SELECTED READINGS IN ORAL AND MAXILLOFACIAL SURGERY

MAXILLOFACIAL INFECTIONS

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INTRODUCTION

Oral and maxillofacial infections are among the most common surgical problems faced by oral and maxillofacial surgeons in the United States. Although severe maxillofacial infections requiring inpatient hospitalization are rare,(1) the mortality rate of patients admitted with maxillofacial infections is estimated to be one in 150.(2)

Proper management of odontogenic infections has important economic implications as well. One study demonstrated that the average hospital bill for a patient admitted with an odontogenic infection was over $17,000, with length of stay, time spent in intensive care, and repeated trips to the operating room accounting for 90% of variation in the hospital bill.(3)

In all phases of treating a maxillofacial infection, from diagnosis to perioperative medical evaluation and surgical intervention, experience and timely intervention is critical to achieving a favorable outcome. An adequate understanding of the etiology, diagnosis, microbiology, and management of these conditions is, therefore, critical for the oral and maxillofacial surgeon.

ETIOLOGY AND PATHOGENESIS

Maxillofacial infections are most commonly caused by odontogenic sources.(4) A retrospective review of hospital admissions for maxillofacial infections by one oral and maxillofacial surgery graduate program showed that 79% were for infections of odontogenic origin. Other sources identified in the study included traumatic cases (10.7%), immunosuppression (1.6%), and pathology (1.6%), while other causes were responsible for the remaining 8% of cases.(5) Byers, et al's multicenter study found a dental origin in 86% of maxillofacial infections presenting to Scottish hospitals.(6)

By definition, odontogenic infections of the head and neck begin in the teeth through a variety of disease processes. Caries is the most common of these dental diseases, followed by periodontal disease and pericoronitis.(7) Lower teeth are much more commonly the source of severe odontogenic infections, with the mandibular third molar as the origin in a majority of cases. This is followed by other mandibular posterior teeth, while maxillary posterior teeth contribute much less frequently to these infections.(7)

Maxillofacial infections have significantly different distribution among children. They are more likely to occur in the upper face than the lower face, and these upper face infections are caused by odontogenic, traumatic, and other unknown sources at very similar rates. In contrast, lower face infections, which occur with less frequency, are much more commonly due to odontogenic sources.(8)

PATIENT DEMOGRAPHICS

Infections of the maxillofacial region are more likely to occur in certain patient populations. Males, both adult and children, are more likely to present emergently with odontogenic and other maxillofacial infections, although there is significant variation in the degree of male predominance.(5,8-12) The mean age of patients presenting with acute maxillofacial infections ranges from 25-38 years in various studies.(6,9-12)

Patients with systemic diseases are more likely to present emergently with significant head and neck infections. Huang, et al. found that 34.1% of such patients suffer from significant medical comorbidities, with 88.9% of those patients having diabetes mellitus.(13) Although the association between maxillofacial and systemic disease is undisputed, there is a lack of data demonstrating a causal relationship.(14)

Socioeconomic status, patient attitudes, and other psychosocial factors correlate with the patients presenting with maxillofacial infections. A survey of Australian patients showed that only 16% regularly visited the dentist, and the majority had unfavorable impressions of oral healthcare, reporting not only difficulty paying for dental treatment, but also phobias and fears of going to the dentist.(15) Additionally, this study found that 34% struggled with either mental illness or substance abuse, which was thought to explain, in part, the poor oral health of those presenting with odontogenic infections. (15) Specifically, an association between drug and alcohol abuse and the development of severe deep space odontogenic infections has been demonstrated.(16)

The findings in the Australian study(15) were consistent with other reviews showing that the uninsured and underinsured, as well as other patients of limited means, compose a very high proportion of patients seeking emergency treatment for maxillofacial infections.(17) In one review of patients hospitalized with odontogenic infections, nearly 62% were unfunded.(3) Of Scottish patients presenting to hospitals with maxillofacial infections, 54% were from the lowest two socioeconomic quintiles, 36% from the lowest quintile alone.(6)

Routine dental care may be instrumental in preventing severe odontogenic infection. British oral and maxillofacial surgeons noted a significant increase in emergency room visits, admissions, and surgeries for maxillofacial infections after the National Health Service changed their reimbursement system, eliminating fees per tooth extracted, and implemented a single fee for the more expensive treatment.(18,19) By decreasing access to needed dental extractions, more severe manifestations of odontogenic infections are likely to occur.

CLINICAL PRESENTATION AND HISTORY

Patients presenting with a significant maxillofacial infection report certain common complaints, particularly when their infection has an odontogenic source. Rapidly-worsening swelling, dysphagia, pain, and trismus are the most common presenting symptoms.(7,17) In fact, Uluibau, et al. found that 44 % of patients had trismus when they presented to the emergency room with an odontogenic infection.(15)

Sato, et al. reviewed records from all maxillofacial infections and found trismus (43%), fever (28%), and dysphagia (25%) were the most common presenting symptoms.(5) Fetid breath and active drainage may also be found, although less often, and 26% of patients present with a draining sinus tract.(6) Among patients in the Byers, et al. audit of Scottish medical centers 16% met the criteria for systematic inflammatory response syndrome (SIRS) on admission.(6) Byers, et al. also found that 34% of patients reported dental treatment within the previous two weeks, while 6% reported recent trauma.(6) Therefore, taking a proper history may help reveal the origin of the infection.

ANATOMICAL SPACES

Flynn, et al. examined the frequency and distribution of spaces involved in severe odontogenic infections.(7) They found the pterygomandibular space most frequently involved (59% of the time), followed by the submandibular space (54%) and then the lateral pharyngeal space (43%), buccal space (41%), and space of the body of the mandible (35%). The average number of spaces involved was 3.3 and ranged from 1-8.(7) Other studies have had similar results although the submandibular space(9) and the buccal mandibular space(5,6) were the most commonly involved.

PREDICTING DISEASE SEVERITY AND PROGRESSION

One of the most important tasks for the oral and maxillofacial surgeon called to evaluate a patient presenting with a maxillofacial infection is to rapidly assess him or her and determine the severity of the infection. This assessment must include an evaluation of the likelihood that the patient will require substantial surgical interventions, more intensive care, or a greater length of hospital stay.

Laboratory Values and Vital Signs

Obtaining a patient's history of symptoms is the first important step in gauging the probability of severe infection. Patients with symptoms for a greater length of time prior to admission are more likely to have a greater number of involved spaces and, subsequently, an increased length of hospital stay (LOS).(20)

Certain admission laboratory values have been shown to be important in assessing a patient with a maxillofacial infection. C-reactive protein (CRP) is perhaps most predictive of the severity of a clinical course (21) and LOS. In fact, every increase in CRP of 100 roughly translates to an additional 24 hours of admission.(22)

WBC count correlates with a difficult clinical course for children(23) and can be predictive of an increased length of hospital stay(10) but may not have the same prognostic value in adults.(24) CRP may be a more accurate predictor of post-operative complications and infection severity than WBC.(25)

Prealbumin, a marker frequently used in nutritional assessment of the inpatient, is frequently low in the patient admitted for an odontogenic infection, and when assessed in conjunction with BUN, accurately predicts length of stay 77% of the time.(26) Temperature may have a bearing on length of stay in adults according to some studies(22,24) while others have found no correlation.(27)

Children are also more likely to progress favorably if they are younger, have a lower admission temperature, and present with upper-face infections that are not of odontogenic origin.(8,23) Overall, children generally require shorter hospital stays than adults.(10) Increasing age is associated with greater LOS.(20)

Surgical Intervention in the Operating Room

Undergoing a surgical intervention in the operating room has been demonstrated in multiple studies to correlate with an increased LOS for the infected patient.(24,27) This association is due in large part to the fact that patients requiring drainage in the OR have more severe infections, with abscesses involving multiple anatomical spaces.(9)

The Role of Pre-existing Systemic Diseases

Patients with medical co-morbidities not only have a greater likelihood of developing maxillofacial infections, but are also susceptible to systemic infection and a longer LOS with a higher chance of mortality.(28) In fact, a pre-existing medical condition is the most significant of all patient factors in prolonging LOS, increasing hospitalization by an average of 1.8 days.(24)

Huang, et al. also found that patients with systemic disease generally have a longer LOS, compared to healthy patients, and also had a higher complication rate (31.7% versus 8.2%) and required tracheostomy more frequently (19% versus 4.9%).(13) In addition, the three deaths in their series were all patients with underlying systemic diseases.

Diabetes mellitus is a common medical condition that predisposes a patient to perioperative complications. A retrospective study demonstrated that admission blood glucose not only accurately correlated with postoperative complications, but higher glucose values were also associated with a longer hospital stays, infections involving more spaces, and surgery requiring more incisions.(29,30) Christensen, et al. similarly found a correlation between hospital LOS and peak blood sugar, but also saw an increased likelihood of ICU admission with higher glucose readings. (31) Han, et al. demonstrated that diabetic patients have a higher WBC and CRP, have a greater complication rate with infections involving more spaces, and are more likely to require tracheostomy.(32) Conversely, dental infections in the diabetic may precipitate complications of the diabetes itself. Chandu, et al. reported two cases of patients with odontogenic infections that caused diabetic ketoacidosis.(33)

HIV-positive patients must also arouse concerns for the treating oral and maxillofacial surgeon. They often present with a lower WBC and temperature than HIV negative patients with odontogenic infections, which could confuse the surgeon. These patients are more likely to require ICU care and remain longer when admitted for intensive care.(34)

Delayed-Onset Infections

A small subset of maxillofacial infections known as “delayed-onset infections” have their own risk factors. These infections can occur approximately one month or longer after an initial elective dental procedure. A Pell and Gregory classification indicating greater depth within the jaw, need for tooth sectioning, and bone or soft tissue impaction are all closely associated with increased risk of developing a delayed-onset infection.(35) Therefore, a patient who underwent a challenging extraction several weeks prior to presentation with an infection without an obvious source should arouse a surgeon's suspicion of a possible delayed-onset infection.

Radiologic Evaluation

Imaging is critical to proper preoperative assessment of the extent and severity of a maxillofacial infection. While maxillofacial infections are frequently clinically apparent, deeper infections may be difficult to assess without imaging. Computed tomography (CT) is often used in the assessment of these patients, and has been shown to accurately predict deep maxillofacial infections. One study demonstrated that in 80.6% of cases, a CT interpreted by an oral and maxillofacial surgeon accurately correlated with operative findings of an abscess.(36) CT scans can also be useful in identifying the course of cutaneous sinus tracts that can develop as a result of these infections.(37)

Ultrasound has also been shown to be a useful modality when an abscess is present. Jones, et al. showed a 92% correlation between ultrasound and intraoperative clinical findings.(38)

Microbiology

Odontogenic infections are caused by a variety of organisms and are typically polymicrobial, which reflects the diversity of bacteria that comprises oral flora. This oral flora grows on the teeth in the form of a biofilm, which is responsible for the initiation of odontogenic disease processes such as dental caries and, subsequently, head and neck infections.(39)

The bacteria isolated from odontogenic infections most commonly include viridans streptococci, peptostreptococci, staphylococci, and *Prevotella*, among others.(7,12,17) Studies have indicated that the bacterial composition of these infections has not changed over time.(40)

Aerobic and anaerobic bacteria are frequently isolated from odontogenic infections.(11) The most common aerobic bacteria isolated by far includes various species of gram positive cocci, while gram positive rods, gram negative rods and gram negative cocci were rarely isolated. Of the gram positive cocci, alpha hemolytic streptococci were the most common (cultured 91 times), followed by *S. epidermidis* (31 times, although the authors assert that this high number reflects sample contamination) unspecified species of *Streptococcus* (21 times), beta hemolytic strepococci(15 times) and finally, *Staphylococcus aureus* (12 times).(11)

The most commonly found anaerobic species were gram negative rods, with bacteroides (196 times) and fusobacterium (54 times) predominating. Gram positive cocci included *Peptococcus* (82 times) and *Peptostreptococcus* (62 times), while gram-negative cocci (*Veilonella*, 19 times) and gram-positive rods (*Eubacterium*, 29 times; *Actinomyce*s,19 times; and *Propionibacterium*, 10 times) were less common.(11)

Bacterial populations likely vary based on the anatomical location with the facial region. Biederman and Dodson demonstrated a greater variety in bacteria found in infections of the upper face than the lower face.(41)

Pericoronitis has been similarly demonstrated to be a largely polymicrobial process, with Streptococcus milleri being the most frequently cultured organism from these infections, present in 78% of cases in one series.(42)

Bacteria produce pathogenicity through several mechanisms including enzymes, metabolites and toxins, capsules that prevent phagocytosis and facilitate abscess formation, tolerance to air, and synergism with other bacteria. Anaerobic bacteria most commonly produce 1) superoxide dismutase, which aids in bacterial aerotolerance, 2) capsular polysaccharides and succinic acid, which have antiphagocytic properties, 3) endotoxins (such as lipopolysaccharides) and hydrogen sulphide to promote cytotoxicity, and 4) proteolytic enzymes that aid in tissue degradation and promote bacterial invasion.(43)

Bacterial composition may influence clinical presentation. For example, authors have sought to explain whether certain bacteria predispose a patient towards abscess formation versus cellulitis. Results indicate that cultures with isolates of peptostreptococci are more likely to manifest as a cellulitis rather than an abscess.(27)

Systemic influence of oral bacteria is an inevitable consequence of oral surgical intervention. Numerous studies have demonstrated that transient bacteremia occurs after dental extractions.(44-47) The incidence of post-extraction bacteremia is high, with rates upwards of 96.2% 30 seconds after extraction, and may detectable up to one hour after extraction.(44) Cultures in these studies grew both aerobic and anaerobic bacteria.(44-47) The pathophysiology of bacteremia in oral and maxillofacial surgery makes the frequent systemic manifestations of maxillofacial infections less surprising.

Antibiotics

Oral and maxillofacial surgeons have utilized numerous antibiotic regimens to treat maxillofacial infections. However, differing treatment philosophies, increases in antibiotic resistance over time, and development and increased use of more broad-spectrum antibiotics have made it difficult to gain consensus on a standard antibiotic treatment course.

Penicillin has been a mainstay treatment for maxillofacial infections since the discovery of its antibiotic properties by Alexander Flemming in 1928, and its subsequent clinical application in 1941. One of the first patients treated with penicillin, a policeman named Albert Alexander, suffered from a facial infection that developed as the result of a scratch from a rose thorn. Although Alexander ultimately died of his infection, his case is cited as an early success for antibiotic treatment, since initially his clinical condition significantly improved once penicillin therapy was initiated, but after the limited supply of the drug was exhausted he deteriorated again.(48)

Today, the clinical effectiveness of penicillin in treating more advanced maxillofacial infections has declined. Flynn, et al. showed a 21% failure rate of penicillin in the treatment of severe odontogenic infections that required hospitalization.(7) Although penicillin has been shown to be equally effective when compared to clindamycin against bacteria with low penicillin resistance, most anaerobic bacteria have a higher rate of resistance to penicillin than to clindamycin.(49)

The potential for development of penicillin resistance during the treatment of a single odontogenic infection should also be considered, although this concept is somewhat controversial. Some evidence suggests that patients treated with penicillin or another beta lactam during the course of an infection that never fully resolves should be switched to a beta lactamase-stable beta lactam. The chances that penicillin-resistant bacteria are present are substantially increased in a failed initial penicillin treatment.(50) However, Flynn, et al. found no correlation between previous antibiotic use and the development of penicillin-resistant bacteria.(27)

Another study examining susceptibility of individual bacterial species showed that the effectiveness of penicillin ranged from 27.3% in treating staphylococci to 87.1% for *Streptococcus viridans*.(12) The author concluded that, overall, penicillin should still be considered the drug of choice in treating odontogenic infections given that empirically *Streptococcus viridans* is isolated much more frequently than staphylococci.

Yuvaraj, et al. reached similar conclusions after they found 81.3% penicillin sensitivity in their isolates from odontogenic abscesses, with the highest rates of resistance in staphylococci strains.(51) Other authors have also concluded that penicillin is still effective against most pathogens found in odontogenic infections.(52) Based on this data, however, it is fair to consider that a failed antibiotic treatment may reflect the presence of penicillin-resistant bacterial species.

In a comprehensive review, Flynn recommended that amoxicillin be used as first-line treatment in the non-allergic patient with an odontogenic infection not requiring hospital admission.(53) For patients with allergies to beta-lactams, clindamycin is the drug of choice.(53) Clindamycin is also a suitable alternative for patients who have previously failed penicillin treatment.(52) A 3-4 day course of antibiotics is generally considered adequate for the otherwise healthy outpatient.(53)

Penicillin failure is more likely with more significant and advanced infections. Flynn, et al. described a “severity score,” for odontogenic infections in which each fascial space involved is assigned a value of 1-3 based on the anatomic location and potential danger to nearby vital structures. The patient is assigned a total score which sums the values of each individual space involved.(7) A greater severity score has been shown to correlate with penicillin failure and increased length of stay.(54) Due to the high rate of penicillin failure in cases of severe odontogenic infection, Flynn recommends that the hospitalized patient should be treated with penicillin combined with a beta-lactamase inhibitor such as ampicillin/sulbactam.(53)

In general, the choice of antibiotic should be made empirically based on the above recommendations, because routine culturing of maxillofacial infections is rarely clinically useful. The use of culture swabs only help identify bacteria about a quarter of the time,(55) and it does not lead to changes in antibiotic regimen in practice.(10) Furthmore, culturing odontogenic infections may needlessly increase the overall cost of treatment.(56)

A significant controversy concerns the prophylactic use of antibiotics for certain procedures in patient populations that present an increased risk of developing a post-operative maxillofacial or systemic infection. Current guidelines by the American Heart Association and the Academy of Orthopedic

Surgeons recommend prophylactic antibiotics in specific circumstances for certain cardiac and orthopedic patients, respectively. These recommendations are controversial, and providers should employ their own clinical judgment when using prophylactic antibiotics in these patients.(57)

Good communication between the orthopedist and the treating oral and maxillofacial surgeon is critical in determining the appropriate use of antibiotics.(58) Patients with immuno-compromising conditions may also benefit from prophylactic antibiotics but, again, inadequate data exists to establish clear guidelines.(57)

Even more controversial is the routine use of prophylactic antibiotics for infection prevention in otherwise completely healthy patients. Most authors consider this practice unsupported by evidence.(57,59-61) However, IV antibiotics administered immediately prior to impacted third molar extraction decreases the risk of surgical site infections (SSI).(62,63) Some have recommend perioperative intravenous antibiotics combined with a postoperative course of oral antibiotics for all patients undergoing extraction of impacted mandibular third molars in order to prevent infections.(64)

Data on antibiotics' effects on other postoperative outcome measures has been mixed. Prophylaxis does not appear to improve wound healing, decrease pain or increase mouth opening, or prevent alveolar osteitis or other postoperative inflammatory conditions.(61,65) However, other studies have demonstrated improved clinical recovery with fewer postoperative visits in the patient treated with antibiotics.(66) Monaco, et al. concluded that antibiotic prophylaxis not only decreased postoperative infection rates after third molar surgery, but also decreased postoperative pain, fever, and need for analgesic medications.(67) The overall benefit of prophylactic antibiotics for routine dental procedures clearly continues to be controversial in oral and maxillofacial surgery.

DEVESTATING MANIFESTATIONS OF MAXILLOFACIAL INFECTIONS

In rare circumstances, maxillofacial infections can spread to neighboring regions of the body, causing potentially life-threatening conditions for the patient. The oral and maxillofacial surgeon must be aware of the possible morbidity and mortality risks associated with maxillofacial infection.

Descending Necrotizing Mediastinitis

Descending necrotizing mediastinitis (DNM) is a particularly dangerous and deadly form of acute mediastinitis that can occur as a result of odontogenic infections spreading via the deep fascial spaces into the chest. DNM can result in cellulitis, abscess, tissue necrosis and sepsis.(68) It is often lethal,(69) having a mortality rate of 40%.(70) Death occurs often as a result of delayed recognition or proper treatment of the condition,(71) and aggressive, multidisciplinary surgical treatment in addition to antibiotics is needed to reduce the high risk of mortality.(69,71)

Cervicofacial Necrotizing Fasciitis

Cervicofacial necrotizing fasciitis (CNF) is a subtype of necrotizing fasciitis in which polymicrobial odontogenic infections spread through the deep fascial planes of the neck causing severe necrosis. This condition classically spares mucous membranes, and progresses downwards from the face towards the neck and chest.(72) Of these infections, 79.71% are of odontogenic origin.(73) CNF presents a diagnostic challenge because it is indistinguishable from other deep neck infections on contrast CT scans.(74)

It is a highly lethal condition, with a mortality rate reported between 7% and 20%, even with proper treatment,(75) but nearly 100% mortality without surgical intervention.(76) The condition is frequently associated with immuno-compromised patients such as those with diabetes mellitus or who are taking high-dose steroids.(75) However, necrotizing fasciitis can occur in any type of patient, and one case report has even described the condition in a 14-year-old boy after elective extraction of wisdom teeth.(77) Classic operative findings include necrotic, grey fascia with a “dishwater” fluid, little bleeding, and minimal resistance to blunt dissection.(78) Occasionally DNM and CNF occur simultaneously, in which case the mortality rate increases from 41% to 64%.(75)

Predicting CNF is challenging, however, the laboratory risk indicator in necrotizing fasciitis (LRINEC) score is a validated method to accurately predict the presence of this condition. Using six laboratory values (CRP, total WBC, hemoglobin, sodium, creatinine, and glucose), a score is assigned. A LRINEC score greater than or equal to 6 has a sensitivity of 0.94 and specificity of 0.95 in detecting necrotizing fasciitis.(78)

Surgical debridement is key, and the standard antimicrobial regimen includes a triple-antibiotic therapy including a broad-spectrum penicillin, an aminoglycoside or third-generation cephalosporin, and either clindamycin or metronidazole.(76) Even with proper therapy morbidity is frequent, with scarring, decreased function and disfigurement being common given the associated extensive soft tissue damage.(76)

Infection of the Orbit

Orbital involvement is another potentially morbid consequence of maxillofacial infections. Although uncommon, a maxillary odontogenic infection can extend into the orbit through several pathways. The root tips of an infected maxillary tooth can cause sinusitis that tracks through the inferior orbital fissure into the orbit. An infected maxillary molar can travel posterolaterally into either the pterygopalatine or infratemporal fossae. An infection can also gain entry into the preseptal space through the eyelid, the angular vein, or the inferior ophthalmic vein through the pterygoid venus plexus.(79)

Patients with nephrotic syndrome and chronic antral inflammation, heroin addicts, and pregnant patients with an upper respiratory infection are all particularly susceptible to these types of infections. Consequences of orbital involvement of an odontogenic infection include vision loss, blindness, or extension to the cranial cavity causing cavernous sinus thrombosis, meningitis, subdural empyema, brain abscess or death.(80,81) Surgical drainage typically uses an approach through the skin, although drainage through a nasal antrostomy procedure has also been described.(82) Signs of orbital involvement, including proptosis or visual changes, should arouse immediate concerns in the oral and maxillofacial surgeon and prompt intervention.

Rare Maxillofacial Infections

Other exceedingly rare maxillofacial infections have been reported in the literature, including mucormycosis,(83-85) *Aerococcus viridans*,(86) *Mycobacterium avium-intracellulare*,(87) *Cryptococcus neoformans* ,(88) and *Salmonella*.(89) Often, infections of this nature spread rapidly, require aggressive surgical management, and can result in severe illness or death. These infections are mostly likely to develop in the severely immunocompromised patient so, while rare, these types of infections should be considered as part of the differential in the patient taking certain medications or with conditions that limit normal immune response.

TREATMENT

Surgical Management and Timing

Two important fundamental questions have been raised in the past regarding management of the patient who presents emergently with an odontogenic infection: 1) if the patient has cellulitis without clear evidence of an abscess, should an incision and drainage be performed? And 2) should the offending tooth be extracted immediately, or is it prudent to wait for swelling to subside before extracting the tooth?

In regards to the first question, it is now accepted that whether or not there is radiographic evidence of abscess on CT, or if there are no clear clinical signs of abscess, a patient who presents with an odontogenic infection associated with facial swelling, should have the infection drained surgically.(15)

Historically, timing of tooth extraction has also been a source of controversy. Patients presenting with odontogenic infections are still frequently given a course of antibiotics without definitive surgical management, particularly when presenting to general dentists.(17) However, it is currently recommended that a tooth causing significant odontogenic infection should be extracted as soon as possible. The longer a necrotic tooth is present, the greater the likelihood of developing significant complications and the higher the risk of mortality.(90)

The anatomic location of a maxillofacial infection is a predictor of the required treatment. Infections of the upper face are likely to be successfully treated with antibiotics alone, while lower face infections are twice as likely to require surgical intervention.(41) Access to deeper spaces, including the parapharyngeal, lateral pharyngeal, peritonsillar, and retropharyngeal spaces present specific challenges. Rupture of the abscess can occur spontaneously, presenting a risk for aspiration. Additionally, airway compromise is a more significant concern in these areas, so the surgeon should always be prepared for urgent surgical airway intervention. Finally, erosion of the abscess into major vessels or direct extension into the mediastinum is possible with the deeper infections.(91)

Surgical incision and drainage is still the treatment of choice in these spaces. The peritonsillar abscess can be managed through needle aspiration alone, and tonsillectomy 6-8 weeks after drainage should be considered.(91) Lateral pharyngeal abscesses can be drained intraorally, extraorally, or through a combination of both approaches.(92)

Alternative methods of drainage have also been described in the literature. Palpable abscesses have been evacuated percutaneously using the modified Seldinger technique.(93) Yusa, et al. discusses success in using Doppler ultrasound in guiding percutaneous drainage of maxillofacial abscesses that are difficult to locate by physical examination alone,(94) particularly deep neck infections.(95) When an abscess begins to track into the mediastinum, CT guided drainage is a favored method.(95)

Use of Drains

Drains are frequently left in place after incision and drainage of the odontogenic infection. There are several types of drains used, including Penrose, closed-suction, and irrigating varieties. Johnson and Krishnan found that silicone drains are easier to place than Penrose drains, are more comfortable for the patient and are more easily irrigated.(96) Balloux, et al., however, found that irrigating a drain postoperatively does not decrease a patient's LOS.(97)

Managing the Airway

Proper airway management in the patient with maxillofacial infections is critical due to the possibility of compromise in more advanced cases. Patients with severe odontogenic infections often require the expertise of an experienced anesthesiologist, and fiberoptic intubation is the most commonly used technique in this patient population.(7) Often times, the patient is intubated awake to avoid further airway compromise, although various sedatives, including dexmedetomidine (Precedex™), have been shown to be appropriate for helping to relax the patient while preserving their ability to maintain their own airway during intubation.(98)

Tracheotomy is rarely required in large trauma centers when anesthesiologists are readily available,(10) although it has been shown to be a relatively safe procedure when a surgical airway is required.(99) Cricothyrotomy, a technique that has historically been avoided due to concerns of potentially causing tracheal stenosis, has been recently re-examined, and may also provide a safe and simple alternative to rapid airway access.(100)

In certain cases of exceptionally severe infections—including, for example, maxillofacial sepsis or odontogenic osteomyelitis—long-term intravenous antibiotics may be indicated. In such an instance, the placement of a peripherally inserted central catheter (PICC), may be safely used in either the inpatient or outpatient for administration of these antibiotics.(101)

ADDITIONAL MANAGEMENT CONSIDERATIONS

Postoperative Infections

Reducing risk of postoperative infection is always a concern of the thoughtful oral and maxillofacial surgeon who is planning an elective procedure. However, given that oral surgical procedures occur in a non-sterile environment (the mouth), different considerations must be evaluated by the treating surgeon. For example, evidence suggests that wearing sterile gloves does not reduce the risk of postoperative complications, including infection, after routine dental extractions,(102,103) or wisdom teeth.(104)

Interestingly, although diabetes puts patients at greater risk for maxillofacial infections, and traditional teaching suggests that poorly controlled diabetics are at greater risk for postoperative infections, other studies suggest that patients with inadequate diabetes control may not necessarily be at risk for delayed healing after extractions, particularly if their blood glucose is less than 180 mg/dL.

(105)

In the event of a delayed-onset infection (around one month after a tooth extraction), surgical intervention may not be immediately warranted. In fact, in such a case, a 7-day course of antibiotics should be administered before performing debridement of the extraction site.(106)

The Pregnant Patient

Management of the pregnant patient with a maxillofacial infection presents a number of unique concerns and challenges. Given the significant radiation associated with CT scans, MRI may be the preferred imaging modality. Although most antibiotics commonly used in the management of the maxillofacial infection are safe, including penicillins and cephalosporins, others, such as tetracyclines and metronidazole, should be avoided given their deleterious effects on the developing fetus. Local anesthetics, including lidocaine, can be used in the pregnant patient, including those containing epinephrine.(107)

Intubating the pregnant patient can be challenging. Given the capillary engorgement and proliferation that normally occurs during pregnancy, bleeding is more likely during intubation. Awake fiberoptic intubation is especially favored in this population, given the higher propensity for airway obstruction. Hyperemesis and superior displacement of the diaphragm also pose a greater risk of aspiration, and lateral decubitus positioning should be used during surgery to allow adequate organ perfusion and allow adequate venous return.(107) Postoperatively, acetaminophen is the analgesic of choice, although opiates can be used safely in the short term to achieve adequate pain control without endangering the fetus.(107)

Pregnant patients with chronic dental infections are also at higher risk for pre-eclampsia, so a woman planning on pregnancy should have her dental disease addressed beforehand to avoid complications of pregnancy.(108) Despite the added perioperative considerations in the gravid population, the actual surgical management is the same as in the non-pregnant patient.(107)

CONCLUSION

Maxillofacial infections present a variety of challenges to the oral and maxillofacial surgeon. Aside from the difficulties associated with identifying the source and extent of the infection, the surgeon must also be aware of the other host factors, including age, medical history, and concurrent pregnancy, that may help predict the potential severity of the infection and guide proper perioperative treatment.

It is also important for the oral and maxillofacial surgeon to carefully consider proper antibiotic treatment for a patient with a maxillofacial infection. Despite the constant evolution of bacterial defenses and ongoing development of new antibiotics, this review should serve as a reminder that many of the classes of drugs traditionally used to treat oral and maxillofacial infections, namely penicillins, remain effective today.

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