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Complications of Third Molar Surgery

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In 1994, the American Association of Oral and Maxillofacial Surgeons Third Molar Clinical Trial research group began an ambitious longitudinal study that has added an immense amount of scientific data to our understanding of third molar surgery outcomes. Concurrently, the American Association of Oral and Maxillofacial Surgeons identified the need to characterize the clinical outcomes of procedures commonly performed by members of the specialty in the 1990s [1]. As a result, an outcomes assessment committee was created to design ways to track and evaluate the results of oral and maxillofacial surgical procedures. These procedures included the extraction of third molars—the most commonly performed procedure by oral and maxillofacial surgeons. A recent retrospective cohort study by Bui and colleagues [2] evaluated the multivariate relationships among risk factors and complications for third molar removal. These efforts represent a continued movement toward the use of evidence-based medicine to elucidate outcomes to help provide more accurate risk:benefit ratios and allow surgeons to better predict the incidence of complications and identify individuals likely to experience them.

Third molar extraction remains one of the most ubiquitous procedures performed by oral and maxillofacial surgeons, and most third molar surgeries are performed without intra- or postoperative difficulties. In all surgical procedures, proper preoperative planning and the blending of surgical technique with surgical principles is of paramount importance for decreasing the incidence of complications. Third molar removal is no different, yet such a common procedure sometimes results in what are relatively rare complications. The possibility of these events should be discussed with patients before the procedure and handled in a timely and corrective manner by the surgeon. Complications related to third molar removal range from 4.6% to 30.9% [2,3]. They may occur intraoperatively or develop in the postoperative period.

The four most common postoperative complications of third molar extraction reported in the literature are localized alveolar osteitis (AO), infection, bleeding, and paresthesia. Major complications discussed in this article, such as mandibular fracture, severe hemorrhage, or iatrogenic displacement of third molar teeth, are rare and as such, studies that evaluate incidence or predisposing factors are difficult to carry out and the literature is limited.

This article addresses the incidence of specific complications and, where possible, offers a preventive or management strategy. Injuries of the inferior alveolar and lingual nerves are significant issues that are discussed separately in this text [4]. Periodontal defects also may follow third molar surgery and are discussed elsewhere in this text [5]. Surgical removal of third molars is often associated with postoperative pain, swelling, and trismus. They are expected and typically transient and are not considered complications or discussed further.

Factors thought to influence the incidence of complications after third molar removal include age, gender, medical history, oral contraceptives, presence of pericoronitis, poor oral hygiene, smoking, type of impaction, relationship of third molar to the inferior alveolar nerve, surgical time,

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surgical technique, surgeon experience, use of perioperative antibiotics, use of topical antiseptics, use of intra-socket medications, and anesthetic technique [1–3,6–19]. Many studies are retrospective, subject to selection bias, or poorly controlled for confounding variables, however. Conclusions drawn from individual studies are often not in agreement, which makes an evidence-based preventive or management approach challenging.

Complications that are discussed further include AO, postoperative infection, hemorrhage, oro-antral communication (OAC), damage to adjacent teeth, displaced teeth, and fractures.

Alveolar osteitis

AO is a clinical diagnosis characterized by the development of severe, throbbing pain several days after the removal of a tooth and often is accompanied by halitosis. The extraction socket is often filled with debris and is conspicuous by the partial or complete loss of the blood clot. The frequency of AO ranges from 0.3% to 26% [1–3,6,8,9,11,12,14,16]. AO is known to occur more frequently with mandibular third molar extraction sockets, although the exact reason is not clear [1,3]. The cause of AO is also poorly understood. Birn [20] suggested that AO is the result of release of tissue factors leading to the activation of plasminogen and the subsequent fibrinolysis of the blood clot. This also may explain the apparent increased incidence of AO when the surgery is more difficult and traumatic. Nitzan [21] suggested that AO is primarily the result of a localized bacterial infection. It is likely that AO is a result of a complex pathophysiology that involves a localized bacterial infection and subsequent fibrinolysis.

In an extensive review of the literature, Alexander [22] found numerous studies that supported increasing age, female gender, oral contraceptives, smoking, surgical trauma, and pericoronitis as risk factors for AO, although a significant number of studies also refuted these purported associations. The same author found a majority of studies that supported the use of generous intraoperative lavage, perioperative antiseptic mouth wash, intra-alveolar medicaments, and systemic antibiotics to reduce the incidence of AO. Unfortunately, however, the literature concerning AO is not consistent. Two recent prospective studies comparing systemic perioperative metronidazole with placebo found the incidence of AO and early postoperative infection to be the same [7,23]. Based on these studies, metronidazole cannot be recommended for the prevention of AO, although the results cannot be extrapolated to the use of all systemic antibiotics. Despite the abundance of obligate and facultative anaerobic micro-organisms in odontogenic infections and possibly AO, it is possible that a more appropriate perioperative antimicrobial would reduce the incidence of AO. Perioperative ampicillin recently was found to reduce clinical recovery time when compared with placebo, although no specific comment was made regarding the incidence of AO or infection [24]. Postoperative antibiotics are generally not considered efficacious in reducing the incidence of AO or infection [25].

The incidence of AO after third molar removal may be reduced by adopting several approaches that, although not universally accepted, are based on the best literature currently available. First, third molars should be removed only when preexisting pericoronitis has been treated adequately. Oral hygiene also should be satisfactory before the surgical procedure. Second, the surgery should be completed as atraumatically as possible using copious irrigation when a drill/bur is needed to remove bone or section teeth. Third, an intra-alveolar antibiotic, such as tetracycline, may be beneficial when placed in the socket before closure [22,26]. The amount of antibiotic should be kept to a minimum to help reduce the likelihood of a giant cell reaction or myospheruloma formation. Finally, chlorhexidine 0.12% mouthwash should be used on the day of surgery and for several days thereafter [10].

The management of AO is less controversial than the etiology and prevention. A combination of antibacterial dressings, obtundant dressings, and topical anesthetic agents is used to alleviate severe pain. A multitude of different medicaments and carrier systems are commercially available with little scientific evidence to guide the choice. The authors have used alvogyl containing butamben, eugenol, and iodoform with good success. Eugenol is a phenolic compound that denatures protein, is neurotoxic, and interrupts neural transmission, whereas iodoform is an antibacterial agent. Patients should be seen regularly after placement of the dressing, which may need to be changed several times to eliminate the symptoms. The use of intra-alveolar dressings in sockets when the inferior alveolar neurovascular bundle is exposed is not recommended. Systemic analgesics may be used as an adjunct, but they are often

unnecessary after local management measures have been undertaken.

Infections

Postoperative infections after third molar removal have been reported to vary from 0.8% to 4.2% [1–3,6,11,12,14,16]. Infections may develop in the early or late postoperative period, with mandibular third molar sites more commonly affected [1,3]. It has been suggested that age, degree of impaction, need for bone removal or tooth sectioning, exposure of the inferior alveolar neurovascular bundle, presence of gingivitis or pericoronitis, surgeon experience, use of antibiotics, and location of surgery (hospital versus office procedure) are all risk factors for postoperative infections [3,6,11–14,16]. The benefit of perioperative or postoperative systemic antibiotics on the incidence of infection remains questionable and cannot be recommended currently [7,18,23,25,27]. Perioperative antibiotics are discussed in detail elsewhere in this issue [18]. Odontogenic infections—both pre- and postoperative—are typically mixed infections with a predominance of anaerobic microorganisms, although streptococci are usually the largest single group of organisms [28,29]. When infections develop they can spread in multiple directions depending on the anatomic location of the infection and adjacent tissue planes. Maxillary third molar infections may extend to the maxillary vestibule, buccal space, deep temporal space, or infratemporal fossa. Mandibular third molar infections may spread to the mandibular vestibule, buccal space, submasseteric space, pterygomandibular space, parapharyngeal space, or submandibular space. Parapharyngeal and submandibular infections may produce significant airway embarrassment. Infections also may involve the retropharyngeal tissues and subsequently the mediastinum, with disastrous results.

The management of postoperative infection involves the systemic administration of appropriate antibiotic and surgical drainage. Penicillin continues to be a good first choice antibiotic given the mixed nature of the infection and the presence of streptococci, although increasing resistance to penicillin has been reported [29,30]. Amoxicillin may be substituted because it has a wider spectrum of activity and is only dosed two or three times a day. Metronidazole also can be added to the antibiotic regimen to increase coverage against anaerobic organisms. Penicillin or amoxicillin and metronidazole (either alone or in combination) continue to be the antimicrobials of choice in the United Kingdom [31,32]. The use of clindamycin as an alternative has become popular because it provides aerobic and anaerobic coverage [33]. The choice of antibiotic should be made carefully considering the likely micro-organisms involved, the potential for allergic reactions, side effects, and complications, such as the increased risk for the development of pseudomembranous colitis with broad-spectrum antibiotics, such as clindamycin.

Bleeding and hemorrhage

The reported range of clinically significant bleeding as a result of third molar extraction has ranged from 0.2% to 5.8% and can be classified as either intra- or postoperative with causes that can be local or systemic. In the recent American Association of Oral and Maxillofacial Surgeons Age-Related Third Molar Study, the investigators found an intraoperative frequency of unexpected hemorrhage of 0.7% and a postoperative frequency of unexpected or prolonged hemorrhage of 0.1% [1]. In a study of 583 patients, Bui and colleagues [2] found the frequency of clinically significant bleeding to be 0.6% and noted that the variability on reported rates is at least partly a result of varying definitions. This value is similar to that found by Chiapasco and colleagues [11], in which they found excessive intraoperative bleeding in 0.7% of mandibular third molars and a 0.6% incidence of postoperative excessive bleeding. Maxillary third molars showed a 0.4% incidence of postoperative excessive bleeding. A higher incidence of excessive hemorrhage was found in distoangular teeth, deep impactions, and older patients. Excessive hemorrhage resulting from extraction of mandibular molars is more common than bleeding from maxillary molars (80% and 20%, respectively) [34].

The causes of hemorrhage can be either local or systemic in nature. Systemic conditions, such as hemophilia A or B and von Willebrand's disease, are often identified early in a patient's life and extractions can be approached in a systematic manner to maximize the patient's ability to form a stable clot. Patients with severe hemophilia A who have been treated previously with plasma-derived or recombinant factor VIII products may develop inhibitors to the factor products and prove to be difficult to manage, however. Alloantibodies against foreign factor VIII develop in

25% to 30% of patients with severe hemophilia A who receive therapeutic infusions of factor VIII [35]. The inhibitor level is measured in Bethesda Units, and patients are placed into either a low or high responder group. Approximately 75% of patients fall within the high responder group. The therapy of choice for patients who have hemophilia with inhibitors is the induction of immune tolerance, and multiple protocols exist to achieve this, including the Bonn protocol and the Malmoe regimen. In the preparation for an elective procedure in a patient in whom long-term immune tolerance has not been accomplished, recombinant FVIIa (Novo-Seven) and activated prothrombin complex concentrates with FVIII inhibitor bypass activity (FEIBA) are well-established therapeutic modalities [35]. FEIBA contains the proenzymes of prothrombin complex proteins II,VII, IX, and X and small amounts of their activation products. Its effects occur mainly through factors II, Xa, and V–dependent activation of the clotting cascade and avoid dependence on factor VIII. There are difficulties with Novo-Seven and FEIBA related to difficulty in determining correct dosage and lack of laboratory tests capable of determining dosage sufficiency [35]. Management of these patients should include close coordination with a hematologist and the maximal use of local measures, including the fabrication of an individually fitted dressing plate before surgery.

Antithrombotic medications, such as Coumadin (warfarin sodium), can be discontinued if medically feasible, switched via protocol to a heparin regimen during the perioperative period, or dealt with in a local manner in an anticipatory fashion.

Local factors that result from soft-tissue and vessel injury represent the most common cause of postoperative hemorrhage and respond best to local control, which includes meticulous surgical technique with avoidance of the inferior alveolar neurovascular bundle and particular care at the distolingual aspect of the mandible. Patients who experience continued postoperative bleeding should be instructed to apply gauze pressure to the extraction site for 45 minutes. The patient's medical history should be reinvestigated and vital signs should be monitored. If the application of pressure proves unsuccessful, the patient and the extraction site should be examined closely. Local anesthesia administered at this time should not contain a vasoconstrictor to enable accurate identification of the cause of bleeding. The extraction site may be curetted and suctioned gently. If the bleeding is from soft tissue and is arterial in nature but does not involve the neurovascular bundle, it is usually amenable to cautery. Bony bleeders may be managed with bone wax or various hemostatic agents (Table 1). These materials may be stabilized and maintained within the socket with sutures. Oral fibrinolysis from salivary enzymes may play a role in some cases, and the use of fibrin-stabilizing factors, such as epsilon-aminocaproic acid (Amicar) or tranexamic acid (Cyclokapron), may be helpful (Table 1).

Massive intraoperative bleeding is a rare occurrence and can be secondary to a mandibular arteriovenous malformation, which can be either low flow (venous) or high flow (arterial). The presence of such a malformation in the maxilla or mandible is potentially life threatening secondary to unmanageable bleeding upon attempted tooth extraction. Eight percent of patients died as a result of massive bleeding during tooth extraction in the series reported by Guibert-Tranier and colleagues [36]. Arteriovenous malformations are a rare condition in the maxillofacial region, occurring with a higher incidence in other regions of the body. Arteriovenous malformations in the maxillofacial region are often apparent on physical examination and panoramic radiography. A history of recurrent spontaneous bleeding from the gingival is the most frequent objective sign. Other physical findings include gingival discoloration, hyperthermia over the lesion, a subjective feeling of pulsation, and the presence of a palpable bruit. Mandibular arteriovenous malformations usually appear as multilocular radiolucencies on radiographic studies, although significant lesions may be nonapparent [37]. Angiography is necessary and essential to confirm the diagnosis and assess the extent and vascular architecture of the lesion [38]. Treatment of mandibular arteriovenous malformations involves either surgical excision or embolization. Multiple reports describing the use of permanent embolic agents support their use and suggest that many arteriovenous malformations whose angioarchitecture support transvenous approach can be cured without surgical resection.

Damage to adjacent teeth

The incidence of damage to adjacent restorations of the second molar has been reported to be 0.3% to 0.4% [11]. Teeth with large restorations or carious lesions are always at risk of fracture

Table 1
Local hemostatic agents useful for oral bleeding

Name	Source	Action	Application
Gelfoam	Absorbable gelatin sponge	Scaffold for blod clot formation	Place into socket and retain in place with suture
Surgicel	Oxidized regenerated methylcellulose	Binds platelets and chemically precipitates fibrin through low pH	Place into socket (Note: cannot be mixed with thrombin)
Avitene	Microfibrillar collagen	Stimulates platelet adherence and stabilizes clot; dissolves in 4–6 weeks	Mix fine powder with saline to desired consistency
Collaplug	Preshaped, highly cross-linked collagen plugs	Stimulates platelet adherence and stabilizes clot; dissolves in 4–6 weeks	Place into extraction site
Collatape	Highly crosslinked collagen	Stimulates platelet adherence and stabilizes clot; dissolves in 4–6 weeks	Place ribbon into extraction site
Thrombin	Bovine thrombin (5000 or 10,000 U)	Causes cleavage of fibrinogen to fibrin and positive feedback to coagulation cascade	Mix fine powder with $CaCl_2$ and spray into area desired; alternatively, mix with Gelfoam before application
Tiseel	Bovine thrombin, human fibrin, $CaCl_2$, and aprotinin	Antifibrinolytic action of aprotinin	Requires specialized heating, mixing and delivery system; inject into extraction site

Adapted from Moghadam H, Caminiti MF. Life threatening hemorrhage after extraction of third molars: case report and management protocol. J Can Dent Assoc 2002;68(11):671.

or damage upon elevation. Correct use of surgical elevators and bone removal can help prevent this occurrence. Discussion should take place preoperatively with patients at high risk. Maxillary mesioangular impactions with a Pell and Gregory class B (crown to cervical relationship) and mandibular vertical impactions may be at a slightly higher risk [11].

Mandibular fracture

Mandibular fracture as a result of third molar removal is a recognized complication and has important medicolegal and patient care implications. It should be included on all third molar extraction consent forms. Mandibular fracture during or after surgical third molar removal is a rare but major complication. The incidence of mandibular fracture during or after third molar removal has been reported to be 0.0049% [39]. Other studies cite even lower incidence. Alling and colleagues [40] retrospectively showed an intraoperative mandibular fracture rate of 1 in 30,583 patients and a postoperative rate of 1 in 23,714, whereas Nyul [41] reported one fracture in 29,000 cases.

Possible predisposing conditions, such as increased age, mandibular atrophy, the concurrent presence of a cyst or tumor, and osteoporosis, have been implicated in increasing the risk of mandible fracture. The preangular region of the mandible is an area of lowered resistance to fracture secondary to its thin cross-sectional dimension, and an impacted tooth occupies a relatively significant space within the bone of this region. The concurrent presence of a dentigerous or follicular cyst around the third molar or a radicular cyst around the second molar and removal of the tooth and any surrounding bone necessary to mobilize it further mechanically weakens this area. Studies that have attempted to characterize the small number

of patients who have experienced a mandibular fracture after or during extraction of a third molar include Iizuka and colleagues [42], who retrospectively evaluated the clinical and radiographic data of 12 patients with 13 mandible fractures after removal of wisdom teeth. They found that patients older than 30 to 40 years with tooth roots superimposed on the inferior alveolar canal or adjacent to the canal on panoramic evaluation are at increased risk for fracture. The study found few intraoperative fractures (one) and found that the late fractures (eight) occurred on average 6.6 days after the surgery exclusively upon mastication. Libersa and colleagues [39] evaluated 37 fractures from 750,000 extractions and identified 17 intraoperative fractures and 10 late fractures. Of the 10 late fractures, 8 occurred in men and 6 occurred during mastication. Most late fractures occurred between 13 and 21 days after surgery, which could be caused by an increase in masticatory function and occlusal forces outstripping the bony healing.

Exclusively late fractures were found in a study by Krimmel and Reinert [43] in a retrospective series of six patients who sustained mandibular fracture from third molar removal. The fractures occurred 5 to 28 days (mean, 14 days) after the tooth removal. The ages of all six patients were between 42 and 50 and all had full dentition. Pell and Gregory vertical classifications for the teeth were Class B in two cases and Class C in four cases. The authors concluded that the major risk factor for the complication seemed to be advanced age in combination with a full dentition.

Regardless of the mechanism, mandibular fractures that occur during or soon after the extraction of a mandibular third molar are usually nondisplaced or minimally displaced. Such hairline fractures that extend from an extraction site are not always easily identified, and clinical suspicion may require CT if the initial panoramic film produces negative results. The practitioner should treat the fracture definitively just as if the patient were a trauma patient. Failure to do so may result in further complications.

Maxillary tuberosity fracture

Fracture of the maxillary tuberosity on extraction of maxillary third molars is a clinically known occurrence. The anatomic position at the end of the dentoalveolar arch is such that the posterior portion has no support, and the internal composition may be significantly maxillary sinus or soft osteoporotic bone. Preoperative radiographic evaluation of the sinus proximity and bone thickness can help anticipate tuberosity fracture. In a study by Chiapasco and colleagues [11], the extraction of 500 maxillary impacted third molars was accompanied by three fractures of the maxillary tuberosity, indicating an incidence of 0.6%. Two instances occurred with teeth classified as class C (crown to root position) by the Pell and Gregory classification scheme, whereas one was class B (crown to cervical position). The fractures occurred with equal incidence in all patient age groups.

Upon encountering a fractured tuberosity during an erupted third molar extraction, the surgeon must revisit the reason why the tooth was to be extracted in the first place. If the tooth is asymptomatic, it may be left in place and the region stabilized with an arch bar. If the tooth is infected or symptomatic and the extraction must be completed, then the tuberosity can be separated from the tooth with a high-speed hand piece and the roots sectioned. The tooth can be removed atraumatically and the tuberosity assessed for viability through evaluation of the attached periosteum and vascular supply. Attention must be given to fastidious closure of palatal and buccal mucosal tears. Possible preventive measures include use of a periosteal elevator to ensure separation of the periodontal ligament from the tooth and palpation with a finger from the nonoperating hand to evaluate the expansion of the cortical plate upon luxation.

Displacement of third molars

Maxillary third molars

Iatrogenic displacement of maxillary third molars can occur, although it is a rarely reported complication with an unknown incidence. Maxillary third molars that are superiorly positioned may have only a thin layer of bone posteriorly separating them from the infratemporal space. The tooth can be displaced in a posterosuperior direction into the infratemporal space if distal elevation is not accompanied by a retractor placed behind the tuberosity within the designed mucoperiosteal flap (Fig. 1). The literature shows that management of a third molar displaced into the infratemporal space is varied. Venous bleeding from the pterygoid plexus often makes intraoral

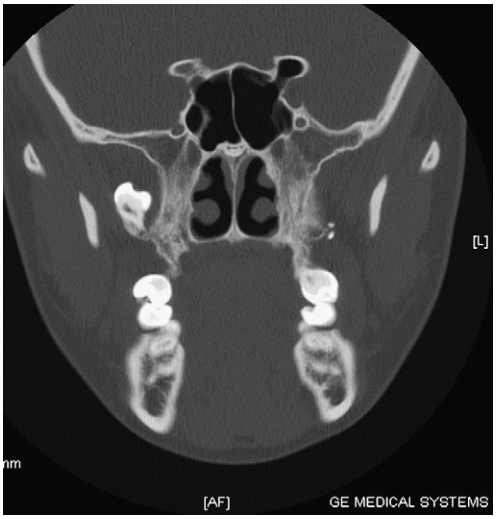

Fig. 1. Coronal cut CT. Bony window of a maxillary third molar #01 displaced into the right infratemporal fossa.

visualization of the tooth difficult [44]. Observation may be chosen but can require secondary removal in the setting of infection, limited range of motion, or a patient's wishes to have the tooth removed. Delayed removal after fibrosis takes place around the tooth also has been advocated because it can more readily be localized radiographically and intraoperatively. This secondary procedure is often completed in the operating room under general anesthesia after a CT scan is obtained to precisely locate the tooth position. Various approaches to retrieving a tooth in the infratemporal space have been described, including an intraoral approach from a sagittal split osteotomy incision, a hemicoronal approach, and manipulating the tooth via a straight needle placed cutaneously in an inferior direction and delivering it through an intraoral incision [45].

Displacement of a maxillary third molar into the maxillary sinus also can occur and has been reported [46–48]. Excessive apical force and incorrect surgical technique are thought to be the most common cause. The accepted treatment of such a displaced tooth is removal to prevent future infections. Pogrel [44] stated that the initial attempt at retrieval should be a suction placed at the opening into the sinus. If suction applied to the opening does not allow delivery, then the sinus may be irrigated with saline and the suction tip reapplied to the opening. If the second attempt is unsuccessful, further attempts should be stopped and the patient placed on a course of antibiotics and nasal decongestants. Retrieval can be accomplished with a Caldwell-Luc approach at a second procedure in concert with closure of the oro-antral fistula and an intranasal antrostomy to facilitate maxillary sinus drainage [44].

There seems to be some discussion as to the timing of this removal. Sverzut and colleagues [48] stated that the removal should be accomplished during the same procedure but indicated that delayed treatment does not always precipitate active sinus disease and that this asymptomatic interval can last several months.

Mandibular third molars

Mandibular third molars can be iatrogenically displaced into the sublingual, submandibular, pterygomandibular, and lateral pharyngeal spaces [46,49–51]. Anatomic considerations, such as a distolingual angulation of the tooth, thin or dehisced lingual cortical plate, and excessive or uncontrolled force upon luxation, are important factors that can lead to this complication.

Lower third molars that are pushed through a perforation in the thin lingual alveolar bone normally pass inferiorly to the mylohyoid muscle. Pogrel [44] recommended that the operator place his or her thumb underneath the inferior border of the mandible in an attempt to direct the tooth back along the lingual surface of the mandible. The lingual gingiva may be reflected as far as the premolar region and the mylohyoid muscle incised to gain access to the submandibular space and deliver the tooth. In this approach, care should be taken to avoid injury to the lingual nerve in this anatomic region. Locating the displaced tooth is challenging secondary to limited working area and hemorrhage with resultant compromised visualization and blind probing that may result in further displacement. Yeh [46] described a technique that is a combination intraoral and lateral neck approach in which the original wound is extended lingually to the distal of the first molar. A 4-mm skin incision is made in the submandibular region and a hemostat inserted along the lingual surface of the mandible to stabilize the tooth while the surgeon palpates the tooth with an index finger. A Kelly clamp can be inserted to deliver the tooth upward into the mouth. The author believed this approach prevents further displacement of the tooth and limits the length of lingual flap reflection necessary.

Gay-Escoda and colleagues [51] reported a case in which a patient underwent unsuccessful extraction of a displaced mandibular third molar that was found between the platysma and sternocleidomastoid muscle. It was removed via a transcutaneous approach and the authors stated that the tooth may have undergone progressive exteriorization as a result of a prolonged inflammatory reaction.

Esen and colleagues [50] described a case in which a patient presented months after attempted extraction of a mandibular third molar with progressive limitation in mouth opening, left neck edema, and difficulty swallowing. A panoramic film was obtained and revealed a tooth in the pterygomandibular region. CT scans showed the precise location of the tooth at the anterior border of the lateral pharyngeal space underlying the left tonsillar region. The tooth was removed transorally from the tonsillar fossa (after completion of a tonsillectomy) through a vertical incision from the tonsillar fossa to the retromolar trigone.

Delayed intervention in the setting of a displaced tooth into the lateral pharyngeal space carries the risk of infection, thrombosis of the internal jugular vein, erosion of the carotid artery or one of its branches, and interference with cranial nerves IX through XII [50].

Displaced roots

Maxillary and mandibular root tips rarely may be displaced into the aforementioned spaces. The management of these displaced roots remains much the same. A mandibular third molar root may be displaced into the inferior alveolar canal. Attempts at retrieval may further injure the neurovascular bundle and should be limited to one attempt with suction.

Aspiration

All third molar extraction procedures carry the risk of tooth aspiration. The use of properly placed oropharyngeal gauze is essential in preventing this complication. The use of intravenous deep sedation by definition compromises the protective reflexes of the airway. The aspiration or swallowing of a tooth or portion of a tooth is usually the result of a patient coughing or gagging.

Oro-antral communication/fistula

An OAC is any opening between the maxillary sinus and the oral cavity. Without diagnosis and treatment this communication may epithelialize and become an oro-antral fistula (OAF).

OAC occurs most frequently from extraction of first molar teeth, followed by second molar teeth [52]. An incidence of 0.008% to 0.25% OAC has been reported with maxillary third molar removal [11,53]. It is likely that the incidence of OAC from maxillary third molar removal is underestimated, because it may be self-limiting in some cases and, in the case of impacted third molars, usually a flap is closed over the extraction site, leading to healing. OAC smaller than 2 mm in diameter likely closes spontaneously without any treatment [54,55].

Various methods for closure of OAC and OAF have been described over the years, including gold foil, buccal flaps, various palatal flaps, tongue flaps, pedicled buccal fat pad (PBFP), cheek flaps, and placement of bioabsorbable root analogs [56–69]. The authors prefer the use of the PBFP for closure of OAFs.

The buccal fat pad was first described by Heister in 1732 as a glandular structure and recharacterized as fatty tissue by Bichat in 1802 [70]. It is a biconvex mass of fatty tissue in a fine capsule with a body and four projections; the total volume is described as approximately 10 mL [68,70–73]. The four projections are buccal, pterygoid, and superficial and deep temporal extensions. The blood supply to the buccal fat pad comes from the buccal and deep temporal branches of the maxillary, transverse facial branch of the superficial temporal, and branches of the facial arteries. The use of the PBFP for closure of OAF was first described by Egyedi in 1977 [74]. The description of this technique included the placement of a split-thickness skin graft over the PBFP. Research has shown that this graft does not need to be covered and epithelializes within a few weeks [55,70,75–77]. The procedure's reported success rate ranges from 92.8% to several reports of 100% [55,78–82].

Technique

The procedure can be performed under local anesthesia or intravenous sedation (Fig. 2). If a fistula is present, an incision with a 3-mm margin is made around the OAF. The fistula is excised or closed and inverted with a purse string suture of 3-0 chromic gut. Two divergent cuts are made from the remaining OAC extending anteriorly and posteriorly into the vestibule. The trapezoidal buccal mucoperiosteal flap is reflected. A 1-cm

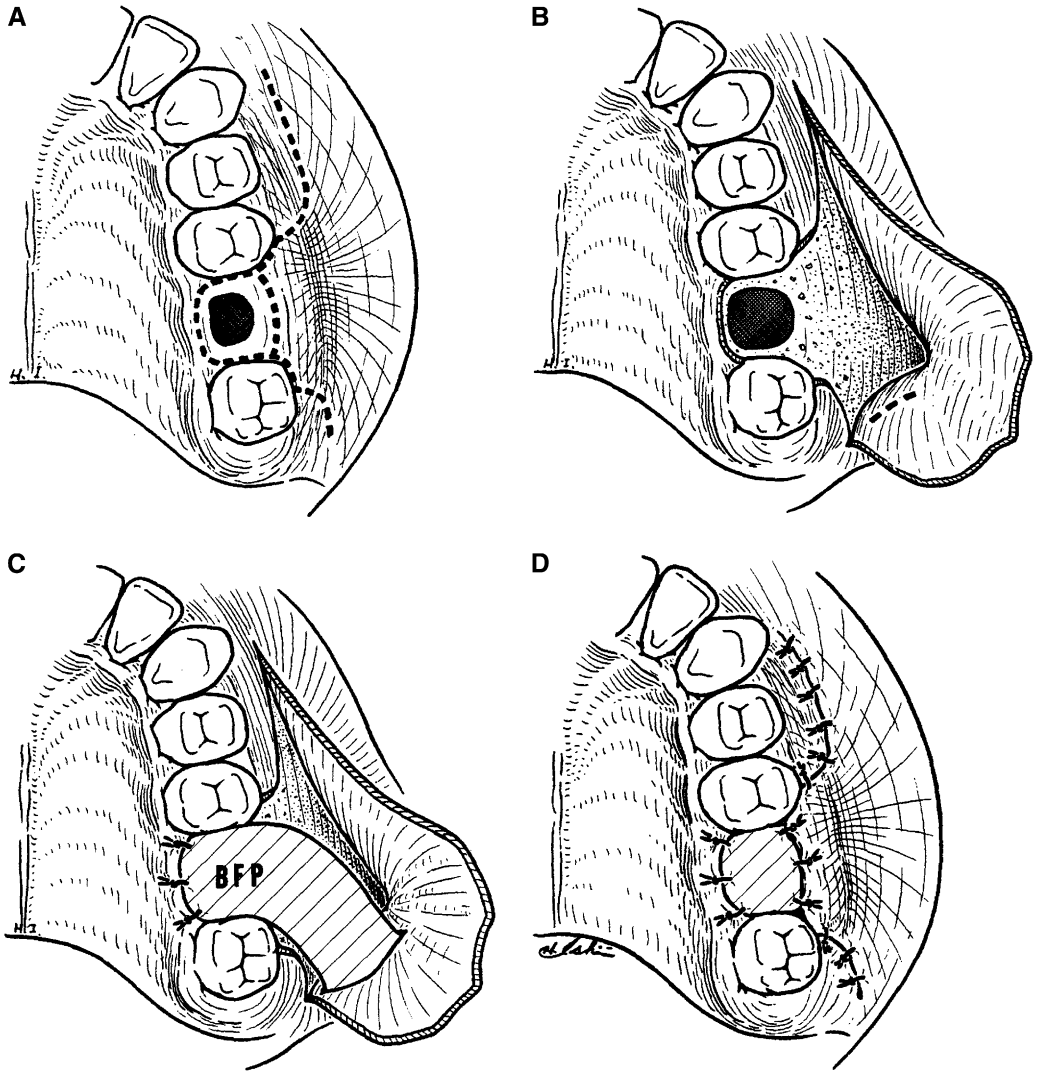

Fig. 2. The BFP method for the closure of OAF. (*A*) Incision line (*dotted line*). (*B*) The mucoperiosteal flap and the incision of the periosteum at the zygomatic buttress (*dotted line*). (*C*) Advancement of BFP into the bony defect and suturing to the palatal gingiva. (*D*) Replacement and suturing of mucoperiosteal flap into its original position. (*From* Hanazawa Y, Itoh K, Mabashi T, et al. Closure of oroantral communications using a pedicled buccal fat pad graft. J Oral Maxillofac Surg 1995;53:771; with permission. © Copyright 1995 – The American Association of Oral and Maxillofacial Surgeons.)

incision is made in the periosteum posterior to the zygomatic buttress. Curved hemostats are used to spread within the submucosal space until the fat herniates. The buccal fat pad is teased from its bed and gently advanced, without tension, and sutured to the palatal mucosa using 4-0 monofilament poliglecaprone (Monocryl) sutures. The sutures to the palate can be interrupted or, after elevation of the edge of the palatal tissue, vertical mattress sutures can be used to "tuck" the tip of the PBFP under the edge of the palatal mucosa. The buccal flap is returned to its original position. The releasing incisions are closed and a suture is placed from the tip of the buccal flap to the PBFP, leaving the PBFP exposed to the oral cavity over the OAC. The fat epithelializes over the next few weeks. Alternatively the buccal mucoperiosteal flap may be advanced over the PBFP and primarily sutured to the palatal mucosa to form a double layered closure. Appropriate antibiotic coverage

for sinus micro-organisms and decongestants are provided for 1 week. Standard sinus precautions are followed. The authors have not yet had a failure with this technique, even in smokers, although smoking cessation is strongly encouraged.

Temporomandibular joint complications

A causal relationship between the extraction of third molars and temporomandibular injury currently has little support in the literature. It has been suggested that because the procedure of extracting mandibular third molars involves the patient opening his or her mouth wide for an extended period of time and exerting a variable amount of force on the mandible, it is possible to overload or injure one or both temporomandibular joints [83]. This result would be the case especially if the surgeon did not use correct surgical technique or failed to support the mandible while removing the mandibular third molars or if the patient's protective mechanism for opening was exceeded while under general anesthesia.

In a matched case control study by Threlfall and colleagues [84], they compared 220 patients diagnosed with disc displacement with reduction to 1100 controls drawn from the participants in the 1998 UK Adult Dental Health Survey. They found that patients with diagnosed anterior disk displacement with reduction were not significantly more likely to have undergone extraction of third molars than the controls (odds ratio 1.28; confidence interval 95%). The study showed that 21 (9.5%) of the 220 patients reported that they had a third molar extracted in the 5 years before the diagnosis of an anterior disc displacement with reduction. The data did not exclude the possibility that patients who have extractions under general anesthesia and patients who have lengthy/traumatic procedures may be at increased risk of developing a temporomandibular disorder, but data did suggest that in most patients with anterior disk displacement with reduction, extraction of a third molar was unlikely to have been the etiologic factor.

Oral and maxillofacial surgeons should include an examination of the temporomandibular region, including an evaluation of joint sounds, opening and excursive movements, and temporal/masseter/pterygoid muscle tenderness in all preoperative third molar extraction patients. Care should be taken in judicious application of force and a bite block should be used to stabilize the mandible upon surgical mobilization of the lower third molar teeth.

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