



## Epidemiologic evaluation of maxillofacial infections and their risk factors and associated complications in a one year period in Shariati hospital in 2013-2014

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### ABSTRACT

**Purpose:** Maxillofacial infections (MIs) commonly occur in patients of all ages, representing a life-threatening challenge when reaching deep facial spaces. The epidemiologic studies of MIs and their characteristics are very important and beneficial for both patients and clinicians. Therefore, the aim of this prospective study was to determine the annual incidence, etiology, risk factors and complications of MIs in all patients who were admitted to the department of oral and maxillofacial surgery of the Shariati hospital during a 1-year period.

**Material and Methods:** The demographic data, levels of some serum markers on day of admission, such as erythrocyte sedimentation rate (ESR) and C-reactive protein (CRP), bandemia, serum albumin, predisposing factors for each patient referred for treatment of MI were recorded by one researcher in November 2013 to November 2014. The linear regression test was used to evaluate whether there was a relationship between the amount of changes in ESR, CRP and albumin levels and age of the patients, pregnancy, gender and severity of infection. Panoramic radiography as well as axial and coronal CT scans with soft tissue window were performed for all cases, except pregnant participants. The origin of MIs, including odontogenic, pathologic and foreign body, was identified for each patient.

**Results:** During the study period, a total of 157 patients (87 female, 70 male), with an age range of 3 to 74 years (mean,  $23.5 \pm 13.2$  years), were admitted to the department of maxillofacial surgery. Regardless of the gender, the most frequent cause of MIs was odontogenic sources (128 cases, 81.5%). The most common affected area was the buccal space with 106 positive cases (67.5%). The most common teeth responsible for maxillofacial fascial space infection were mandibular third molars. A positive association was found between CRP and ESR levels and the severity of infections. Serum albumin and ESR levels were significantly reduced and increased in the patients with severe infection and pregnant patients, respectively.

**Conclusion:** The results of this study indicated that odontogenic origins were the main cause of MIs and the most common involved space was the buccal space. Diabetes mellitus was the most commonly found systemic disease among the participants of this study. The findings of this study suggest that dentists should consider that the most appropriate treatment of odontogenic infections involves surgical intervention and selection of a suitable antibiotic as an adjunct.

**Keywords:** Maxillofacial infection; Risk factors; Complications.

### Introduction

MI commonly occur in patients of all ages, representing a life-threatening challenge when reaching deep facial spaces. MIs are infections that affect the potential spaces and fascial planes of maxillofacial region which has a complex anatomy [1]. These

infections are mostly developed secondary to necrotic pulpal tissue following a deep dental carious lesion [2]. However, MI can also have infective, inflammatory, and traumatic origins, of which, odontogenic infections are the most common causes [3-4].

Management of MIs, especially those originated from odontogenic sources, is a challenging task for surgeons [5]. Symptoms of MIs are evident due to the proximity between muscles, ligaments, and nerves, which quickly impairs the function of affected region, resulting in pain and trismus [6]. Untreated patients with odontogenic MI often present involvement of multiple secondary spaces that can be life-threatening due to airway obstruction [6]. Odontogenic infections originate from pulpal or periodontal tissues as well as infected tooth sockets after extractions [7]. Various risk factors and complications have been reported to be associated with infection in maxillofacial area. Even though the epidemiology of MIs are more or less similar in different societies, it is necessary for each country to have its own epidemiologic data to be able to have a more precise planning to prevent and treat such infections. In addition, epidemiologic studies of MIs and their characteristics are very important and beneficial for both patients and clinicians [8]. Therefore, the aim of this study was to determine the annual incidence, etiology, risk factors and complications of MIs in all patients who were admitted to the department of oral and maxillofacial surgery of the Shariati hospital from November 2013 to November 2014.

## Material and Methods

This prospective study was performed during a 1-year period starting from November 2013 to November 2014. Participants of this study included all patients who were admitted to maxillofacial surgery ward of the Shariati hospital for treatment of MIs. The demographic data, including sex, age, cause of infection, the involved fascial space, levels of some serum markers on day of admission, such as erythrocyte sedimentation rate (ESR) and C-reactive protein (CRP), bacteremia, serum albumin (to assess nutritional status), predisposing factors, including diabetes mellitus, pregnancy, hypothyroidism, anemia, immunodeficiency, and chronic steroid use, type of treatment, post admission antibiotic therapy, previous endodontic treatment of the causative tooth, the presence of post extraction or post RCT infection and the presence of trismus for each patient were recorded by one researcher.

Culture and sensitivity tests to antibiotic therapy were not performed prior to the initiation of antibiotic therapy. Panoramic radiography as well as axial and coronal CT scans with soft tissue window were performed for all cases, except pregnant participants to study the involved spaces? The origin of MIs, including odontogenic, pathologic and foreign body, was identified for

each patient. The superficial and deep fascial spaces of maxillofacial region were classified as follows: vestibular, subcutaneous, buccal, sublingual, submandibular, submental, masticator, parotid, lateral pharyngeal, retropharyngeal, pretracheal, visceral, danger, carotid sheath, mediastinum, palatal, infraorbital, periorbital spaces and space of the body of mandible [9]. All the above-mentioned data were collected by one researcher. Ethical code and ethical approval ethics committee of Tehran University of Medical Sciences approved the study design and informed consent was obtained from all patients to include their data in this study.

## Statistical Analysis

The obtained data were analyzed using the SPSS 20.0 software package (SPSS Inc., Chicago, IL, USA). Descriptive statistics were used for gender, space involvement, immune system status, causative permanent teeth, antibiotic therapy, and origin of infectious frequencies. The differences in CRP, ESR, and albumin levels between male and female patients were analyzed by one way ANOVA. Pearson correlation test was used to evaluate the relationships between each of ESR, CRP and albumin together. Linear regression test was applied to evaluate whether there was an association between the amount of changes in ESR, CRP and albumin and age of the patients, pregnancy and severity of infection indicated by the number of space involvement.

## Results

During the study period, a total of 157 patients, with an age range of 3 to 74 years (mean,  $23.5 \pm 13.2$  years), were admitted to the department of maxillofacial surgery. The patients were classified into 8 age groups that are presented in Table 1. Most of the patients (33.8%) were between 21 to 30 years old. The study group consisted of 87 females (55.4%) and 70 males (44.6%). Regardless of the gender, the most frequent cause of MIs was odontogenic sources (128 cases, 81.5%) followed by maxillofacial pathologies (7 cases, 4.5%), prosthesis (6 cases, 3.8%), plates and free bone grafts (4 cases each, 2.5% each), fillers (3 cases, 1.9%), free fat graft (2 cases, 1.3%), foreign body, fungal infection and post trauma infection (1 case each, 0.6%). In terms of the pathological properties 5 cases of bisphosphonate-related osteonecrosis of the jaw (BRONJ), one odontogenic kerato cyst (OKC) and one florid cemento osseous dysplasia (FLCOD) were identified.

Of the 7 cases of infected prosthesis, 3 were acrylic prosthesis placed in frontal area, one was a silicone prosthesis placed in mental area, and the remaining three medpore, preimplants were placed in mental area, malar region and orbital floor. Of the infected bone grafts, 3 were placed in mandible and one was placed in maxilla. All of the infected grafts were harvested from iliac crest. In all 3 cases of filler infection, the alloplastic filler was injected in malar and perioral areas. Of the 2 infected fat grafts, one was placed in the orbital floor in a trauma patient and the other one was used for malar augmentation in a case with hemifacial microsomia.

The infected foreign body was a piece of wood entered in submandibular area in a trauma. The fungal infection was related to *acerebero rhino orbital mucormycosis* in a patient with ALL which was started in the maxillary sinus and the necrotic and infected tissue was found on the ala of the nose. The most common affected area was the buccal space with 106 positive cases (67.5%). The rate of involvement of other spaces is presented in Table 2. The most common teeth responsible for maxillofacial fascial space infection is presented in Table 3. In just one case with retropharyngeal space, carotid sheath involvement and mediastinitis, the causative tooth was mandibular second molar. The number of causative teeth determining the involvement of different facial and maxillofacial spaces is presented in Table 3. Multiple space involvement was used as an indicator of severity of the infection (Table 4). Left mandibular second molar had the highest mean value for space involvement (mean: 5). The number of the involved spaces was between 1 to 10 spaces in the patients of this study. Although more than 73.9% of the patients had no predisposing factors, some of

them suffered from various conditions, such as diabetes mellitus, anemia, chronic steroid administration, malignancy and radiation therapy (Table 5).

### Maximum Interincisal Opening (MIO)

The MIO of the patients of this study ranged between 0 to 50 mm (mean:  $23.5 \pm 13.24$  mm) on the day of admission. The patients were classified into four MIO groups; 0 to 10 mm (49 patients, 31%), 11 to 20 mm (28 patients, 18%), 21 to 30 mm (30 patients, 19%), and more than 31 mm (50 patients, 32%).

### Initial levels of CRP, ESR and albumin and their correlations

In this study, 1 to 10 mg/L and mm/hr of CRP and ESR were respectively considered as the normal ranges of these two indices. On the day of admission, the levels of CRP and ESR were within the normal range in 12.7% and 16.6% of the patients, respectively (Table 6). Most of the patients had a normal albumin level. The mean levels of these three parameters are presented in Table 6. Pearson correlation test was used to evaluate the relationships between the three variables. The results indicated that there was a significant positive relationship between ESR and CRP (correlation coefficient: 0.421, P value < 0.001). (Table 6).

Age group (Years)	No. (%)
0-10	9 (5.7%)
11-21	12 (7.6%)
21-30	53 (33.8%)
31-40	43 (27.4%)
41-51	17 (10.8%)
51-60	16 (10.2%)
61-70	3 (2%)
>70	4 (2.5%)
Total	157

Table 1. Frequency of MIs in participants of different age groups.

Space	No. (%)
Buccal	106 (67.5%)
Submandibular	102 (65%)
PTM	82 (52.2%)
Vestibular	66 (42%)
Canine	21 (13.4%)
Submental	19 (12.1%)
Subcutaneous	17 (10.8%)
Submasseteric	17 (10.8%)
Lateral pharyngeal	8 (5.1%)
Frontal	3 (1.9%)
Temporal	3 (1.9%)
Sublingual and frontal	3 (1.9%)
Retropharyngeal	1 (0.66%)
Carotid sheath	1 (0.66%)
Mediastinum	1 (0.66%)

Table 2. Space involvement in MIs.

Space involvement	Teeth (number of involved cases)
Vestibular	Mandibular third molars (10 teeth)
Canine	Maxillary canines (6 teeth)
Buccal	Mandibular third molars (26 teeth)
Submental	Mandibular second molars (5 teeth)
Sublingual	Mandibular second molars (2 teeth)
Submandibular	Mandibular third molars (39 teeth)
PTM	Mandibular third molars (42 teeth)
lateral pharyngeal	Mandibular third molars (5 teeth)
Submasseteric	Mandibular third molars (8 teeth)
Temporal	Maxillary third molars (3 teeth)
Retropharyngeal	Mandibular second molar (1 tooth)
Frontal area	Non odontogenic

Table 3. Involvement of various spaces and teeth.

Multiple space involvement	Number (frequency %)
1 space	15/9.6
2 space	43/27.4
3 space	62/39.5
4 space	28/17.8
5 space	5/3.2
6 space	2/1.3
7 space	1/0.6
10 space	1/0.6

Table 4. The number and frequency of multiple space involvement in MIs.

Medical condition	Frequency	Percent
None	116	73.9
Diabetes mellitus	17	10.8
Anemia	14	8.9
Chronic steroid administration	6	3.9
Malignancy+radiation therapy	3	1.9
Chronic steroid and immunosuppressive drug therapy	1	0.6
Total	157	100

Table 5.

Parameter	Min	Max	Mean±SD (mg/L)	Percent of patients in normal range
ESR	1	97	38.8±23.6	16.6
CRP	1	135	51.7±32.8	12.7
Albumin	2.9	5.1	4.1±0.4	91.1

  

	CC (ESR admission)	CC (CRP admission)	CC (Albumin)
ESR admission	1	0.421**	-0.233**
P value		0.000	0.003
CRP admission	0.421	1	-0.174*
	0.000		0.029
Albumin	-0.233**	-0.174*	1
	0.003	0.029	

\*\* : Correlation is significant at the 0.01 level (2-tailed).  
\* : Correlation is significant at the 0.05 level (2-tailed).

CC. Correlation coefficient.

Table 6.

### Associations between ESR, CRP and albumin levels and gender, age, pregnancy and severity of infection

The linear regression test was used to evaluate whether there was an association between the amount of changes in ESR, CRP and albumin levels and age of the patients, pregnancy, gender and severity of infection. The results showed that ESR level was significantly higher in pregnant patients ( $p: 0.006$ ). Moreover, CRP level was significantly higher in male patients ( $p: 0.04$ ), those with more severe infections ( $p < 0.001$ ) and the patients with advanced age ( $p: 0.092$ ). The serum albumin level was significantly higher in men ( $p: 0.029$ ), whereas it was considerably lower in pregnant patients ( $p: 0.003$ ) and those with more severe infection ( $p < 0.001$ ).

### Treatment

In this study, the most common treatment was antibiotic therapy combined with incision, drainage

and tooth extraction which was performed in 67 cases (42.7%) followed by combination of antibiotic therapy and incision & drainage (I&D) in 54 cases (34.4%), combination of antibiotic therapy and extraction in 11 cases (7.0%), and each of antibiotic therapy alone, antibiotic therapy and debridement, and device removal was performed in 7 patients (4.5%), antibiotic therapy and I&D followed by debridement in 3 cases (1.9%) and graft removal in 1 case (0.6%). Among the 128 teeth implicated in odontogenic infections, only 8 teeth had undergone root canal therapy (RTC) previously. No significant relationship was found between the severity of infection and previous endodontic therapy ( $p: 0.481$ ).

Overall, 9 participants (5.7%) required hospital admission due to disseminated infection following endodontic treatment. In this study, molars and premolars were the only causative teeth. Mandibular molars were the most common causative tooth for post-RCT with



5 teeth. Post-extraction infection occurred in 14 cases (8.9%), among them, mandibular third molars and maxillary third molars were respectively the causative teeth in 8 (57%) and 4 cases (28.5%). In this study, only 5.4% of odontogenic infections and 4.4% of MIs were caused by primary teeth. The average age of these pediatric patients was 7.4 years old, with a range of 3 to 9 years. In the deciduous dentition the causative teeth were only the posterior teeth.

## Discussion

MI is significantly increasing worldwide, however, their incidence, etiology, and pattern vary from one country to another, probably due to socioeconomic, cultural and environmental differences [10]. This study aimed to determine the annual incidence, etiology, risk factors and complications of MIs in all the patients who were admitted to the maxillofacial surgery of Shariati hospital over a one-year period. A total of 157 MI patients were included in this study during the one year of study period. During the same period of time, the number of admitted patients to the Shariati hospital, where this study was conducted, was higher than those reported by other studies from different countries [11-12].

The patients, with the mean age of  $23.5 \pm 13.2$  years, were classified into 8 age groups. The results indicated that the patients at their second and third decades of life were at a higher risk of MIs. In consistent with the findings of this study, Nading and Taylor (2018) have reported that the highest odontogenic infection-related admission rate belonged to the patients who were at their second and third decades of life [13]. This finding may be attributed to greater rates of untreated caries in this age group. However, their studies have demonstrated that patients with odontogenic infections were within an age range of 31 to 47 years [14-16].

It has been reported that smoking is directly correlated with a higher risk of MIs, moreover, the number of male smokers is considerably higher than females and men tend to care less about their oral health compared to women [17]. Nevertheless, in this study, the overall female to male ratio (female: male) was 1.24:1. This finding is inconsistent with those reported by other studies from various countries, such as India [16], United States [18], and China [19]. The most frequent number of involved spaces was 3 spaces which were detected in 62 patients (39.5%). In 99 cases (63%), more than three spaces were involved. Rasteniene et al (2015) have reported that 42.9% of cases with odonto-

genic MIs had two or more involvement of anatomic spaces. Inconsistent with findings of this study, they have reported that single-space infections were more common in their patients [20]. A higher risk of maxillofacial multiple space infection has been reported in China [19] and India [16]. In the present study, the most commonly involved space was the buccal space with 106 positive cases (67.5%). However, some of previous studies have reported the submandibular space as the most commonly involved space [16,21]. The predominant involvement of buccal space may be due to the fact that buccal space can be infected by numerous teeth in both the maxilla and mandible. It has been recently reported that the submandibular and buccal spaces are the most frequently involved fascial spaces in odontogenic MIs [12].

In the present study, the main source of MIs was odontogenic factors followed by maxillofacial pathologies. Moreover, the most frequently implicated teeth were mandibular third molars which were involved in 81.5% of cases (128/157) for odontogenic infections. It has been reported that the frequency of odontogenic MI almost remain unchanged during a 10-year period [20]. Odontogenic infections have been reported to be the most commonly encountered orofacial infections, which may spread into the adjacent anatomical spaces along the contiguous fascial planes, leading to involvement of multiple spaces which can progress to life-threatening situations [22]. Odontogenic MIs, which are the second most prevalent oral disease worldwide secondary to periodontal diseases, such as gingivitis, and periodontitis, dental caries, and endodontic infections, are associated with local (tooth loss) or systemic implications [23]. The results of this study indicated that infection following extraction of third molars occurred in some of the patients. This predominance of molars as the causal teeth in MI might be due to the deficient oral hygiene as well as the technical difficulty of restorative treatments in these locations [20].

Although, in this study, more than 73% of the patients did not have any systemic disease, diabetes mellitus was the most commonly found systemic disease among the patients with MI. Alcohol consumption and intravenous drug addiction have been reported as the most common risk factors of MIs in USA. Since self-report of drug addiction and alcoholism is not reliable, we did not collect the drug and alcohol abuse-related. In this study, 10.2 % of the MIs patients were pregnant. Pregnancy is accompanied by various physiological changes which place the mother at a

higher risk of infections. Reduction of neutrophil chemotaxis, activity of natural killer cells, inflammatory macrophages and cell-mediated immunity have been found to be present during pregnancy [24]. The hormonal changes in pregnancy may manifest orally by changes in periodontal tissue [25]. The obtained serological data showed that hypoalbuminemia was not a common incidence among patients with MIs, however, it is interesting to note that the lowest serum albumin level (2.9mg/dl) belonged to the patients with the most severe infection and involvement of 11 facial spaces, including retropharyngeal space, carotid sheath and mediastinum. Moreover, the results of this study indicated that serum albumin level was significantly lower in pregnant patients and those with severe infection. Serum albumin level decreases during inflammatory processes and infection due to depression of hepatic synthesis of negative acute phase proteins, such as albumin [26]. Decrease in the level of serum albumin also occurs during pregnancy [27].

The results of this study indicated a positive relationship between CRP levels and gender (male), severity of infection and advanced age. CRP is a positive acute-phase protein which is present in a few healthy people. The serum level of CRP remarkably rises in response to severe infections or inflammatory processes [28]. It has been demonstrated that CRP can be an effective marker for determining the severity of an infection as well as the efficacy of a treatment in patients with fascial space infections of odontogenic origin [26]. Ren and Malmstrom (2007) have reported that the half-life of CRP in the circulation is not significantly influenced by sex or age [29]. The results of the present study showed that CRP concentrations are significantly different in various ages. However, it has been recently demonstrated that age does not induce any significant difference in CRP concentration [28]. The results of this study showed that ESR was significantly higher in pregnant patients. The increase in ESR level during pregnancy is due to the pregnancy-related increase in plasma fibrinogen level and hemodilution [30].

In this study, the most common treatment performed for MIs patients was antibiotic therapy combined with incision, drainage and tooth extraction in 67 cases (42.7%) followed by combination of antibiotic therapy and I&D in 54 cases (34.4%). Clindamycin was administered to the majority of the hospitalized MI patients (60.5%). Treatment of oro-facial infection is controversial. Amoxicillin and penicillin alone or in combination with other antibiotics have been the most

commonly applied treatment of odontogenic space infections by other researchers [22]. However, Bhagania et al (2018) have demonstrated that clindamycin alone and the combination of penicillin and metronidazole are both effective antibiotic regimens for treatment of infections of odontogenic origins [31].

## Conclusion

The results of this study indicated that odontogenic origins were the main cause of MIs. The most frequent number of involved spaces was three spaces. Multiple space infections were more common than infections involving one space, moreover, the most common involved space was the buccal space. Diabetes mellitus was the most commonly found systemic disease among the participants of this study. The participants at their second and third decade of life were at higher risk of MIs. A positive relationship was found between CRP and ESR levels and the severity of infections. Serum albumin and ESR levels were significantly reduced and increased in the patients with severe infection and pregnant patients, respectively. The findings of this study suggest that dentists should consider that the most appropriate treatment of odontogenic infections involves surgical intervention and selection of a suitable antibiotic as an adjunct.

## Conflict of Interest

There is no conflict of interest to declare.

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