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Clinical Management of Orofacial Odontogenic Infection: A Four Year Retrospective Study

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ABSTRACT

Orofacial odontogenic infection, although arises from dental origin, can extend into the facial spaces and lead to debilitating complications. This study analysed the clinical pattern and management of orofacial odontogenic infection in a tertiary hospital namely Hospital Raja Permaisuri Bainun in Perak, Malaysia. We investigated any associations between socio-demographic factors, diabetic, comorbidities, smoking, pregnancy, antibiotic resistance, number and type of space infected towards prolonged hospital stay. All adult patients with orofacial odontogenic infections treated by Department of Oral and Maxillofacial Surgery from 2014 to 2018 were included. Clinical patterns were evaluated. Statistical analysis was performed to measure various variables towards prolonged hospital stay. A total of 154 patients (78 male, 76 female) were included in this study with mean age of 37.95 ± 14.9 years. Key factors of orofacial odontogenic infection requiring admissions were swelling, pain, trismus, odynophagia, reduced oral intake, raised floor of mouth and dyspnea. Among inpatients, three factors were significantly associated with prolonged hospital stay, namely antibiotic resistance, multiple space and secondary space infection. Local prevalence data was reported. Pus culture and sensitivity tests were recommended for all inpatients with multiple space and secondary space involvement, in order to rule out antibiotic resistance and to improve recovery rate.

Keywords: *Abscess; dental infection; hospital stay; orofacial odontogenic infection*

INTRODUCTION

Orofacial odontogenic infection can be defined by infection arising either from dental caries, periodontal infections or pathology of dental origin that have extended beyond the alveolar bone, resulting in the involvement of the facial spaces in the head and neck region. These infections tend to spread along planes of least resistance from the supporting structures of the affected tooth.

The spread of odontogenic infection to the facial spaces could lead to debilitating complications, including airway obstruction, mediastinitis, necrotizing fascitis, cavernous sinus thrombosis and sepsis (Bali *et al.*, 2015). Hence, prompt treatment including hospitalization for monitoring, intravenous antibiotics, and surgical intervention has remained the mainstay of treatment options for severe orofacial odontogenic infection (Hupp *et al.*, 2014). Because of the high variability and unexpected progression of orofacial odontogenic infection, some patients ended with prolonged hospital stay which is associated with unfavourable outcomes and higher healthcare cost.

This research aims to analyse the clinical pattern and management of orofacial odontogenic infection in Hospital Raja Permaisuri Bainun (HRPB) in Ipoh, Perak, Malaysia. We explored the key clinical features for admission cases. We also investigated any associations between socio-demographic factors, diabetic, medical comorbidities, smoking, pregnancy, antibiotic resistance, number and type of space infected towards prolonged hospital stay.

MATERIALS AND METHODS

Study Design and Sample

This four year cross-sectional study was conducted in a HRPB. All adult patients with orofacial odontogenic infections who attended the Department of Oral and Maxillofacial in HRPB from March 2014 to February 2018 were included in this study. Universal sampling method was used. Relevant data on patients' demography, medical history, smoking status, clinical presentation, source and site of infection, as well as management were collected using customised pro forma. There was a standard data collecting procedure and training was provided to all data collectors prior to data collection. Patients aged less than 16 years old and case notes with inadequate information were excluded from this study. Ethical approval was obtained from the Medical Research and Ethics Committee, Ministry of Health, Malaysia (NMRR-18-1943-42316).

All patients diagnosed with orofacial odontogenic infection were either admitted or managed as outpatients. Outpatient cases mainly consisted of patients with localised infection that were managed with removal of the offending teeth, with or without incision and drainage under local anaesthesia, supplemented with oral antibiotics. Meanwhile, cases for hospital admission included those with space infections that compromised airway, cases presented with poor oral intake secondary to trismus or dysphagia, cases in need for general anaesthesia and cases requiring multidisciplinary management for control of other medical comorbidities. The identification of space involvement among patients with orofacial odontogenic infection were made by clinical judgement supported by imaging such as plain radiograph, ultrasound imaging, and computed tomography scan.

Data Analysis

Descriptive statistics were computed for all the variables. Key criteria for admission cases were identified by analysing the clinical features and their distributions among the patients. Meanwhile for inpatients, the clinical outcome used to measure the severity of infection was prolonged hospital stay. Statistical analysis was performed using the dichotomous dependent variable, namely short stay (≤ 5 days) and prolonged stay (> 5 days). The cut-off point of five days was chosen as the average length of hospital stay in Malaysia ranged around four days (Sivasampu *et al.*, 2013). The variables explored in this study included sociodemographic factors, smoking status, diabetic status, medical comorbidities, antibiotic resistance, number and type of spaces infected. Binary statistical analyses were done to determine which factors were associated with prolonged hospital stay. All data was analysed using SPSS Version 22.0 (SPSS Inc., Chicago, USA), with the level of significance set at $p \leq 0.05$.

RESULTS

Demographics

A total of 154 patients (78 male, 76 female) with orofacial odontogenic infection were included in this study, after excluding five patients with incomplete data. The sociodemographic pattern, diabetic status and smoking status were reported in Table 1. The mean age of the study was 37.95 years, with a standard deviation (SD) of 14.94 years. A total of 38 patients (24.7%) were diabetic, while another 18 cases of other medical comorbidities that could contribute to an immune-compromised condition were reported. This included intravenous drug use (one case), chronic liver disease (two cases), chronic renal disease (two cases), patients on long-term steroid therapy due to various reasons (four cases), and history of radiotherapy with/or chemotherapy (nine cases). These illnesses were of small quantity and were analysed together under the grouping of medical comorbidities. About 26 of the patients (16.9%) were active smokers and 8 of them were pregnant (5.2%).

Key Clinical Features for Admission

The most common sign and symptoms observed by our patients were swelling (92.2%), followed by pain (79.2%), trismus (38.3%), odynophagia (20.1%), pus discharge (28.0%), fever (20.1%), reduced oral intake (9.1%), raised floor of mouth (7.1%), and dyspnoea (3.9%). This pattern is shown in Table 1. All of these clinical features, pus discharge, were significantly distributed among inpatients with $p < 0.05$ by Pearson's chi-square test. This revealed that swelling, pain, trismus, odynophagia, fever, reduced oral intake, raised floor of mouth and dyspnea were key clinical criteria for admission. Most of the orofacial spaces involved were single (70.8%), with the mean number of infected spaces was 1.48 with SD of 0.909.

Management and Complications

Table 2 depicts the distribution of the source of odontogenic infection, type of spaces involved, along with the management in this study. The main source of odontogenic infection was caries and pulpal disease (38.3%), followed by root stumps (13.6%), impacted teeth (21.4%), pericoronitis (17.5%), periodontal (14.3%), infected tooth socket (7.1%) and others (15.6%) consisted of pathology and trauma cases. Facial spaces involved were classified into primary and secondary spaces (Chang *et al.*, 2013; Hupp *et al.*, 2014). Primary space is defined as infection that passes beyond the alveolar process towards the next potential space adjacent to the offending teeth. Severe infection can then extend beyond these primary spaces into the deeper facial spaces of the head and neck region, known as secondary spaces. All cases were managed with antibiotic therapy (100.0%), complemented with various dental treatment such as normal extraction (50%), surgical removal of offending impacted teeth (18.2%), pulpectomy and root canal treatment (8.4%), scaling (3.9%), and other dental treatment (15.6%) such as enucleation of odontogenic cyst. Nearly half of them (43.5%) also received incision and drainage to evacuate purulent discharge.

Of all the cases of orofacial odontogenic infection, about half of them (53.3%) were successfully managed as an outpatient basis. The remaining cases (72 cases, 46.7%) were managed with admissions with short stay of ≤ 5 days (43 cases) and long stay of > 5 days (29 cases). All inpatient cases were managed with empirical antibiotics, where the selection consisted of penicillin group drug, second or third generation cephalosporin, amoxicillin and clavulanic acid combination, along with metronidazole for anaerobes cover. The definitive choices of antibiotics were confirmed by clinical response and pus culture sensitivity report. A total of 13 patients were found with antibiotics resistance, mainly towards penicillin and

Table 1 Demographic and clinical characteristics of patients with orofacial odontogenic infection by type of visit

Variable	All patients (*n* = 154)		Out patients (*n* = 82)		In patients (*n* = 72)		*p*-value
	n (%)	Mean (SD)	*n* (%)	Mean (SD)	*n* (%)	Mean (SD)	
Age (years)		37.95 (14.94)		37.91 (14.40)		37.99 (15.63)	0.524†
Gender							
Male	78 (50.6)		40 (48.8)		38 (52.8)		0.858‡
Female	76 (49.4)		42 (51.2)		34 (47.2)		
Ethnicity							
Malay	99 (64.3)		52 (63.4)		47 (65.3)		
Chinese	26 (16.9)		15 (18.3)		11 (15.3)		
India	24 (15.6)		14 (17.1)		10 (13.9)		
Others	5 (3.2)		1 (0.6)		4 (2.6)		
Diabetes	38 (24.7)		16 (19.5)		22 (30.6)		0.113‡
Comorbidities	18 (11.7)		12 (14.6)		6 (8.3)		0.225
Smoking	26 (16.9)		10 (12.2)		16 (22.2)		0.097‡
Pregnancy	8 (5.2)		4 (4.9)		4 (5.6)		0.850‡
Number of space		1.48 (0.909)		1.06 (0.241)		1.96 (1.131)	
Single	109 (70.8)		77 (93.9)		32 (44.4)		**<0.005‡**
Multiple	45 (29.2)		5 (6.1)		40 (55.6)		
Clinical features							
Swelling	142 (92.2)		71 (86.6)		71 (98.6)		**0.005‡**
Pain	122 (79.2)		55 (67.1)		67 (93.2)		**<0.001‡**
Pus	43 (28.0)		28 (34.1)		15 (20.8)		0.066‡
Fever	31 (20.1)		2 (2.4)		29 (40.3)		**<0.001‡**
Trismus	59 (38.3)		12 (14.6)		47 (65.3)		**<0.001‡**
Odynophagia	31 (20.1)		4 (4.9)		27 (37.5)		**<0.001‡**
Reduced oral intake	14 (9.1)		1 (1.2)		13 (18.1)		**<0.001‡**
Raised floor of mouth	11 (7.1)		0 (0.0)		11 (15.3)		**<0.001‡**
Dyspnea	6 (3.9)		0 (0.0)		6 (8.3)		**0.008‡**
Length of stay						5.51 (2.385)	
(not admitted) 0 days	82 (53.3)		82 (100)				
(admitted) 1–5 days	43 (27.9)				43 (59.7)		
> 5 days	29 (18.8)				29 (40.3)		

Note: SD = standard deviation; *n* = frequency; †Independent-test; ‡Pearson's chi-square test.

amoxicillin, which result in change of antibiotics in the midst of their treatment. Their distributions according to microbial subtype and antibiotic resistance were reported in Table 3. Among the patients who were admitted, 13 patients with severe complications such as airway obstructions, acute kidney injury, and septic shock were reported. Their clinical profile was described in Table 4. Fortunately, none of the patients suffered mortality and all of them recovered and were eventually discharged.

Table 2 Distribution of source of infection, spaces involvement and management

Variable	Frequency (*n*)	Percentage
A) Source of odontogenic infection		
Caries and pulpal disease	59	38.3
Root stump	21	13.6
Impacted	33	21.4
Periodontal	22	14.3
Pericoronitis	27	17.5
Infected tooth socket	11	7.1
Others (e.g. pathology, trauma and others)	24	15.6
B) Spaces involvement		
i. Primary space		
Vestibular	69	44.8
Canine	14	9.1
Buccal	44	28.6
Infratemporal	2	1.3
Submental	21	13.6
Sublingual	9	5.8
Submandibular	44	28.6
ii. Secondary space		
Temporal	1	0.6
Submessenteric	7	4.5
Pterygomandibular	7	4.5
Lateral pharyngeal	6	3.9
Retropharyngeal	4	2.6
C) Management		
Normal extraction	77	50.0
Surgical removal of teeth	28	18.2
Scaling	6	3.9
Pulpectomy and root canal treatment	13	8.4
Other dental treatment	24	15.6
Incision and drainage	67	43.5
Antibiotics	154	100.0

Table 3 Cases of infection by organisms that require a change in antibiotic

Organism	Penicillin	Ampicillin	Amoxicillin + clavulanate	Cefuroxime
Klebsiella pneumonia	5	2	1	1
Acinetobacter baumanii	1			
Streptococcus sp.		1		
Enterobacter cloacae		1		
Citrobacter preudil	1	1		

Table 4 Profile of patients with severe complications

Case	Age	Sex	Comorbid(s)	Origin of infection	Space(s) involved	Complication	Management	Length of stay
1	55	M	Chronic kidney disease	Caries and pulpal disease, impacted teeth	Ludwig angina	Airway obstruction	Drainage and surgical removal of impacted teeth	5
2	42	M	Diabetes Mellitus	Caries and pulpal disease, periodontal disease	Ludwig angina and parapharyngeal space	Airway obstruction and preseptal orbital cellulitis	Tracheostomy, drainage	13
3	41	M	Diabetes Mellitus, hypertension, ischemic heart disease	Caries and pulpal disease, impacted teeth	Buccal	Airway obstruction, acute kidney injury	ICU admission, septic shock, drainage	5
4	41	M	Diabetes Mellitus	Infected tooth socket	Ludwig angina	Airway obstruction	Drainage and intubation	5
5	29	F	-	Caries and pulpal disease	Submandibular	Airway obstruction	Drainage	3
6	18	F	-	Infected odontogenic cyst	Buccal	Airway obstruction	Drainage and removal of infected cyst	8
7	33	M	-	Caries and pulpal disease	Submandibular	Airway obstruction	Drainage	6
8	78	M	Hypertension, dyslipidaemia	Caries and pulpal disease	Ludwig angina	Airway obstruction	ICU admission, drainage	7
9	34	F	-	Caries and pulpal disease	Ludwig angina	Airway obstruction	ICU admission, drainage	8
10	27	F	-	Impacted teeth	Ludwig angina	Airway obstruction	ICU admission, drainage	6
11	59	M	Diabetic Mellitus, hypertension, ischemic heart disease, hepatitis B	Periodontal disease	Ludwig angina and parapharyngeal space	Airway obstruction	ICU admission, tracheostomy and drainage	10
12	60	F	Leiomyosarcoma	Caries and pulpal disease and impacted teeth	Submandibular and submasseteric	Airway obstruction	ICU admission, drainage and surgical removal of impacted teeth	5
13	23	F	-	Caries and pulpal disease	Submandibular	Airway obstruction	ICU admission, drainage	4

Statistical Analysis between Study Variables and Prolonged Hospital Stay

Specifically for inpatient cases, the clinical outcome known as prolonged hospital stay was analysed. Table 5 presented three factors that were statistically significant to it, namely antibiotic resistance ($p = 0.050$), number of space infected ($p = 0.029$) and type of space infected ($p = 0.025$).

DISCUSSION

Various epidemiological studies across the world had been conducted to understand the prevalence of orofacial odontogenic infections. In America, referring to Harborview Medical Centre, Washington, a total of 318 patients with severe odontogenic infection requiring hospitalization were observed in a 10 year period from 2001 to 2011 (Christensen *et al*., 2013). Whereas

Table 5 Factors associated with prolonged hospital stay among inpatients (*n* = 73 patients)

Variable	Short stay (≤ 5 days) (*n* = 43)		Prolonged stay (> 5 days) (*n* = 29)		*p*-value
	n (%)	Mean (SD)	*n* (%)	Mean (SD)	
Age		37.16 (15.01)		39.21 (16.69)	0.590†
Race					
Malay	28 (65.1)		19 (65.5)		0.904§
Chinese	7 (16.3)		4 (13.8)		
Indian	5 (11.6)		5 (17.2)		
Other	3 (7.0)		1 (3.4)		
Diabetes					
Yes	11 (25.6)		11 (37.9)		0.304‡
No	32 (74.4)		18 (62.1)		
Other Comorbidities					
Yes	5 (11.6)		1 (3.4)		0.391§
No	38 (88.4)		28 (96.6)		
Smoking					
Yes	10 (23.3)		6 (20.7)		0.797‡
No	33 (76.7)		23 (79.3)		
Pregnancy					
Yes	3 (7.0)		1 (3.4)		0.644§
No	40 (93.0)		28 (96.6)		
Number of Space Involved					
Multiple	19 (44.2)		21 (72.4)		0.029‡
Single	24 (55.8)		8 (27.6)		
Type of Space Involved					
Secondary	6 (14.0)		11 (37.9)		0.025‡
Primary	37 (86.0)		18 (62.1)		
Antibiotic Resistance					
Yes	4 (9.3)		8 (27.6)		0.050‡
No	39 (90.7)		21 (72.4)		

Note: SD = standard deviation; *n* = frequency; †Independent sample *t*-test; § Fisher's exact test; ‡Pearson's Chi-square test

in Europe, namely Berlin, Germany, there were 814 patients with severe odontogenic infection over eight years (Opitz *et al.*, 2015). As in the Asia region, a total of 137 patients of odontogenic maxillofacial space infection were recorded in Ludhiana, North India during a five year period between 2006 and 2010 (Mathew *et al.*, 2012). Meanwhile in West China, 212 patients over a five years duration were reported with maxillofacial space infection, where 56.1% of them were associated with odontogenic cause (Zhang *et al.*, 2010). One recent local study conducted in a different state had reported a total of 207 orofacial infections from 2015 to 2019, with 145 cases consisting of odontogenic source of infection (Yew *et al.*, 2021). Our study of 154 patients in the span of four years' time had shown a similar prevalence.

Most patients reported in this study were Malay in ethnicity (64.3%), and this is in concordance with the fact that Malaysia is a multiracial nation comprising Malays as the majority. The mean age of occurrence for orofacial odontogenic infection in this study was 37.95 years. This correlates with some other studies (Seppänen *et al*., 2008; Mathew *et al*., 2012; Stathopoulos *et al*., 2017), although several had reported a higher age group prevalence around fifth decade of life, perhaps due to the nature of their aging population (Zhang *et al*., 2010; Heim *et al*., 2019; Park *et al*., 2019). Meanwhile, the male/female ratio was nearly equal in this study (1:1.02), similarly reported by some authors (Stathopoulos *et al*., 2017; Heim *et al*., 2019); whereas a higher male prevalence was contrarily presented by others (Wang *et al*., 2005; Mathew *et al*., 2012; Park *et al*., 2019).

The key clinical features of orofacial odontogenic infections requiring admission were identified as swelling, pain, fever, trismus, odynophagia, reduced oral intake, raised floor of mouth and dyspnea. Trismus, fever, dysphagia and dyspnea were similarly reported by others too as major criteria for hospital admission of patients with severe odontogenic infection (Alotaibi *et al*., 2015; Gholami *et al*., 2017). Understandably, fever indicated systemic involvement of a severe infection which should be monitored and managed with systemic antibiotics. Meanwhile, pain was an important clinical feature that motivated most patients to seek treatment. Besides, this centre was supporting the "Pain Free Hospital" concept as introduced by the Ministry of Health, and emphasised pain as the fifth vital sign (Walid *et al*., 2008). Other key features such as trismus and dysphagia indicated the involvement of deep spaces, which could lead to reduced oral intake. The involvement of the submandibular and sublingual spaces that communicate posteriorly could also cause the backward displacement of the tongue. As the floor of the mouth was raised, dyspnea could follow next, indicating early signs of airway obstruction and warranted immediate intervention. Orofacial odontogenic cases with these key clinical features mentioned above required immediate attention and were highly recommended for admission.

In fact, most of our patients with severe complications presented in Table 2 were Ludwig's angina cases, where the airway was compromised and immediate intervention was required. Most of them received intubation or tracheostomy, incision and drainage, administration of antibiotics and observation in the intensive care unit. The incidence of complications in our study was 8.44%, which was well within the range of reported incidence between 1.7% (Opitz *et al*., 2015) to 14.6% (Mathew *et al*., 2012; Han *et al*., 2016). More than half of these cases presented with some medical comorbidities which could have compromised the immune system. Hence, it was crucial that multidisciplinary management involving various specialties such as otolaryngology, internal medicine, and anaesthesiology were on board and working seamlessly to improve their prognosis.

Our study found that various factors including elderly age, gender, diabetes status, medical comorbidities, smoking status and pregnancy did not show any association with prolonged hospital stay. Although elderly age may contribute to compromised immunological status, it may also imply a lesser amount of dentition available to be susceptible for odontogenic infection to begin with (Peters *et al*., 1996). Hence, it is understandable that advanced age can have a controversial relationship with orofacial odontogenic infection by various studies (Park *et al*., 2019; Yew *et al*., 2021). Meanwhile, our patients that were grouped under medical comorbidities although had a variety of different illnesses that could contribute towards immune-compromised status; unfortunately, their direct relationship towards prolonged hospital stay could not be established statistically, perhaps due to the heterogeneity and limitation of sample size.

The relationship between smoking and prolonged hospital stay was not proven in this study. Contrary, Alrouni *et al* had reported an association of longer hospital stay among patients with severe sepsis, especially in need of mechanical ventilation (Alroumi *et al*., 2018). This could be explained by the worse hypoxia indicated by higher rates of chronic obstructive pulmonary disease among smokers. Unfortunately, their research did not focus on odontogenic orofacial infection as the primary source of sepsis. Despite the fact that the adverse reactions of smoking with periodontal disease were already clearly established by numerous studies (Bergström, 2004; Bagaitkar *et al*., 2008), surprisingly the exact pathophysiology between smoking and bacterial infection in the orofacial region remained complex and not yet well understood (Bakathir *et al*., 2009; Yew *et al*., 2021). There is a lack of systemic data regarding the outcome of the majority of infections among smokers, where the exact potential dose-dependent effect is worthy for further epidemiological research (Huttunen *et al*., 2011). Another challenge of analysing smoking as a variable was that it could be influenced by socioeconomics and education background too; hence the direct association was difficult to be proven.

Pregnancy was another interesting variable explored in this study. The immune system in a gravid patient may show some alterations such as shifts in leukocytes with increased monocytes and regulatory T cells. Despite that, pregnancy associated anaemia and leukopenia may occur because the increase in monocytes and regulatory T cell count was not well compensated by the increased plasma volume, especially in the third trimester (Turner & Aziz, 2002; Creasy *et al*., 2009). Local oral environments could also experience some unfavourable changes such as aggravated response towards plaque accumulation due to hormonal changes and altered immunological activities (Silva de Araujo Figueiredo *et al*., 2017). Currently, there was insufficient literature to establish the relationship of pregnancy towards increased risk of prolonged hospital stay, and this association was not observed in this study too. It was likely due to the limited number of four pregnant inpatients, where only two were in their third trimester which carried the highest susceptibility towards infection.

The influence of diabetes on the progression of orofacial odontogenic infection has been controversial in the literature. Ko *et al*. (2017) conducted a nationwide research in Taiwan and concluded that facial cellulitis is likely to occur two years after being diagnosed with diabetes mellitus, with the risk occurrence of 1.409 times greater. It was however utilising information on dental procedure codes, where severity of the infection could not be determined. A study in Korea also reported a significant rate of multiple secondary space involvement and prolonged hospital stay among the diabetic group (Chang *et al*., 2013), unfortunately it was a research of relatively small sample size consisting of 51 patients only. Some other studies also showed similar findings, however most of them could not confirm the circumstances of glycaemic control among the patients (Mathew *et al*., 2012; Yew *et al*., 2021). This had made it difficult to conclude if all diabetic patients are likely to have poorer prognosis, or was it limited to the poorly-controlled diabetic patients only. As diabetic patients could have different levels of glycemic control, it may be postulated that the diagnosis of diabetes alone could not negatively influence the infection severity, as long as optimal serum glycemic control was achieved. This could explain why our study did not establish any association between diabetes mellitus with the outcomes of the study, and was supported by others (Rao *et al*., 2010; Igoumenakis *et al*., 2015). It was also worth mentioning that prolonged hospital stay could be indirectly due to optimisation of other underlying medical illnesses, rather than referring to the complete resolution of the infection alone.

This study found that prolonged hospital stay was significant among inpatients that had multiple space and secondary space involvement. Naturally, with more spaces involved, especially deep secondary spaces, cases became more complex and difficult. Local oedema due to the extensive inflammatory process may need some time to subside before extubation or deccanulation of the tracheostomy tube could be performed, as the airway needed to be protected at all cost. Drainage might also take longer time until significant clinical improvements can be observed to allow patients for discharge. Rarely, patients might require second surgery if the first surgery did not completely drain all purulent discharge, or additional spaces were identified at the later course of disease progression.

Our study had found a significant association between antibiotic resistances towards prolonged hospital stay. The influence of antibiotic resistance for empiric treatment on patients' clinical course was similarly reported by others (Rao *et al*., 2010; Zirk *et al*., 2016; Kim *et al*., 2017). In our study, a total of 13 cases of antibiotics resistance were detected, giving rise to a percentage of 8.44%. This is an acceptable percentage, where Poeschl *et al.* (2010) reported similar 8% of penicillin resistance in a deep space infection, while Kim *et al.* (2017) had reported a higher percentage of penicillin resistance in 32.5% of aerobic isolates of orofacial infections.

Orofacial odontogenic infections usually consist of various types of bacterial colonies. Aerobic streptococcus is the predominant bacterial strain in the beginning of infection. With deeper spaces involved, anaerobic bacteria such as *Klebsiella pneumonia* became dominant, similarly present in our antibiotic resistance group, and as found by others (Chang *et al*., 2013). In fact, *Klebsiella Pneumonia* had been isolated as the predominant infectious organism among diabetic patients with maxillofacial space infection (Rao *et al*., 2010).

The empirical antibiotic therapy in this centre (consisted of a choice of amoxicillin, amoxycillin with clavulanate, or cefuroxime; and metronidazole) were well reported to be effective against most orofacial infection in the literature (Wang *et al*., 2005; Mathew *et al*., 2012). Metronidazole although has excellent activity against strict anaerobes, it has no effect against facultative bacteria such as streptococci that is commonly found in orofacial odontogenic infections (Poulet *et al*., 1999). Hence, it is widely used as an adjunct to beta-lactam antibiotics. Even with appropriate dental treatment, drainage, and antibiotic therapy, if patients' condition did not improve clinically, antibiotic resistance needs to be suspected, and to be modified according to the sensitivity report. The recent emergence of beta-lactamase producing organisms is already well reported by others (Rao *et al*., 2010; Zirk *et al*., 2016; Kim *et al*., 2017), and this supported the findings of our study that reported penicillin and ampicillin as the main type of antibiotic resistance.

The authors however acknowledged the difficulty of assessing the clinical importance of bacterial resistance pattern, because in some cases, patients can get well despite culture data that indicated resistance of one of the isolates only, out of the many. Clinicians need to bear in mind that the treatment of orofacial odontogenic infection are multifaceted; with extraction, drainage and pharmaceutical drugs each playing their roles towards recovery. Perhaps a well-designed study of a more complete aerobe and anaerobe speciation and sensitivity would be more appropriate to evaluate the relationship of antibiotics resistance with orofacial odontogenic infection.

Finally, readers should be made aware that the definition of prolonged hospital stay was reported differently by various studies. Some study defined prolonged hospital stay as more than 12 days according to the country's average length of hospital stay; while ours was defined as more than five days (Sivasampu *et al*., 2013). The diversity of healthcare settings and insurance policies in different populations could also affect this number remarkably. Nevertheless, the mainstay of treatment of orofacial odontogenic infection remained the same, which included earliest removal of source of infection, sufficient drainage of purulent collection, accompanied by antibiotics therapy of the right choice.

CONCLUSION

Local prevalence data was reported. Key factors of orofacial odontogenic infection requiring admissions were swelling, pain, trismus, odynophagia, reduced oral intake, raised floor of mouth and dyspnea. Among inpatients, three factors were significantly associated with prolonged hospital stay, namely antibiotic resistance, multiple space and secondary space infection. Pus culture and sensitivity tests are recommended for all admitted cases with multiple space and secondary space involvement, in order to rule out antibiotic resistance and to improve recovery rate. The value of this study remained critical to provide some insight on local prevalence data in Malaysia, to support some clinical impressions, and to provide a scientific basis for further research.

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