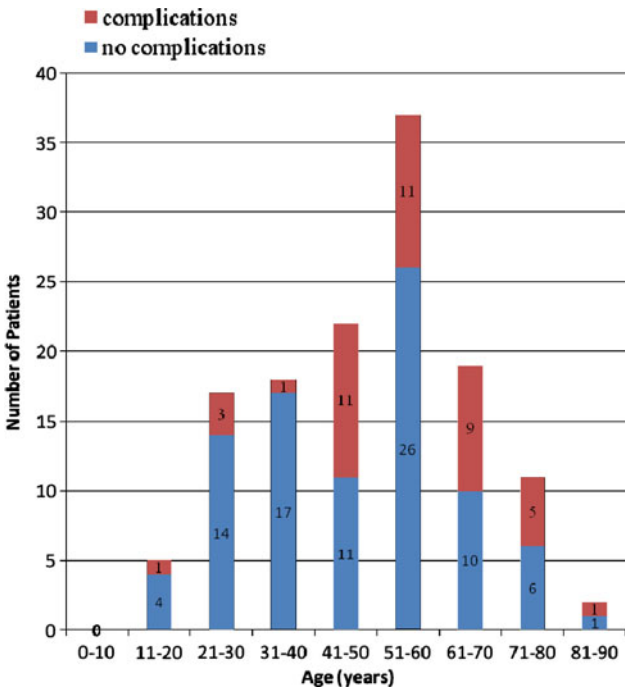

Fig. 1 Age distribution of 131 patients with deep neck abscesses

clinical suspicion was high but imaging non-contributory, needle aspiration and surgical exploration were undertaken. Distribution of the sites of deep neck space abscesses is shown in Table 1.

Patients with multi-space abscesses were usually older, had a longer duration of hospital stay, and were more prone to suffering complications (Table 2). Both sets of patients with multi-space abscesses (33.3%, $p = 0.001$) and floor of mouth abscesses (75.0%, $p = 0.01$) also tended to suffer from upper airway obstruction more frequently.

The causes of deep neck abscesses were identified in 75 patients (57.3% of all patients), of which odontogenic infections (21 patients, 16.0%) and upper airway infections (21 patients, 16.0%) were the two leading causes. Odontogenic infections accounted for 75.0% (3 of 4, $p = 0.013$) of the patients with floor of mouth abscesses and 44.0% (11 of 25, $p < 0.001$) with submandibular space abscesses. All three carotid space abscesses in our series were associated with preceding upper respiratory tract infections ($p = 0.004$). The causes of deep neck abscesses are recorded in Table 3.

Of the 131 patients, 59 (45.0%) had underlying systemic disease or were on immunosuppressive therapy. The most common systemic disease was diabetes mellitus (54 cases, 91.5%). The diabetic patients tended to be older and although not statistically significant, showed a trend towards having a longer hospital stay and a higher risk of developing complications (Table 4). There were 3 (5.1%) patients on immunosuppressive therapy, 3 (5.1%) who are

Table 1 Distribution of the space of deep neck abscesses

Space	No. of patients (%) ($N = 131$)	No. of patients with associated systemic diseases	Mean duration of hospital stay ± SD (days)	No. of complications	
				Total	Airway obstruction
Parapharyngeal space	31 (23.7)	14	7.7 ± 4.6	9	4
Multi-space	30 (22.9)	17	20.2 ± 18.3	20	10
Submandibular space	25 (19.1)	6	5.9 ± 2.8	1	0
Parotid space	20 (15.3)	11	8.2 ± 5.2	3	0
Retropharyngeal space	8 (6.1)	4	10.9 ± 5.7	2	1
Anterior cervical space	6 (4.6)	3	5.7 ± 2.7	1	0
Floor of mouth abscess	4 (3.1)	1	8.0 ± 2.2	3	3
Carotid space	3 (2.3)	2	8.3 ± 2.3	2	1
Posterior cervical space	2 (1.5)	0	4.5 ± 0.7	1	0
Pre-tracheal space	1 (0.8)	0	7	0	0
Pre-vertebral space	1 (0.8)	0	4	0	0

Table 2 Comparison of patients with and without multi-space abscesses

	No. of patients	Mean age ± SD	Mean duration of stay ± SD (days)	No. of complications (%)
Multi-space abscess (+)	30	55.1 ± 15.1	20.2 ± 18.3	20 (66.7)
Multi-space abscess (−)	101	47.7 ± 16.4	7.4 ± 4.3	22 (21.8)
p values		0.0297*	<0.0001*	<0.0001†

* Student's *t* test

† Pearson's Chi-square test

Table 3 Etiology of deep neck infections

Etiology	Total ($N = 131$) (%)
Odontogenic	21 (16.0)
Upper airway infection	21 (16.0)
Peri-tonsillar abscess	15 (11.5)
Parotitis	6 (4.6)
Foreign body	6 (4.6)
Infected thyroglossal cyst and brachial cyst	6 (4.6)
Unknown	56 (42.7)

Table 4 Comparison of patients with and without diabetes mellitus

	No. of patients	Mean age ± SD	Mean duration of stay ± SD (days)	No. of complications (%)
Diabetes mellitus (+)	54	58.0 ± 11.0	12.5 ± 10.6	20 (37.0)
Diabetes mellitus (−)	77	43.7 ± 17.0	8.8 ± 10.9	22 (28.5)
p values		<0.0001*	0.0551*	0.307†

* Student's *t* test

† Pearson's Chi-square test

HIV positive, 2 (3.4%) with liver cirrhosis, and 2 (3.4%) patients with uremia or chronic renal insufficiency. Five (3.5%) patients had multiple systemic diseases. The most commonly involved space in these patients was the multi-space (28.8%), followed by the parapharyngeal space (23.7%) and parotid space (18.6%).

Culture results were available in 96 patients. 18 patients had polymicrobial culture results. 78 patients grew aerobic bacteria, while 30 patients grew anaerobic bacteria. The bacteriology of deep neck abscesses can be seen in Table 5. The most common organisms were *Klebsiella pneumoniae* (27.1%), *Streptococcus* milleri group (21.9%), anaerobic bacteria [not otherwise specified (NOS)] (20.1%), and *Staphylococcus aureus* (10.4%). Amongst deep neck abscesses with an odontogenic source of infection, *Streptococcus* milleri group bacteria was isolated in 62.5% ($p < 0.001$) and anaerobic bacteria (NOS) in 43.8% ($p = 0.037$). In contrast, 56.3% ($p = 0.011$) of the deep neck abscesses with a preceding or concurrent upper airway infection yielded a positive culture for *K. pneumoniae*.

K. pneumoniae grew in 50.0% of the diabetic patients, while anaerobic bacteria (NOS) and *Streptococcus* milleri group were cultured in 32.7 and 30.8% of the non-diabetic patients, respectively (Table 6). The association between diabetes mellitus and *K. pneumoniae* infections was

Table 5 Most frequent organisms in pus culture

Organism	No. of patients (%)[a]
Klebsiella pneumoniae	26 (27.1)
Streptococcus milleri group	21 (21.9)
Anaerobic bacteria (NOS)	20 (20.1)
Staphylococcus aureus	10 (10.4)
Streptococcus agalactiae (Group B)	3 (3.1)
Beta-hemolytic streptococci	2 (2.1)
Coagulase-negative staphylococcus	2 (2.1)
Acinetobacter baumannii	2 (2.1)
Salmonella enteritidis	2 (2.1)
Eikenella	2 (2.1)
Peptostreptococcus	2 (2.1)
Acinetobacter baumannii	2 (2.1)
Coliform	2 (2.1)

NOS not otherwise specified

[a] Of the 96 patients with positive cultures

Table 6 Distribution of organisms in patients with and without diabetes mellitus

No. patients (%) by organism			
Patient group	*Klebsiella pneumoniae*	Anaerobic bacteria (NOS)	*Streptococcus* milleri group
DM ($N = 44$)	22 (50.0)	3 (6.8)	5 (11.4%)
Non-DM ($N = 52$)	4 (7.7)	17 (32.7)	16 (30.8%)
p values	<0.0001*	0.002*	0.027*

DM diabetes mellitus, *NOS* not otherwise specified

* Fisher's exact test

statistically significant ($p < 0.001$).Their distribution between the diabetic and non-diabetic patients is compared in Table 6.

Anti-microbial therapy was part of routine treatment. 108 patients received surgical drainage, 17 underwent needle aspiration, 4 received tooth extractions, and the other 6 patients only had anti-microbial therapy. Amoxicillin–clavulanic acid (83.7%) was usually given as the first line antibiotic. The antibiotics were changed if the culture results or clinical course warranted it. The other antibiotics used commonly in different combinations were third generation cephalosporins and metronidazole. The intervals between diagnosis and surgical drainage ranged from 0 to 9 days, with a mean of 0.75 ± 1.64.

Forty-two patients (mean age of 55.5 ± 15.5 years) suffered from complications. Of these 42 patients, 28 were male and 14 were female. Patients with complications tended to be older (55.9 ± 15.5 vs. 46.6 ± 16.1 years, $p = 0.0031$) and have a longer hospital stay (17.0 ± 16.5 vs. 7.22 ± 4.2 days, $p < 0.0001$). Seven patients had multiple complications. All 19 patients who suffered upper airway obstruction either had a tracheostomy or were intubated. One patient died from sepsis and internal jugular vein thrombosis. All the complications are shown in Table 7.

Table 7 Complications of deep neck infections

Complication	No. of patients[a] (%) ($N = 131$)
Airway obstruction	19 (14.2)
Skin defect	8 (6.1)
Sepsis	7 (5.3)
IJV thrombosis	7 (5.3)
Facial palsy	2 (1.5)
Vocal cord palsy	2 (1.5)
Supraglottitis	2 (1.5)
Mediastinitis	1 (0.8)
Pneumonia	1 (0.8)
AMI	1 (0.8)
Osteomyelitis	1 (0.8)

IJV internal jugular vein, *AMI* acute myocardial infarct

[a] An individual patient may have multiple complications

The duration of hospital stay ranged from 2 to 76 days with a mean of 10.3 ± 10.9 days. All the patients were discharged stable except for one who died.

Discussion

The data from this study show a predominance of males (63.1%) over females (36.9%). Studies by Wang et al. [2] and Eftekharian et al. [7] also demonstrated this male predominance, while several reports in the West showed an equal distribution [3, 8]. Old age and the presence of systemic disease appear to increase the risk of developing deep neck infections as reported by Huang et al. [6].

The most commonly involved space was the parapharyngeal space (31 cases, 23.7%). This is because the peritonsillar, submandibular, masticatory, and parotid space communicates with the parapharyngeal space and infection in these spaces can spread to the parapharyngeal spaces [5]. This space was also most commonly involved in other studies [1, 3, 4]. 17 of 30 patients (56.7%) with multi-space abscesses had an underlying systemic disease or were under immunosuppressive therapy. Patients with systemic disease or receiving immunosuppressive therapy tend to have poorer defense against infections and thus result in higher rates of more severe infection in the form of multi-space abscesses. As such, multi-space abscesses were also associated with a significantly higher frequency of complications (20/30, 66.7%), leading to a prolonged mean duration of hospital stay (20.2 ± 18.2 days).

Odontogenic infections and upper airway infections were the two leading causes of deep neck abscesses in our

study. Several other studies have also implicated odontogenic infections as the most common cause. While some studies have shown that intravenous drug abuse and trauma were frequent etiologies [1, 4, 9], more recent papers have also reported upper airway infections to be major causes of deep neck abscesses [2, 6]. This can be attributed to the low rates of intravenous drug abuse and violence in our society. The cause of infection remains unknown in 42.7% of the cases, probably because the inciting infection can precede the deep neck infection by weeks. Odontogenic infections can spread contiguously from the mandible or maxilla into the sublingual, submandibular, and masticatory spaces, thus explaining its high rate of association with floor of mouth (75.0%) and submandibular abscesses (44.0%).

In contrast to western studies [1, 3, 9, 10], the most common organism cultured was *K. pneumoniae* (26 cases, 27.1%). This can be attributed to the large number of diabetic patients in our study (54 cases, 41.2%). Studies in Taiwan have also shown high rates of positive culture for *K. pneumoniae* in diabetic patients [6, 11]. As such, it is important to select antibiotics that *K. pneumoniae* are susceptible to in diabetic patients.

Both *Streptococcus* milleri group bacteria and anaerobic bacteria (NOS) were the next two most commonly encountered organisms in our study. The high incidence of positive culture for these organisms can be explained by the large number of odontogenic infections. Amongst the deep neck abscesses with an odontogenic source of infection, 62.5% isolated *Streptococcus* milleri group bacteria and 43.8% isolated anaerobic bacteria (NOS). The predominance of these two organisms in odontogenic related deep neck infections was also reported by Har-El et al. [1]. No growth was reported in 23.2% of the pus samples in this study. This rate was comparable to the Huang et al. [6] and Eftekharian et al. [7] reports. This high proportion of no growth is probably due to the prompt use of high dose antimicrobials early in the course of the disease [6]. In our study, 18.8% of the positive pus cultures were polymicrobial.

As reported in Huang et al. [6], diabetes mellitus (90.5%) was the most commonly associated systemic disease. Reduced polymorphonuclear leukocytes function, which plays a key role in the maintenance of gingival and periodontal health, has been found in patients with diabetes [12]. Furthermore, some microorganisms have an enhanced ability to adhere to diabetic compared to non-diabetic cells [13]. Although not statistically significant, diabetes show a trend towards increased rates of complications (37.0 vs. 28.6%) and multiple complications (9.3 vs. 2.6%) as well as longer duration of hospital stay (12.5 vs. 8.8 days). Furthermore, the control of these patients' blood glucose level plays a crucial role in the management of infections [2]. In this study, all diabetic patients' blood glucose level were closely monitored and kept below 11.1 mmol/l with oral hypoglycemic agents or insulin. Therefore, more attention should be paid to patients with diabetes and co-management with an endocrinologist to achieve better control of the patients' blood sugar levels may be advisable.

Evaluation of deep neck abscesses solely by clinical examination is inadequate as they can underestimate the extent of the disease in up to 70% of the patients [14]. As such, every patient in our center was assessed either with a contrast enhanced CT scan or by invasive intervention. Contrast enhanced CT scans are useful for diagnosis and identification of the spaces of infection for surgical drainage [15, 16]. Although MRI scans may be better for diagnostic purposes [17], they are more difficult to perform in practice, as they require good patient compliance and are also more costly.

Management of deep neck abscesses involves high dose intravenous antibiotics and surgical drainage of abscess. Securing the airways with tracheostomy or intubation is also necessary when upper airway obstruction occurs, as it is the most likely cause of fatality in this patient group [18]. While the therapeutic application of needle aspiration has been used in patients with no difference in complication rates [19], early open surgical drainage remains the definitive treatment for deep neck abscesses. If the size of the abscess is small and there are no imminent complications, a trial of conservative management may be attempted. In our study, all the patients who were treated conservatively had deep neck abscesses that were smaller than 50 mm in greatest dimension. However, surgical drainage is indicated in patients with significant abscesses, signs of impending complications or unsatisfactory response to conservative management.

Despite the widespread use of antibiotics, life-threatening complications can still result from deep neck abscesses. It is statistically proven that patients who suffered complications were older and had longer hospital stays. In our study, the most common complication was upper airway obstruction. Although the parapharyngeal space was the most commonly involved space, floor of mouth (75%) and multi-space (33.3%) abscesses had the highest rates of airway obstruction. This is similar to the Huang et al. study. Multi-space abscesses suggest a more severe form of infection, thus explaining the high rate of upper airway obstruction. Floor of mouth abscesses can cause rapidly progressive edema of the soft tissues of the neck, floor of the mouth, and pre-epiglottic space, thus leading to high rates of upper airway obstruction [20]. As such, there should be a higher index of suspicion of upper airway obstruction in patients with multi-space and floor of mouth abscesses.

Conclusion

Old age and diabetes mellitus are important risk factors of developing deep neck abscesses. These same factors together with multi-space neck abscesses also increase the likelihood of developing complications and prolonged hospital stay. Odontogenic infections are an important cause of deep neck abscesses and are associated with *Streptococcus* milleri group bacteria and anaerobic bacteria (NOS). Thus, patients with an odontogenic cause of deep neck abscesses should be given appropriate empirical antibiotic coverage against these pathogens and co-management with the dental team can help to optimize the patient's treatment. *K. pneumoniae*, *Streptococcus* milleri group bacteria, and anaerobic bacteria (NOS) were the most commonly cultured organisms. Diabetic patients should receive antibiotic coverage against *K. pneumoniae*. Although early surgical drainage remains the treatment of choice, conservative treatment can be considered in selected patients with small abscesses and no impending complications, as it does not increase the risk of developing complications. Patients with multi-space and floor of mouth abscesses have a higher risk of developing airway obstruction. As such, more attention should be paid to securing the airway of patients with abscesses in these spaces.

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Conflict of interest The authors declare that they have no conflict of interest.

References

1. Har-El G, Aroesty JH, Shaha A, Lucente FE (1994) Changing trends in deep neck abscess. A retrospective study of 110 patients. Oral Surg Oral Med Oral Pathol 77(5):446–450
2. Wang LF, Kuo WR, Tsai SM, Huang KJ (2003) Characterizations of life-threatening deep cervical space infections: a review of one hundred ninety-six cases. Am J Otolaryngol 24(2):111–117 Review
3. Boscolo-Rizzo P, Marchiori C, Montolli F, Vaglia A, Da Mosto MC (2006) Deep neck infections: a constant challenge. ORL J Otorhinolaryngol Relat Spec 68(5):259–265
4. Parhiscar A, Har-El G (2001) Deep neck abscess: a retrospective review of 210 cases. Ann Otol Rhinol Laryngol 110(11):1051–1054
5. Marra S, Hotaling AJ (1996) Deep neck infections. Am J Otolaryngol 17(5):287–298 Review
6. Huang TT, Liu TC, Chen PR, Tseng FY, Yeh TH, Chen YS (2004) Deep neck infection: analysis of 185 cases. Head Neck 26(10):854–860
7. Eftekharian A, Roozbahany NA, Vaezeafshar R, Narimani N (2009) Deep neck infections: a retrospective review of 112 cases. Eur Arch Otorhinolaryngol 266(2):273–277 Epub 2008 Jun 14
8. Ridder GJ, Technau-Ihling K, Sander A, Boedeker CC (2005) Spectrum and management of deep neck space infections: an 8-year experience of 234 cases. Otolaryngol Head Neck Surg 133(5):709–714
9. Tom MB, Rice DH (1988) Presentation and management of neck abscess: a retrospective analysis. Laryngoscope 98(8 pt 1):877–880
10. Gidley PW, Ghorayeb BY, Stiernberg CM (1997) Contemporary management of deep neck space infections. Otolaryngol Head Neck Surg 116(1):16–22
11. Chen MK, Wen YS, Chang CC, Lee HS, Huang MT, Hsiao HC (2000) Deep neck infections in diabetic patients. Am J Otolaryngol 21(3):169–173
12. Shetty N, Thomas B, Ramesh A (2008) Comparison of neutrophil functions in diabetic and healthy subjects with chronic generalized periodontitis. J Indian Soc Periodontol 12(2):41–44
13. Darwazeh AM, Lamey PJ, Samaranayake LP, MacFarlane TW, Fisher BM, Macrury SM, MacCuish AC (1990) The relationship between colonisation, secretor status and in vitro adhesion of *Candida albicans* to buccal epithelial cells from diabetics. J Med Microbiol 33(1):43–49
14. Crespo AN, Chone CT, Fonseca AS, Montenegro MC, Pereira R, Milani JA (2004) Clinical versus computed tomography evaluation in the diagnosis and management of deep neck infection. Sao Paulo Med J 122(6):259–263
15. Freling N, Roele E, Schaefer-Prokop C, Fokkens W (2009) Prediction of deep neck abscesses by contrast-enhanced computerized tomography in 76 clinically suspect consecutive patients. Laryngoscope 119(9):1745–1752
16. Endicott JN, Nelson RJ, Saraceno CA (1982) Diagnosis and management decisions in infections of the deep fascial spaces of the head and neck utilizing computerized tomography. Laryngoscope 92(6 pt 1):630–633
17. Muñoz A, Castillo M, Melchor MA, Gutiérrez R (2001) Acute neck infections: prospective comparison between CT and MRI in 47 patients. J Comput Assist Tomogr 25(5):733–741
18. Peterson LJ (1993) Contemporary management of deep infections of the neck. J Oral Maxillofac Surg 51(3):226–231 Review
19. Oh JH, Kim Y, Kim CH (2007) Parapharyngeal abscess: comprehensive management protocol. ORL J Otorhinolaryngol Relat Spec 69(1):37–42
20. Reynolds SC, Chow AW (2009) Severe soft tissue infections of the head and neck: a primer for critical care physicians. Lung 187(5):271–279