



## UNIVERSITÀ DEGLI STUDI DI TORINO

This Accepted Author Manuscript (AAM) is copyrighted and published by Elsevier. It is posted here by agreement between Elsevier and the University of Turin. Changes resulting from the publishing process - such as editing, corrections, structural formatting, and other quality control mechanisms - may not be reflected in this version of the text. The definitive version of the text was subsequently published in *ORAL SURGERY, ORAL MEDICINE, ORAL PATHOLOGY AND ORAL RADIOLOGY*, 113, 2012, 10.1016/j.tripleo.2011.02.006.

You may download, copy and otherwise use the AAM for non-commercial purposes provided that your license is limited by the following restrictions:

- (1) You may use this AAM for non-commercial purposes only under the terms of the CC-BY-NC-ND license.
- (2) The integrity of the work and identification of the author, copyright owner, and publisher must be preserved in any copy.
- (3) You must attribute this AAM in the following format: Creative Commons BY-NC-ND license (<http://creativecommons.org/licenses/by-nc-nd/4.0/deed.en>), 10.1016/j.tripleo.2011.02.006

The definitive version is available at:

<http://linkinghub.elsevier.com/retrieve/pii/S1079210411000795>

## **Management of 112 Hospitalized Patients with Spreading Odontogenic Infections: Correlation with DMFT and Oral Health Impact Profile 14 Indexes**

Boffano, Paolo, Roccia, Fabio, Pittoni, Dario, Di Dio, Davide, Forni, Paolo, Gallesio, Cesare

Address correspondence and reprint requests to Dr. Paolo Boffano, Corso Dogliotti 14, 10126, Turin, Italy

### **OBJECTIVE**

The aim of this study was to report our experience in treating patients affected by spreading odontogenic infections and to discuss their management and outcome.

### **STUDY DESIGN**

Demographic and clinical information was collected from hospitalized patient records. Decayed, missing, and filled teeth (DMFT) index was calculated for 45 randomly selected patients. Statistical analysis was used to search for associations among multiple variables.

### **RESULTS**

Statistical analysis of the variance by univariate test found significant associations between a longer hospital stay and patients >30 years old ( $P < .05$ ) and patients with the presenting symptoms of dysphagia and/or dyspnea ( $P < .05$ ). Statistical analysis using Fisher exact test found significant associations between patients with a DMFT index >10 and female patients ( $P < .05$ ), patients >30 years old ( $P < .005$ ), and a hospital stay >4 days ( $P < .0005$ ).

### **CONCLUSIONS**

Rapid resolution of the infection was appreciated when removal of the cause, drainage of the infection, and intravenous antibiotics were performed.

Dentoalveolar infections are usually self-limiting and localized, but they may occasionally become destructive polymicrobial infections that spread rapidly through the fascial spaces or deep planes of the neck into the mediastinum, pleural cavities, and pericardium.<sup>1, 2, 3, 4, 5, 6 and 7</sup> Following unsuccessful or late treatment, spreading odontogenic infections (SOIs) may lead to serious complications, such as descending necrotizing mediastinitis, necrotizing fasciitis, septic shock, multiorgan failure, and death.<sup>1, 2, 3, 4, 5, 8, 9, 10 and 11</sup> SOIs can therefore be considered to be a major public health concern.

The assessment and management of patients affected by this condition can be challenging for oral and maxillofacial surgeons. Furthermore, there is no consensus about the gold standard treatment, as evidenced by the wide variety of proposed antibiotic protocols.<sup>12 and 13</sup>

The aim of the present study was to report our experience in treating patients affected by SOIs, to analyze their demographic and clinical aspects, to investigate possible correlations with the decayed, missing, and filled teeth (DMFT) and Oral Health Impact Profile (OHIP) 14 indexes, and to present and discuss their management and outcome.

### **MATERIAL AND METHODS**

Between January 2003 and June 2010, 112 patients were admitted and hospitalized for SOIs at the Division of Maxillofacial Surgery, Head and Neck Department, University of Turin, Italy.

The criteria for hospital admission were swelling of the face or neck suggesting abscess or cellulitis, dysphagia, dyspnea, and/or trismus (maximum interincisal opening <10 mm). The following information was collected from patient records: age, gender, medical history, etiology of the infection (causative teeth), symptoms, adopted therapeutics (antibiotic therapy, drainage, tooth extractions, endodontic treatment), and length of stay. Causative teeth were classified as follows: mandibular third molars, other mandibular posterior teeth, maxillary third molars, other maxillary posterior teeth, maxillary anterior teeth, mandibular anterior teeth, and postoperative infection (third molar exodontia).<sup>14 and 15</sup>

The OHIP-14 questionnaire was administered to 45 randomly selected patients from this sample, and dental status and panoramic radiographs were analyzed to calculate DMFT indexes.<sup>16 and 17</sup>

Statistical analyses were used to compare the demographic aspects of the selected patients with those of the admitted population. We also examined associations among multiple variables, including age, gender, comorbidity, mandibular or maxillary location of causative teeth, presenting symptoms, and DMFT index. Statistical significance was assessed using the  $\chi^2$  test or Fisher exact test when the sample size was small.

## RESULTS

Of the 112 patients affected by SOIs, 57 were male and 55 female. Ages ranged from 13 to 82 years (mean 38.45, median 35, SD 16.6). SOIs occurred most commonly in patients aged 10-20 years (n = 31; 27.68%), followed by patients aged 20-30 years (n = 28; 25%; Fig. 1).

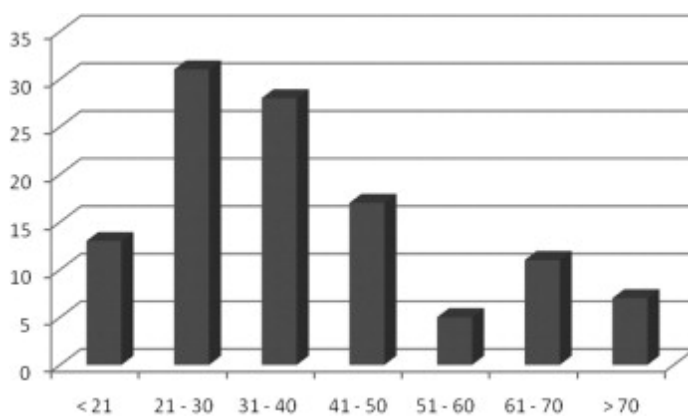


Fig. 1.

Patients' age distribution (years).

Fourteen patients (12.5%) reported comorbidities: 8 were allergic to penicillin, 2 had insulin-dependent diabetes, 2 were HIV-seropositive consumers of illicit drugs, 1 patient was hepatitis B virus positive, and 1 patient suffered from major depressive disorder.

The mandibular posterior teeth (premolars, first and second molars) were most frequently involved, followed by the mandibular third molars. Thirty-six patients showed multiple tooth involvement (Table I). The mean number of involved teeth per patient was  $1.54 \pm 0.85$  (range 1-4). Postoperative infection after surgical removal of third molars was responsible for SOI in 10 cases.

Table I.

Involved teeth in spreading odontogenic infections in our study population

<i>Involvedteeth</i>	<b>n</b>
Mandibularthirdmolars	33
Othermandibularposterioriorteeth	92
Maxillarythirdmolars	6
Othermaxillaryposterioriorteeth	20
Maxillaryanterioriorteeth	6
Mandibularanterioriorteeth	6
Postoperative infection (third molars exodontia)	10

On admission, all patients demonstrated clinical swelling of the face or neck and pain. Patients presented with trismus alone (68/112, 60.7%), dysphagia alone (11/112, 9.8%), trismus and dysphagia (31/112, 27.7%), or trismus, dysphagia, and dyspnea (2/112, 1.8%; Fig. 2).

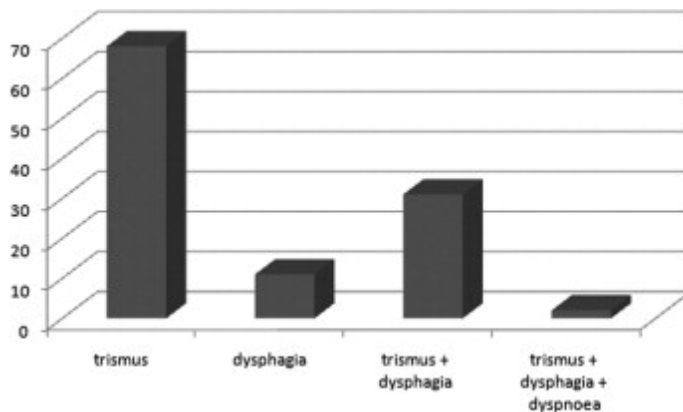


Fig. 2.

Patients' symptoms distribution.

Preoperative imaging methods included panoramic radiographs, as well as preoperative computerized tomography scans in selected cases, such as in the absence of considerably improved clinical condition 4 days after tooth extraction and/or drainage or when dyspnea or dysphagia were present.

Before hospital admission, all patients had received oral or intramuscular antibiotics that had proven inadequate in preventing progression of the odontogenic infection. All patients were started on intravenous antimicrobial therapy immediately on presentation. The majority of patients (53.6%) received amoxicillin plus clavulanic acid (2.2 g/8 h for 48 h, then 2.2 g/12 h), and the others (39.3%) received ceftriaxone (2 g/12 h for 48 h, then 1 g/12 h). For patients with a known allergy to penicillin, a combination of metronidazole (500 mg/8 h for 48 h, then 500 mg/12 h) and ciprofloxacin (400 mg/12 h) was prescribed. Consistent with Sato et al.<sup>3</sup> and Wang et al.,<sup>2</sup> culture and sensitivity tests are not routinely performed in our institution unless the patient failed to respond effectively to antibiotic therapy. To relieve symptoms, such as dysphagia and dyspnea, intravenous steroids (methylprednisolone 125 mg/12 h for 48 h) were used for patients showing trismus and local edema.

Except for the 10 patients with SOIs due to postoperative infection after surgical removal of third molars, causal teeth were extracted or endodontically treated. Endodontic therapy was performed in

6 patients with limited periapical lesions. In all other patients, the involved teeth were removed and drainage attempted through the alveolus. When that strategy was not successful, skin incision and drainage were performed.

The mean hospital stay was  $5.2 \pm 3$  days (median 5, range 1-58; Fig. 3). After discharge, patients who had received intravenous antibiotic treatment for <14 days during hospitalization completed a  $\geq 2$ -week course of oral antibiotic therapy.

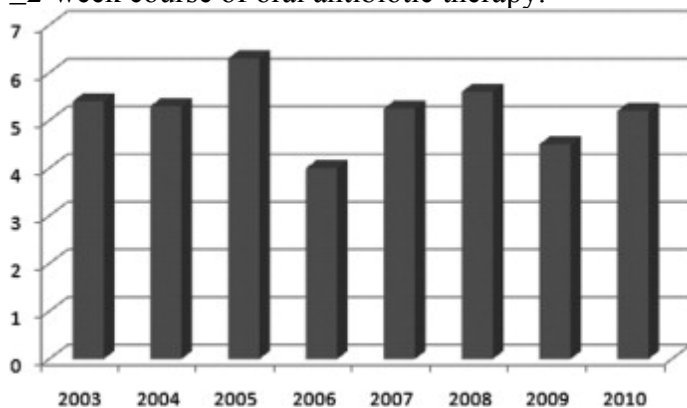


Fig. 3.

Mean hospital stays (days) of patients.

Two patients developed descending necrotizing mediastinitis due to late presentation: one patient was successfully treated and discharged, and the other died. Except for these cases, postoperative courses were uneventful, and the infection did not recur in any patient.

Statistical analysis using the  $\chi^2$  test or Fisher exact test found significant associations between patients >30 years old and hospital stays >4 days (relative risk [RR] 3.2, 95% confidence interval [CI] 1.32-7.48;  $P < .05$ ), and between patients affected by comorbidities and longer hospital stays (RR 7.067, 95% CI 1.43-67.28;  $P < .05$ ). No significant association was found between hospital stays >4 days and gender, mandibular or maxillary location of causative teeth, or presenting symptoms. Univariate analysis of variance (Table II) showed that age and presenting symptoms were significantly associated with specific lengths of hospital stay (in days), rather than being uniformly clustered. Patients >30 years old and/or with the presenting symptoms of dysphagia and/or dyspnea were more likely to have longer hospital stays.

Table II.

Analysis of variance with “hospital stay” as a dependent variable

Source	Type III sum of squares	Degree of freedom	Meansquare Fisher	Significance (P)
Location	1.364	1	1.364	0.153 .696
Presentingsymptoms	42.932	1	42.932	4.820 .030
Comorbidities	2.322	1	2.322	0.261 .611
Gender	5.701	1	5.701	0.640 .425
Age	63.997	1	63.997	7.185 .009

The 45 randomly selected patients (25 female, 20 male) had a mean age of  $36.76 \pm 13.73$  years (range 15-76) and a mean hospital stay of  $4.89 \pm 1.48$  days (range 3-8). The average DMFT index was  $12.3 \pm 6.36$  (range 2-32). Statistical analysis using the  $\chi^2$  test or Fisher exact test found significant associations between patients with a DMFT index >10 and the following variables: female patients (RR 4.18, 95% CI 1.03-17.39;  $P < .05$ ), those >30 years old (RR 8.53, 95% CI 1.81-44.9;  $P < .005$ ), and those with hospital stays >4 days (RR 13.46, 95% CI 2.74-73.22;  $P < .0005$ ).

Figure 4 and Table III summarize the distribution of answers to each OHIP-14 item in the group of 45 patients. The highest mean values were found for items related to physical pain (OH 3 and 4), psychological discomfort (OH 5 and 6), psychologic disability (OH 9 and 10), and social disability (OH 11 and 12). Fewer patients referred to problems such as functional limitation, physical disability, or handicap.

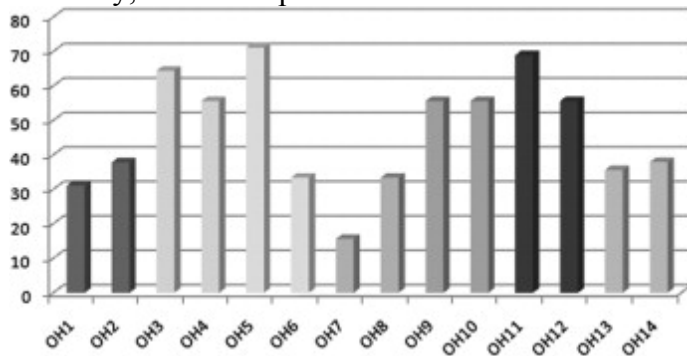


Fig. 4.

Percentages of patients answering occasionally, fairly often, or very often for each Oral Health Impact Profile 14 item.

Table III.

Distributions of responses to Oral Health Impact Profile 14 scale items (%)

Item	How often in the last year ...	Never (0)	Hardly ever (1)	Occasionally (2)	Fairly often (3)	Very often (4)	Mean score
Functional limitations							
OH1	Have you had trouble pronouncing any words because of problems with your teeth, mouth, or dentures?	48.9%	20%	6.7%	20%	4.4%	1.11
OH2	Have you felt that your sense of taste has worsened because of problems with your teeth, mouth, or dentures?	42.2%	20%	11.1%	20%	6.7%	1.29
Physical pain							
OH3	Have you	15.6	20%	42.2%	13.3%	8.9%	1.8

Item	How often in the last year ...	Never (0)	Hardly ever (1)	Occasionally (2)	Fairly often (3)	Very often (4)	Mean score
OH4	had painful aching in your mouth?	22.2%	22.2%	20%	20%	15.6%	1.84
	Have you found it uncomfortable to eat any foods because of problems with your teeth, mouth, or dentures?	22.2%	22.2%	20%	20%	15.6%	1.84
Psychologic discomfort							
OH5	Have you felt self-conscious because of problems with your teeth, mouth, or dentures?	15.6%	13.3%	20%	42.2%	8.9%	2.15
OH6	Have you felt tense because of problems with your teeth, mouth, or dentures?	33.3%	33.3%	0	13.4%	20%	1.53
Physical disability							
OH7	Has your diet been unsatisfactorily because of problems with your teeth, mouth, or dentures?	42.2%	42.2%	0	15.6%	0	0.89
OH8	Have you had to interrupt meals because of problems with your	33.3%	33.3%	13.4%	20%	0	1.2

Item	How often in the last year ...	Never (0)	Hardly ever (1)	Occasionally (2)	Fairly often (3)	Very often (4)	Mean score
	teeth, mouth, or dentures?						
Psychologic disability							
OH9	Have you found it difficult to relax because of problems with your teeth, mouth, or dentures?	22.2%	22.2%	20%	20%	15.6%	1.84
OH10	Have you been a bit embarrassed because of problems with your teeth, mouth, or dentures?	22.2%	22.2%	20%	20%	15.6%	1.84
Social disability							
OH11	Have you been a bit irritable with other people because of problems with your teeth, mouth, or dentures?	6.7%	24.4%	40%	24.4%	4.5%	1.95
OH12	Have you had difficulty doing your usual jobs because of problems with your teeth, mouth, or dentures?	22.2%	22.2%	20%	20%	15.6%	1.84
Handicap							
OH13	Have you felt that life in general was less	40%	24.4%	6.7%	24.4%	4.5%	1.29



Item	How often in the last year ...	Never (0)	Hardly ever (1)	Occasionally (2)	Fairly often (3)	Very often (4)	Mean score
OH14	satisfying because of problems with your teeth, mouth, or dentures? Have you been totally unable to function because of problems with your teeth, mouth, or dentures?	26.7%	35.4%	6.7%	15.6%	15.6%	1.58

## DISCUSSION

Dental practitioners and oral and maxillofacial surgeons frequently encounter odontogenic infections in everyday practice. Most SOIs affect patients between the ages of 31 and 45 years<sup>20, 21, 22 and 23</sup> (21-40 years in the present study population; Fig. 1). Untreated or misdiagnosed odontogenic infections may spread rapidly and are potentially life-threatening, due to serious complications, such as descending necrotizing mediastinitis, necrotizing fasciitis, septic shock, and multiorgan failure. SOIs thus require immediate and accurate treatment.<sup>2, 3, 4, 5, 8, 9, 10, 11, 18 and 19</sup>

SOIs are initially due to the chronic inflammatory reaction of necrotic dental pulp or periradicular tissues and subsequent development of periradicular diseases, such as abscesses and periradicular bone cysts.<sup>1</sup> Pericoronitis is another major cause of orofacial odontogenic infections.<sup>24</sup> Disequilibrium between host immune responses and microorganism-related factors may cause an acute and severe disseminating infection, with the involvement of potential spaces created by fascial insertion.<sup>1</sup> SOIs usually spread from structures supporting the affected tooth to the nearest fascial spaces.<sup>20</sup>

Published reports show that mandibular molars are the most frequently involved teeth in odontogenic infections.<sup>6, 14, 15, 20 and 25</sup> This frequency is due primarily to the wider masticatory surface area susceptible to caries, the greater risk of impaction, and the reduced accessibility to hygiene.<sup>6</sup> Furthermore, the root apices of the mandibular second and third molars extend below the mylohyoid muscle, thereby allowing an infection to spread to submandibular and submental spaces.<sup>3, 4, 19, 25 and 26</sup> Our findings confirm the results of these earlier studies; mandibular posterior teeth and third molars were the most frequently involved teeth, and the submandibular space was the most frequently involved region in the present sample.

Clinical manifestations associated with SOIs, such as neck rigidity, trismus, dysphagia, respiratory distress, and sialorrhea, are often determined by the involvement of the submandibular space. Moreover, inflammation may spread from this space to the parapharyngeal space, potentially causing rapid and critical airway obstruction.<sup>26</sup> Significant reactive facial swelling is often present in patients affected by SOIs; trismus, dysphagia, and dyspnea are other common presenting signs and symptoms that should be considered highly suggestive of this condition (Fig. 2).<sup>14, 15 and 26</sup>

Panoramic radiographs and clinical examination are essential to identify the causative teeth; contrast-enhanced computerized tomography reveals the extent of infections and/or the presence of airway involvement.<sup>14 and 15</sup> Early diagnosis, control of the airway, and prompt surgical management

are essential in the management of odontogenic abscess.<sup>27</sup> Treatment of SOIs follows a universally recognized protocol that includes the removal of the cause, abscess drainage, and antibiotic therapy. In particular, the timely extraction of involved teeth is mandatory when pericoronitis, extended periodontal lesions, and/or destructive caries are found. Such endodontic therapy should be restricted for limited periapical lesions, as reported in the present study. The surgical drainage of any pus is fundamental. We attempted drainage through the alveolus in all patients and performed skin incision and drainage when necessary.

Intravenous steroids were used for 48-72 hours in patients showing trismus and pronounced local edema, to relieve symptoms such as dysphagia and dyspnea. Because the long-term administration of steroids may be immunosuppressive, we limited intravenous steroid use to a limited period of time and to cases exhibiting dysphagia and dyspnea. The antiinflammatory effect of steroids resolved edema and cellulitis, provided chemical decompression, protected the airways, and facilitated antibiotic penetration into the area.<sup>5, 28, 29 and 30</sup>

Initial antimicrobial therapy for odontogenic abscesses is primarily empiric, not only because of the time required for definitive microbiological results, but also because of the well known composition of the typical underlying flora.<sup>24</sup> Odontogenic infections are typically polymicrobial, with a mixed bacterial flora in which anaerobes outnumber aerobes.<sup>20</sup> Owing to bacterial synergism, polymicrobial infections are more pathogenic than monoinfections.<sup>24</sup> Viridans-group streptococci and staphylococci are the most frequently isolated aerobic bacteria.<sup>18 and 20</sup> Streptococci may be particularly important in the early phases of abscess formation, because they can provide a reduced environment for the subsequent invasion of anaerobic bacteria, represented primarily by gram-positive anaerobic cocci, *Prevotella* and *Porphyromonas* spp., *Fusobacteriumnucleatum*, and the *Streptococcus milleri* group.<sup>24</sup>

Stefanopoulos and Kolokotronis<sup>24</sup> listed 3 important virulence factors for anaerobic bacteria: the ability to survive the oxygen tension of living tissues, the production of substances associated with tissue damage, and the presence of cell-surface constituents, such as capsular polysaccharides, or, in gram-negative organisms, lipopolysaccharide endotoxins.

Penicillin remains the empiric antibiotic of choice for SOIs owing to its effectiveness, low cost, patient tolerability, minimal side effects, and ready availability.<sup>19 and 24</sup> Moreover, it has broad antimicrobial action against aerobic and anaerobic microorganisms.<sup>3</sup> However, antibiotic resistance is an important issue in the management of orofacial odontogenic infections.  $\beta$ -Lactamase activity among gram-negative anaerobic rods may be responsible for clinical failures with penicillin treatment.<sup>24</sup> The addition of clavulanate (or other  $\beta$ -lactamase inhibitors) to broad-spectrum penicillin regimens has expanded the antimicrobial spectrum. Parenteral expanded-spectrum cephalosporins are also effective against aerobic and anaerobic bacteria. We therefore adopted parenteral amoxicillin/clavulanate or ceftriaxone for the empiric treatment of SOIs in 93% of patients with good results. In the remaining 7%, we used metronidazole and amoxicillin/clavulanate (when no improvement was observed after 4 days of intravenous therapy) or ciprofloxacin and metronidazole (in patients with reported allergies to penicillin). Clindamycin and moxifloxacin have also been proposed for the treatment of SOIs.<sup>24</sup>

Patients typically remain hospitalized until the infection is controlled and regressed, no further airway compromise or dysphagia is present, and the patient presents an oral opening of  $\geq 25$  mm. Thus, as Rao et al.<sup>31</sup> have stated, hospital stay appears to be related to the severity of infection, because patients with more serious infections require more time to show improvement. The present study population had a relatively brief mean hospital stay of 5.2 days. Despite a recent trend toward outpatient management of patients and reduction of hospitalization time, we did not observe such changes in the treatment of patients with SOIs during the study period (Fig. 3).

The risk of infection, severity of SOI, and length of hospitalization depend on several factors, including host factors and the virulence of the infecting microorganism.<sup>31</sup> In the present study, univariate analysis (Table II) showed that age and presenting symptoms were significantly associated with length of hospital stay. Patients  $>30$  years old and/or with presenting symptoms of

dysphagia and/or dyspnea appeared to suffer from more severe SOIs and to need longer periods of hospitalization.

The globally recognized DMFT index allows the assessment of oral status through the quantification of decayed, missing, and filled teeth. The mean DMFT index for the 45 randomly selected patients in the present study was 12.3 (range 2-32). Significant associations were found between higher DMFT index and female patients, older patients, and longer hospital stays.

The OHIP-14 is a self-administered 14-item questionnaire designed to measure self-reported functional limitation, discomfort, and disability attributed to oral conditions. It is derived from an original extended version containing 49 items. It focuses on 7 dimensions of impact (functional limitation, physical pain, psychologic discomfort, physical disability, psychologic disability, social disability, and handicap). For each of the OHIP-14 questions, subjects were asked how frequently they had experienced an impact in the preceding 12 months. They responded using a Likert-type scale in which 0 = never; 1 = hardly ever; 2 = occasionally; 3 = fairly often; and 4 = very often. This test has been shown to be reliable, to be sensitive to changes, and to have adequate cross-cultural consistency.<sup>16 and 17</sup>

Figure 4 and Table II summarize the distribution of answers to each OHIP-14 item for the selected group of 45 patients. The highest mean values, representing the greatest complaints, were found for items related to physical pain (OH 3 and 4), psychological discomfort (OH 5 and 6), psychologic disability (OH 9 and 10), and social disability (OH 11 and 12). Fewer patients reported problems with functional limitation, physical disability, or handicap; this could explain the delay in patients' presentation to a dental practitioner or hospital until trismus and eating difficulties appeared. Many patients reported that they had experienced pain for several months but had controlled it with analgesics. They decided to present at the hospital only when considerable swelling, trismus, or dysphagia appeared.

## CONCLUSIONS

We achieved rapid resolution of SOIs and dramatic improvement of clinical conditions when we removed the cause, drained the infection, and administered antibiotics intravenously. The prompt removal of involved teeth is mandatory; endodontic therapy should be reserved to limited periapical lesions. The empiric use of amoxicillin/clavulanate and ceftriaxone was effective for odontogenic infections and produced no noteworthy side effects. However, we believe that the drainage of abscesses is of great importance in achieving rapid success. According to our experience, complications are uncommon when SOIs are adequately and promptly treated.

## REFERENCES

1. M.P. Riggio, H. Aga, C.A. Murray, M.S. Jackson, A. Lennon, N. Hammersley, *et al.*  
Identification of bacteria associated with spreading odontogenic infections by 16S rRNA gene sequencing  
*Oral Surg Oral Med Oral Pathol Oral Radiol Endod*, 103 (2007), pp. 610–617
2. J. Wang, A. Ahani, M.A. Pogrel  
A five-year retrospective study of odontogenic maxillofacial infections in a large urban public hospital  
*Int J Oral Maxillofac Surg*, 34 (2005), pp. 646–649
3. F.R. Sato, F.A. Hajala, F.W. Freire-Filho, R.W. Moreira, M. de Moraes  
Eight-year retrospective study of odontogenic origin infections in a postgraduation program on oral and maxillofacial surgery  
*J Oral Maxillofac Surg*, 67 (2009), pp. 1092–1097
4. M. Bassiony, J. Yang, T.M. Abdel-Monem, S. Elmogy, M. Elnagdy  
Exploration of ultrasonography in assessment of fascial space spread of odontogenic infections  
*Oral Surg Oral Med Oral Pathol Oral Radiol Endod*, 107 (2009), pp. 861–869
5. F. Roccia, G.C. Pecorari, A. Oliaro, E. Passet, P. Rossi, J. Nadalin, *et al.*  
Ten years of descending necrotizing mediastinitis: Management of 23 cases  
*J Oral Maxillofac Surg*, 65 (2007), pp. 1716–1724
6. B.O. Akinbami, O. Akadiri, D.C. Gbujie  
Spread of odontogenic infections in Port Harcourt, Nigeria  
*J Oral Maxillofac Surg*, 68 (2010), pp. 2472–2477
7. P.H. Warnke, S.T. Becker, I.N. Springer, F. Haerle, U. Ullmann, P.A. Russo, *et al.*  
Penicillin compared with other advanced broad spectrum antibiotics regarding antibacterial activity against oral pathogens isolated from odontogenic abscesses  
*J Craniomaxillofac Surg*, 36 (2008), pp. 462–467
8. L.M. Sancho, H. Minamoto, A. Fernandez, L.U. Sennes, F.B. Jatene  
Descending necrotizing mediastinitis: a retrospective surgical experience  
*Eur J Cardiothorac Surg*, 16 (1999), pp. 200–205
9. M. Makeieff, N. Gresillon, J.P. Berthet, R. Garrel, L. Crampette, C. Marty-Ane, *et al.*  
Management of descending necrotizing mediastinitis  
*Laryngoscope*, 114 (2004), pp. 772–775
10. S. Novellas, K. Kechabtia, P. Chevallier, J. Sedat, J.N. Bruneton  
Descending necrotizing mediastinitis: A rare pathology to keep in mind  
*Clin Imaging*, 29 (2005), pp. 138–140
11. P. Mihos, K. Potaris, I. Gakidis, D. Papadakis, G. Rallis  
Management of descending necrotizing mediastinitis  
*J Oral Maxillofac Surg*, 62 (2004), pp. 966–972
12. T. Kuriyama, E.G. Absi, D.W. Williams, M.A. Lewis  
An outcome audit of the treatment of acute dentoalveolar infection: impact of penicillin resistance  
*Br Dent J*, 25 (2005), pp. 759–763
13. D. Robertson, A.J. Smith  
The microbiology of the acute dental abscess  
*J Med Microbiol*, 58 (2009), pp. 155–162

14. T.R. Flynn, R.M. Shanti, M.H. Levi, A.K. Adamo, R.A. Kraut, N. Trieger  
Severe odontogenic infections, part 1: prospective report  
*J Oral Maxillofac Surg*, 64 (2006), pp. 1093–1103
15. T.R. Flynn, R.M. Shanti, C. Hayes  
Severe odontogenic infections, part 2: prospective outcomes study  
*J Oral Maxillofac Surg*, 64 (2006), pp. 1104–1113
16. D.S. Brennan, K.A. Singh, A.J. Spencer, K.F. Roberts-Thomson  
Positive and negative affect and oral health-related quality of life  
*Health Qual Life Outcomes*, 4 (2006), p. 83
17. J. Montero-Martín, M. Bravo-Pérez, A. Albaladejo-Martínez, L.A. Hernández-Martín, E.M. Rosel-Gallardo  
Validation of the Oral Health Impact Profile (OHIP-14sp) for adults in Spain  
*Med Oral Patol Oral Cir Bucal*, 14 (2009), pp. E44–E50
18. P.W. Poeschl, L. Spusta, G. Russmueller, R. Seemann, A. Hirschl, E. Poeschl, *et al.*  
Antibiotic susceptibility and resistance of the odontogenic microbiological spectrum and its clinical impact on severe deep space head and neck infections  
*Oral Surg Oral Med Oral Pathol Oral Radiol Endod*, 110 (2010), pp. 151–156
19. A.J. Rega, S.R. Aziz, V.B. Ziccardi  
Microbiology and antibiotic sensitivities of head and neck space infections of odontogenic origin  
*J Oral Maxillofac Surg*, 64 (2006), pp. 1377–1380
20. W. Storoe, R.H. Haug, T.T. Lillich  
The changing face of odontogenic infections  
*J Oral Maxillofac Surg*, 59 (2001), pp. 739–748
21. D.W. Kannangara, H. Thadepalli, J.L. McQuirter  
Bacteriology and treatment of dental infections  
*Oral Surg Oral Med Oral Pathol Oral Radiol Endod*, 50 (1980), pp. 103–109
22. D.S. Sethi, R.E. Stanley  
Deep neck abscess—changing trends  
*J Laryngol Otol*, 108 (1994), pp. 138–143
23. M. Sakaguchi, S. Sato, T. Ishigama, S. Katsuno, K. Taguchi  
Characterization and management of deep neck infections  
*Int J Oral Maxillofac Surg*, 26 (1997), pp. 131–134
24. P.K. Stefanopoulos, A.E. Kolokotronis  
The clinical significance of anaerobic bacteria in acute orofacial odontogenic infections  
*Oral Surg Oral Med Oral Pathol Oral Radiol Endod*, 98 (2004), pp. 398–408
25. O.O. Daramola, C.E. Flanagan, R.H. Maisel, R.M. Odland  
Diagnosis and treatment of deep neck space abscesses  
*Otolaryngol Head Neck Surg*, 141 (2009), pp. 123–130
26. Y. Arijji, M. Gotoh, M. Kimura, M. Naitoh, K. Kurita, N. Natsume, *et al.*  
Odontogenic infection pathway to the submandibular space: imaging assessment  
*Int J Oral Maxillofac Surg*, 31 (2002), pp. 165–169
27. A.K. Agarwal, A. Sethi, D. Sethi, S. Mrig, S. Chopra  
Role of socioeconomic factors in deep neck abscess: a prospective study of 120 patients

Br J Oral Maxillofac Surg, 45 (2007), pp. 553–555

28. R.F. Busch, D. Shah  
Ludwig's angina: improved treatment  
Otolaryngol Head Neck Surg, 117 (1997), pp. S172–S175

29. R.F. Busch  
Ludwig's angina: early aggressive therapy  
Arch Otolaryngol Head Neck Surg, 125 (1999), pp. 1283–1284

30. S. Srirompotong, T. Art-Smart  
Ludwig's angina: a clinical review  
Eur Arch Otorhinolaryngol, 260 (2003), pp. 401–403

31. D.D. Rao, A. Desai, R.D. Kulkarni, K. Gopalkrishnan, C.B. Rao  
Comparison of maxillofacial space infection in diabetic and nondiabetic patients  
Oral Surg Oral Med Oral Pathol Oral Radiol Endod, 110 (2010), pp. e7–e12