Chapter 1

Complications Following Surgery of Impacted Teeth and Their Management

Çetin Kasapoğlu, Amila Brkić,
Banu Gürkan-Köseoğlu and
Hülya Koçak-Berberoğlu

Additional information is available at the end of the chapter

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1. Introduction

One of the most performed procedures in the specialty of oral and maxillofacial surgery is removal of impacted teeth, especially third molars. Impaction is defined as failure of teeth to erupt into the dental arch within the expected time [1,2]. The reasons for tooth impaction include several factors subdivided into a local and general factors such as position and size of adjacent teeth, dense overlying bone, excessive soft tissue or a genetic abnormality including abnormal eruption path, dental arch length and space in which to erupt [1-3]. Clinically and radiographically, there are two types of impactions namely complete and partial. Complete impaction means that the tooth is covered by bone and mucosa and is prevented from erupting into a normal functional position; partial impaction means that the tooth is partially visible or in communication with oral cavity, but it has failed to erupt fully into a normal position [1]. The most common impacted teeeth are mandibular and maxillary third molars, followed by the maxillary canines and mandibular premolars. New data suggests that 72,2% of the world population has at least one impacted tooth (usually lower third molar) [3,4]. From the last 40 years, the incidence of impacted teeth has grown through different populations, due to living habits such as soft food diet and lower intensity of the use of the masticatory apparatus [3]. Only a few decades earlier, Inuits and Latin American Indians were described as populations with no impacted teeth [1]. Some authors suggest that race and gender have an influence on occurrence of impactions; thus, the impactions are more common in Caucasians than in Negroes; and females are more predisposed to this phenomenon than males. The age of the patients also play an important role in impacted teeth occurrence. Patients between 20 and 30 years of age are the most frequently affected with symptomatic impactions [4-7]. As age

increases, the phenomenon of impaction is reduced and after the age of 50 it is in a range from 6-14% [4,8]. Although in many cases, removal of impacted teeth can be easily performed, using just an elevator and forceps, occurrence of potential complications, causing distress to both the patient and the surgeon, should not be neglected. Clinical conditions such as position and relationship of the impacted tooth to adjacent teeth and anatomic structures such as the maxillary sinus, blood vessels, nerves, and anatomic spaces play an important role in development of complications [9]. However, despite surgical skills and expertise, some of the complications are iatrogenic origin, thus knowledge of their potential development might be helpful in their prevention. The aim of this chapter is to describe and discuss the most common and predictable complications related to the surgical removal of impacted teeth.

2. Complications associated with surgery of impacted teeth

Complications associated with impacted teeth removals are not irrelevant and their development is conditioned by local and general factors including tooth position, age and health status of the patient, knowledge and experience of the surgeon and surgical equipment. Because of osteoporotic or sclerotic bones, dental ankylosis, use of various drugs for coagulation, osteoporosis etc., which are more common seen at the older patients, the complication results associated with removal of impacted teeth might be more serious comparing with the same complications at younger patients. Generally speaking the complications related to removal of impacted teeth might be subdivided into a two groups:

Complications during surgery of impacted teeth and complications after surgery [9].

2.1. Complications during surgery of impacted teeth

Complications during the impacted teeth surgery are the most common and expected complications. They might be subdivided into seven groups:

1. Complications associated with impacted or adjacent tooth, 2. Soft tissue complications,3. Nerve injuries,4. Bone complications, 5. Maxillary sinus complications,6. Complications associated with surgical equipment, 7. Swallowing and aspiration [9].

2.1.1. Complications associated with the impacted or adjacent tooth

Caries is mentioned as one of the common pathological features associated with partially impacted third molars [10-12]. Mesioangular and horizontal positions of third molars are also responsible for development of distal cervical caries on the second molar, which are difficult to be restore without extraction of the impacted tooth. In many cases even use of lower force by an elevator or forceps, the fracture of the impacted tooth crown or fracture of the adjacent tooth or its restoration may be expected (Fig. 1) [13].

Variability in root shape and number may lead to fracture of the impacted tooth or roots. In cases when a small portion of the fractured root is in close relation to the maxillary antrum or mandibular canal and there is possibility of its displacement to these anatomic spaces, the

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Figure 1. Control panoramic radiograph during lower left third molar surgery shows a fracture of the tooth.

fragment should not be removed [9]; provided that the fragments are not associated with pathologic lesions such as periapical lesions, cysts or tumors, and do not produce any clinical symptoms, in which case they should be removed [14]. Displacement of the adjacent tooth is common (deciduous tooth or permanent tooth bud) [1,9]. It may occur in cases when the impacted and neighboring permanent teeth are in close contact. It is also seen in cases of deep palatally- impacted maxillary canines and adjacent lateral incisors, lower third and adjacent second molars or mesiodens and adjacent central incisors. Displacement is mostly the result of uncontrolled force during extraction, although the loss of supporting bone during surgery may be influential [9]. In case of this complication, the treatment modality would be to place the displaced tooth in its previous position and immobilize it for three to four weeks. Fixation often can be obtained using additional sutures placed laterally across the occlusal surface, thereby holding the tooth in place. Use of other means of fixation, including dental wires, arch bars, and composite splints, has also been effective [15]. The patient should be given a soft diet.

2.1.1.1. Displacement of lower third molars

During surgery of impacted teeth, especially in cases of third molars, accidental displacements into the lingual, submandibular, pterygomandibular, infratemporal and maxillary sinus spaces may be seen. Lower third molars are more commonly displaced to one of anatomic spaces than other impacted teeth. Reasons for this complication may be of anatomic nature, angulation of the tooth, dehiscence in lingual cortical plate, excessive or uncontrolled force, lack of experience of the surgeon, or inadequate clinical and radiographic examinations [16,17]. Distolingual angulated lower third molars are the most prone to be displaced, comparing with other positions (Figs. 2,3) [18].

Figure 2. Axial CT scan shows the displaced lower right third molar in the sublingual space.

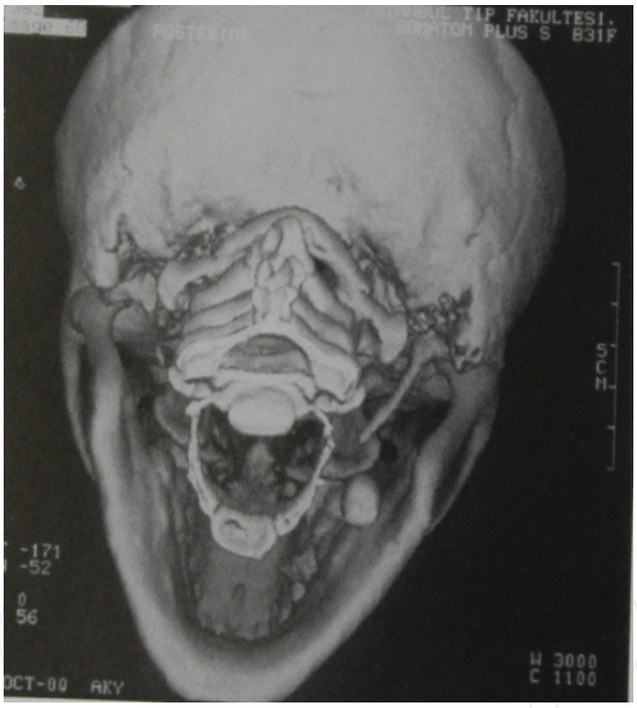

Figure 3. Coronal CT scan of the same patient shows the position of the displaced tooth.

The lingual plate is thin and easy to perforate ; these are the most important factors for displacement of lingually positioned lower third molars into the sublingual and submandibular spaces [16]. Placement of a retractor or finger lingually may prevent this mishap. Although in some cases displaced teeth might be asymptomatic [14], persistent pain and swallowing of adjacent anatomic spaces or trismus are the most common symptoms that may insue [9]. Surgical approach to displaced teeth may be achieved by intraoral incision only, but sometimes it may be necessary to do a combined intraoral and extraoral approach with a submandibular

incision in the neck [9,14,16]. A modified approach for removing fragments displaced lingually is to osteotomize the lingual plate and then approach the fragments [9].

The second most common location for displaced lower third molars is the pterygomandibular space [9]. The displaced tooth or fragments may lodge near the inferior attachment of the medial pterygoid muscle, which is difficult to diagnose without computed tomography(CT). Clinical symptoms include trismus and swelling on the lingual aspect of the mandibular angle [20]. Removal of displaced teeth is usually by intraoral approach, except in cases of deeply positioned teeth, when an extraoral approach is necessary [20].

Although rarely seen, lower third molars might be displaced into the lateral pharyngeal space [17-19]. Clinical symptoms usually include significant swelling and edema in the neck and cheek region including the retromolar region. In diagnosis of a displaced tooth or its fragment, panoramic, lateral, posteroanterior, occlusal radiographs and CT images can be useful [18]. If the fragment is displaced near the tonsils, tonsillectomy may have to be considered to remove the fragment [17].

2.1.1.2. Displacement of upper third molars

Removal of impacted maxillary third molars is a simple and easy procedure. Although rarely reported, displacement of either a root fragment, the crown, or the entire tooth into the infratemporal fossa and maxillary sinus space may occur [21-27]. Several factors that may predispose to tooth displacement into the infratemporal fossa including: Incorrect extraction technique, distolingual angulated tooth, decreased visibility during surgical removal or limited bone distal to the third molar [21]. To prevent a displacement of the tooth into the infratemporal fossa, use of a distal retractor is recommended. Displacement is usually through the periosteum adjacent to the lateral pterygoid plate and inferior to the lateral pterygoid muscle; the tooth may lodge between the zygomatic arch and lateral pterygoid plate [22]. It is difficult to be determined clinically without a new panoramic x-ray and CT scans. Clinical symptoms of a displaced tooth into the infratemporal fossa may vary from asymptomatic to symptomatic with swelling, pain, limitation of mandibular motion or even trismus, if fibrosis is present [23]. Some authors are in opinion that displaced teeth can migrate downwards into the oral cavity, allowing an easy surgical removal [21,23,24]. However, Gulbrandsen et al. [26] does not share this opinion because of fibrosis and anatomic boundaries of the infratemporal space. Therapeutic approaches to displaced teeth into the infratemporal fossa may include coronal, Gillies, Caldwell-Luc or resection of the coronoid process [21-27]. Some authors prefer to postpone the retrieval surgery for two weeks based until fibrous tissue formation immobilizes the tooth and the possibility that inferior displacement of the tooth may occur [25]. This delay also avoids the possible displacement of the tooth deeper to the skull base if an early retrieval attempt is performed [25]. The second most common displacement location of maxillary third molars is the maxillary antrum. It is important to note that the occurrence of this complication is in a close relation with excessive apical force during use of elevators and incorrect surgical technique [9]. Also deeply positioned upper third molars without formed roots are prone to this. Especially when the roots of the maxillary third molar are only half formed and the tooth is located in a more inferior position (Figs. 4-6).

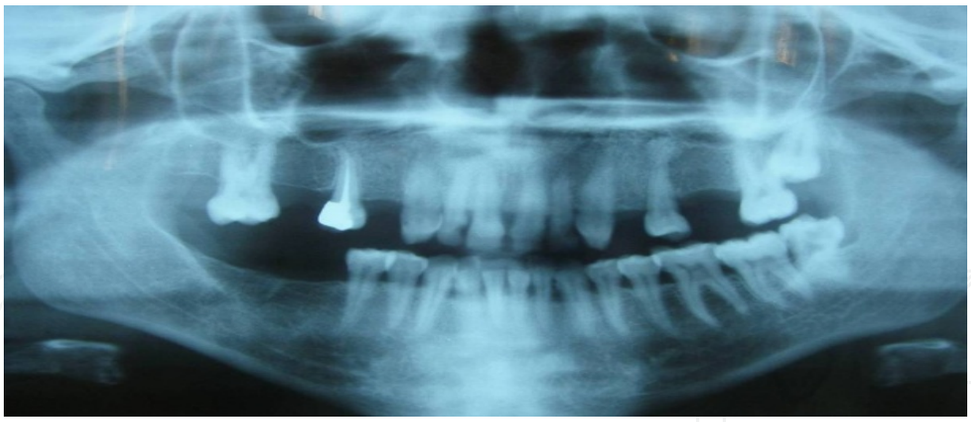

Figure 4. Preoperative panoramic radiograph shows impacted upper left third molar.

Figure 5. Control panoramic radiograph from the same patient, shows displacement of the tooth into the infratemporal space.

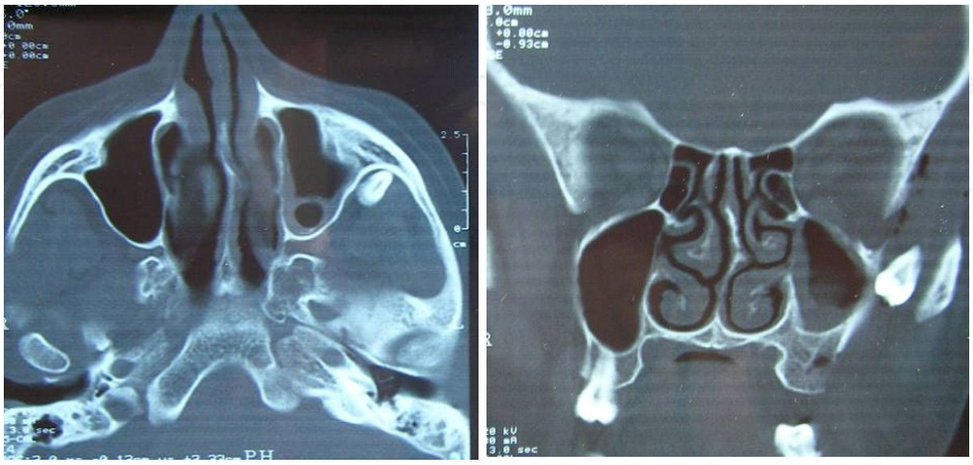

Figure 6. Axial CT (left) and coronal CT scan (right) shows the position of the displaced tooth in the infratemporal space.

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The presence of a tooth, as a foreign body, inside the sinus may lead to complications such as infection, and thus its surgical removal is strongly recommended [15,27]. The management of removal foreign bodies from the maxillary sinus space includes a several methods such as Caldwell-Luc procedure and transnasal maxillary sinus surgery [27]. Access to the maxillary sinus is achieved through the nose via the ostium. The foreign body is captured and removed using an urological retrieval basket through the endoscopic working channel port. The advent of endoscopic techniques has made it the preferred choice, especially for patients with chronic sinusitis. In contrast to the endoscopic technique, which involves accessing the maxillary sinus via the nose, the Caldwell-Luc procedure involves gaining access to the maxillary sinus by a fenestration of the anterior lateral wall of the maxillary sinus or canine fossa.

One of the rare displacements of deeply and buccaly positioned maxillary third molars is into Bichat's fat pad. Incorrect use of the elevator may lead to a fracture of the buccal bone, which consists mostly of trabecular bone with a thin cortical layer, and push the tooth into the buccal space. The risk increases if the bone height buccal and/or distal to the molar is inadequate [28].

Impacted upper canines, or mesiodens, if deeply positioned, may be displaced into the nasal cavity during surgery [9].

Teeth and their fragments are not the only objects displaced into anatomic spaces. In the literature accidental displacement of a high-speed handpiece bur during third molar surgery has been described [29]. One of the reasons for this is attributed to improper excessive use of force during the surgery.

2.1.2. Soft tissue complications

Soft tissue complications during surgery of impacted teeth involves several injuries such as injuries of the neighbouring soft tissues including Bichat's fat pad, hemorrhage and hematoma formation or surgical emphysema [9].

Buccal fat also known as Bichat's fat pad is one of several encapsulated fat masses in the cheek located on both sides of the face between the buccinator muscle and the masseter, the zygomaticus major, and the zygomaticus minor [30]. Injury of the buccal fat pad is mostly the result of deep incision performed during upper third molar surgery (Fig. 7).

Hemorrhage is a common complication during and after surgery, and can be of either local or systemic nature. Systemic conditions include hemophilia A or B, von Willebrand's disease etc., thus good anamnesis is important in approach to maximize the patient’s ability to form a stable clot [9,31]. Hemorrhage complicating third molar surgery has ranged from 0.2% to 5.8% [31]. It is of note that impacted mandibular third molars show a higher risk of hemorrhage compared to maxillary third molars [31,32]. Tooth position and inclination including patient age are important factors in development of this complication; thus deeply positioned and distoangular or horizontally- positioned lower third molars show a higher risk of hemorrhage. In the upper jaw high vertically- positioned third molars are most often implicated [33]. Old patients are more prone to this complication [32,33].

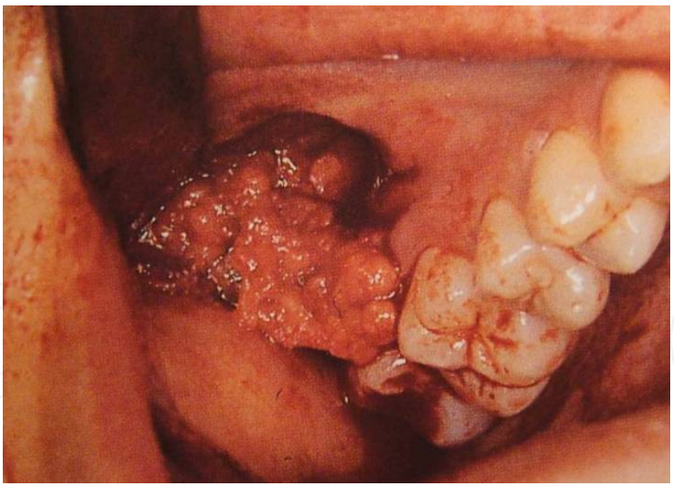

Figure 7. Prolapse of Bichat's fat pad during upper third molar surgery.

A hematoma is defined as a collection of blood in a virtual space. The size and spread of a hematoma depends on its vascular origin (capillary, venous or arterial) and the tissue into which it is bleeding (muscle, fat or interstitia) [33]. It stops expanding when the pressure of the pooling blood exceeds the vascular pressure of the bleeding site. However, in some cases hemorrhage and hematoma formation can occur into deeper spaces without immediate signs or symptoms. This complication often occurs during injection of local anesthesia without aspiration in the buccal vestibule [33]. In management of hematoma antibiotic therapy and follow up for next 2-5 days may be necessary [9].

Iatrogenic surgical subcutaneous emphysema another complication of third molar surgery occurs when an air-driven high-speed turbine is used for tooth sectioning; air is forced into the soft tissue through the reflected flap and invades the adjacent tissues [9,34]. Flap size for exposure of impacted tooth and bone may also play a role in subcutaneous emphysema development. For these reasons, a low-speed straight handpiece with copious sterile saline irrigation should be used during osteotomy and tooth separation. Clinical signs are local swelling, tenting of the skin and crepitation on palpation immediately after tooth sectioning. However, in some cases the symptoms develop after the surgery making the differential diagnosis of emphysema difficult. It is important to mentioned that air may pass through the masticatory space into the parapharyngeal and retropharyngeal areas, penetrating into the mediastinum [34].

2.1.3. Nerve injuries

Nerve injuries are mostly associated with removal of mandibular impacted teeth (third molars and premolars). The inferior alveolar nerve (IAN), lingual and mental nerves are the most prone to injury during anesthesia and surgical procedures [35-38]. However, available literature describes a case of facial nerve injury during upper third molar surgery [39].

Nerves can be damaged by traumatic, compressive or toxic injuries, which usually result in neuropraxia; however traumatic anatomic breakdown of the nerve may occur leading to

axonotmesis or neurotmesis. Neuropraxia is defined as physiological damage to the myelin sheath after transcient ischemia or metabolic disturbance characterized by transient impossibility to transmit action potentials. Whenever the causative factor is removed, the damage of the Schwann cells and the impairment of the myelin sheath can heal completely [40]. Axonotemesis is antomic breakdown in the axon without cutting the nerve trunk. It may be seen even in cases where the irritating factor (for example displaced rooth fragment near inferior alveolar nerve) is not removed. Complete breakdown of axons is defined as neurotmesis. Axonotmesis and neurotmesis can lead to subsequent paresthesia which may almost never resolve [40]. Neurosensory dysfunctions associated with nerve injuries includes anesthesia or numbness (loss of sensation, because of damage to a nerve or receptor), paresthesia (abnormal touch sensation, such as burning, prickling or formication, often in the absence of an external stimulus), dysesthesia or hypoesthesia. The incidence of temporary neurosensory disturbances after third molar surgery is more than 20% in the first 24 hours postoperatively and range from 0.3% to 5.3 % after six months [41]. The nerve damage depends of several factors such as type of anesthetic, state of eruption, depth of impaction, patient age, experience of the surgeon and type of lingual flap retraction [38,41]. Some studies suggest that the patient's age increases the risk of inferior alveolar nerve damage, but only in the presence of other preoperative risk factors such as the anatomic relation between the third molar roots and the mandibular canal [36,37]. Radiographically, diversion of the canal, darkening of the roots and interruptions of the“ white lines“ are indicative signs of close relation of third molars with the inferior alveolar canal [37]. Clinical symptoms of lingual nerve damage can vary from drooling, tongue biting, a burning sensation of the tongue, burns on the tongue from hot food and drinks, pain, change in speech pattern and change in taste perception of foods and drinks [38].

Lingual nerve damage is mostly seen when a lingual flap is reflected during third molar surgery; and because of this, placement of a lingual retractor such as Howarth's, Ward's, Maede's, Howell's or Rowe's retractor on the lingual bone subperiosteally is strongly recommended [35,38]. The lingual nerve can be within 1mm of the bone –essentially in the periosteum-on the lingual or distal aspect of the third molar [38].

In cases of maxillary third molar surgery, facial nerve paralysis may develop after local dental block anesthesia or even after tooth extraction [9,39]. Although the mechanism of development after dental procedures is unknown, there are three explanations of its occurrence such as: Direct trauma to the nerve from the needle, intraneural hematoma formation or compression and local anesthetic toxicity. However, a blast of air into the tissue with dissection through the fascial spaces mayalso cause facial nerve paralysis. Thus, forced air while cleaning an extraction site should not be used [39].

2.1.4. Bone complications

Bone complications associated with surgery of impacted teeth include mandibular or maxillary fractures, mostly associated with position of the impacted tooth or improper excessive use of force during the surgery. In some cases this complication must be predicted (Fig. 8).

Figure 8. Panoramic radiograph shows deeply positioned lower right impacted teeth.

2.1.4.1. Mandibular fracture

One of the commonly seen complications associated with impacted lower wisdom teeth is the fracture of the mandibular angle. Angle fractures were the subjects of many studies in which the fracture risks and therapeutic approaches were evaluated [42-47]. Oikarinen and Malmström in their study, evaluating 1248 maxillofacial fractures, found that 17 % of the cases were the fractures of the mandibular angle [42]. Fractures may result from high force impact or stress and certain medical conditions that weaken the bones (osteoporosis, osteogenesis imperfecta, bone cysts and tumours etc.). Factors that play an important role in the angle fractures are the patient age, atrophic and sclerotic mandible, tooth position, dental ankylosis, abnormality of the number, shape and size of the roots, and presence of odontogenic lesions [9, 46].

Impacted teeth also play an important role, leading to weakness of the angular bone and mandibular fracture [9]. A study by Schön et al. have shown 43% of fractures were found in the mandibular angle, and in these fractures, 97% were associated with the presence of third mandibular molars [47].

Fractures develop during and after third molar surgery. The study of Wagner et al. [44] evaluated mandibular fractures following third molar removals and the results showed that 14 out of 17 fractures occurred postoperatively. Although in many cases no fracture was visible on radiographs during the primary investigation, a cracking noise reported later by the patient was the most important indication of a fracture. The authors also concluded that food chewing might play an important role in postoperatively fractures with suggestions for soft diet for up to 4 weeks after the operation [44]. The same authors also presented a case of mandibular fracture associated with osteomyelitis following third molar surgery [44]. In many cases depending on impacted tooth position and angulation ostectomy must be performed. This leads to weakening of the bone, mandating use of the less force by elevators and forceps for

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removal of impacted teeth. An animal study by Reitzik et al. showed that less force is necessary to fracture mandibles with impacted third molars than mandibles with erupted third molars concluding that they significantly weaken the mandible (Figs. 9,10) [45].

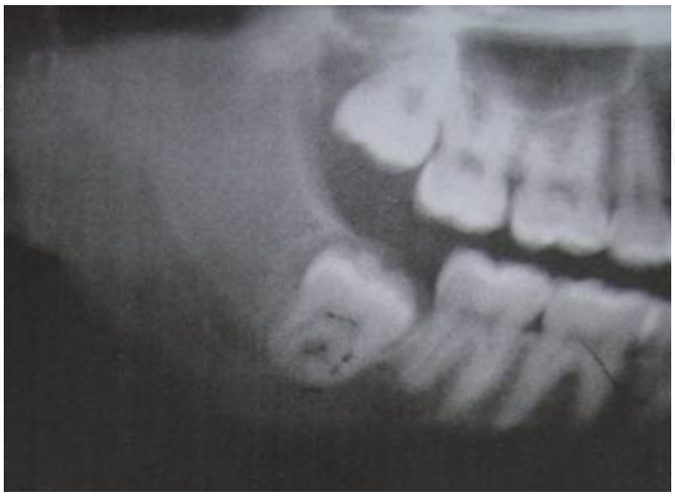

Figure 9. Preoperative radiograph of impacted lower right wisdom tooth.

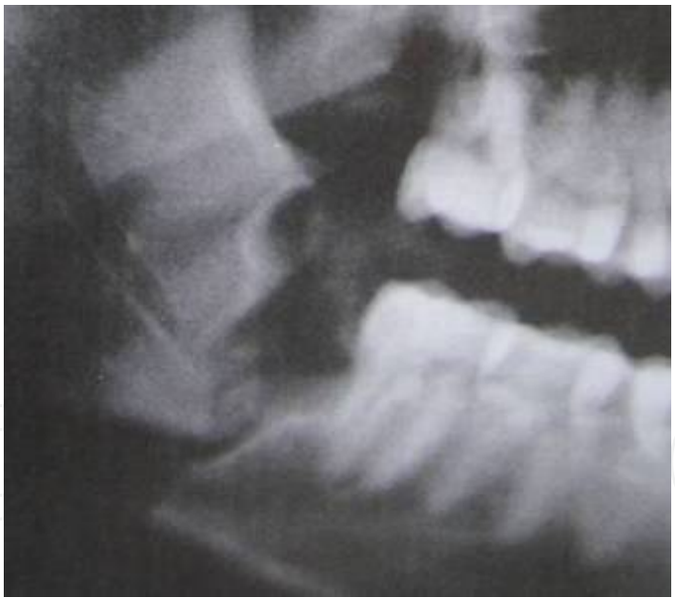

Figure 10. Postoperative radiograph of the same patient shows a mandibible fracture in the area of the extracted tooth.

The risk of the angle fractures is higher if the presence of bone sclerosis, atrophy or dental ankylosis is noted; bone sclerosis increases with age, thus a lower incidence of fracture is seen in the younger patients. Wagner et al. state that the mandible angle fractures were mostly seen in the male patients at the mean age of forty [44].

2.1.4.2. Fractures of the maxillary tuberosity

Fracture of the maxillary tuberosity is complication associated with extraction of upper molars. There is an opinion that that a maxillary tuberosity is more predisposed to fracture, if the maxillary sinus has enlarged between the teeth and into the tuberosity creating thin bony walls [9]. Dental anomalies of the maxillary molars may also be contributory including; tooth fusion, tooth isolation, over eruption, ankylosis, hypercementosis, chronic periapical infection and roots which are widely divergent [9, 48]. This complications is rarely seen in cases of unerupted wisdom teeth, because it usually develops during extraction of first and second erupted molars.

Clinical signs and diagnosis of the maxillary tuberosity fractures include crunch or loud crack of bone breaking, sudden loosening of the tooth and bone together, with segment still attached to soft tissue and observable opening into the maxillary sinus (visible hole or "hollow" sound when suctioning the socket). Mobility of fracture fragments will confirm the maxillary tuberosity fracture, which will be diagnosed by radiographs [9]. However, in some cases the fracture may be asymptomatic, thus diagnosis is delayed. The patient may complain of sharp pain at the time of fracture, reflux of fluids from mouth to nose, sinus stuffiness, or presence of overt sinusitis. Management of maxillary tuberosity fracture include a few steps; the procedure of extraction must be stopped before inadvertent laceration of the soft tissue occurs. In cases of small fractures without sinus perforation, dissection of the fractured segment (including the tooth with small bony fragments) from gingiva and periosteum should be done and sutured. If sinus perforation (less than 3 to 4 mm) occurs, dissection of the segment and closure of the socket primarily and use of gelatin sponges (Gelfoam® sponge) to obturate the opening is recommended (Figs. 11,12) [9,48,49].

Figure 11. Panoramic radiograph of the patient after extraction of upper left first molar

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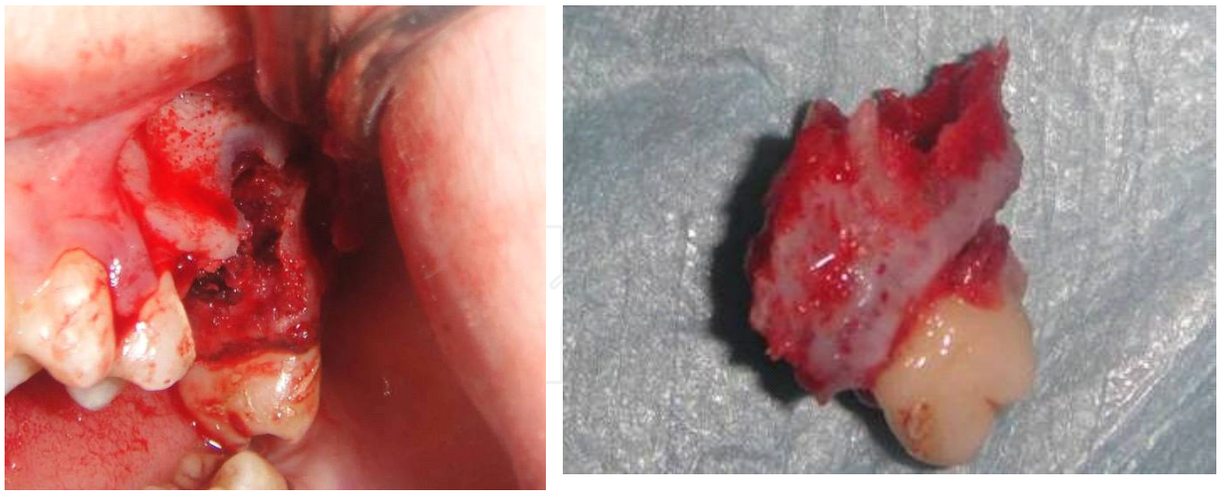

Figure 12. Intraoral view of the same patient with fractured maxillary tuberosity.

In cases of a large bony fragment, it is recommended that the extraction be abandoned and surgical removal of the tooth be performed at a later date using root sectioning. The clinician that the dentist tries to detach the fractured tuberosity from the roots, or that the dentist stabilizes the mobile part(s) of the bone by means of a fixation technique for 4–6 weeks; after union surgical removal without the use of a forceps is done [49]. However, if the large segment includes multiple teeth, stabilization for 6 to 8 weeks by wiring to the adjacent teeth, allowing the segment to heal and then returning for the extraction in a more controlled fashion should be performed. Large bone fragments usually means large oro-antral communication (4 mm or greater). Its management may require more specialized procedures such as the mobilization of local flaps, autogenous or allogenic bone, or use of synthetic materials. The patient must be under antibiotics and decongestants therapy, following instructions such as avoiding nose blowing, smoking, etc., so the oro-antral communication does not reopen [9]. Consequences of maxillary tuberosity fractures include oro-antral fistula formation, sinusitis and poorer retention for eventual prostheses. Every patient undergoing maxillary molar extraction should be advised of the possibility of tuberosity fracture.

2.1.5. Maxillary sinus complications

Extraction of impacted maxillary teeth may lead to development of maxillary sinusitis and chronic oroantral fistula formation, if an oroantral communication is present. The size of the communication and the preoperative sinus status are important factors [15]. Incidence of perforating Schneiderin membrane during third molar surgery is not low. In a multicentric study Rothamel et al., reported a 13% rate mostly associated with intraoperative fracture of the root, higher degree of impaction and higher age of the patient [50]. Due to fact that many oral and maxillofacial surgeons in cases of diagnosed sinus mucosa perforations use a buccal sliding mucoperiostal flap to close the oroantral comunication, the incidence of oroantral fistula is not very high. Some authors suggest that the incidence is 0,06% [33].

2.1.6. Complications associated with surgical equipment

Complications associated with surgical equipment are mostly the result of metal fracturing because of effects of heat, torsion etc. Torsional strength and flexibility of the instruments, making them more prone to fracture under torsional stress. Improper excessive use of force during the surgery, may also lead to breaks. In cases of the instrument fracture, fragments should be immediately removed.

2.1.7. Swallowing and aspiration

Swallowing or aspiration of the extracted tooth or its fragments may be encountered. The incidence is around 0.004% [51] and sometimes it may be associated with the dental practitioner's lack of experience. The study of Obinata et al. [51] have showed that accidental ingestion was more common in dentists with careers shorter than 5 years. Accidental swallowing usually does not cause any clinical signs or symptoms thus most of the foreign objects are passed after passage through the gastrointestinal tract without complications within 7-10 days. [51,52]. However, if the patient develops symptoms of perforation, such as pain, vomiting, tenderness or abdominal guarding, and if objects remain lodged longer than 2 weeks, surgical intervention is required [51]. Ingested objects might be diagnosed by X-ray of the esophagus, the stomach and the intestine.

Comparing with swallowing, aspiration during tooth extraction is rarely seen and there is an opinion that the cough reflex is responsible for it. Right main-stem bronchus, due to fact that is more wider, shorter, and more vertical than the left main bronchus, is the most common location of aspirated foreign bodies. In cases of aspiration the patient should be immediately referred to a pulmonologist for identification and potential removal of the foreign body. If a foreign object is lost into the oropharynx, the patient should be placed in a reclining position, and encouraged to cough vigorously to secure the airway [51]. The Heimlich maneuver for relieve the laryngeal obstruction may be required. Symptoms such as choking, inspiratory stridor, and labored breathing are signs of airway obstruction [53].

For accurate diagnosis and to avoid unnecessary complications such as recurrent pneumonia, lung abscess, bronchiectasis and hemoptysis, a chest X-ray is necessary. It is important to note that elderly patients may show impairment of sensory and motor nerve responses, which could result in deterioration or dysfunction of the gag/cough reflex [51].

2.2. Complications after the impacted teeth surgery

Pain, swelling, trismus, hemorrhage and dry socket are the most common symptoms following removal of impacted teeth [15,54-58]. Morbidity increases with age of the patient, position and location of the tooth (for example, deeper impactions are more prone to develop complications), and duration of the surgical procedure [55]. Sequelae of the surgery have a direct effect on the quality of the patients life [56]. Sex of the patient may have also an influence on the complication development; a female patient due to the small size of their jaws, limited surgical field, hormonal status and more dense bone may make the surgery more difficult and traumatic [57,58].

2.2.1. Pain

Pain usually begins after the anesthesia from the procedure wears off and reaches peak levels 6 to 12 hours postoperatively [54,58]. It is usually moderate and of short duration for the first 24-48 hours [56]. Pathophysiology of pain may be explained by facts that following tissue injury or inflammation, there is a sequential release of mediators from mast cells, the vasculature and other cells. Histamine and serotonin appear first, followed shortly after by bradykinin and later prostaglandins. Bradykinin has been shown to produce pain in man when given intradermally, intraarterially or intraperitoneally and the hyperalgesia associated with prostaglandin is also due to its potentiation of Bradykinin [58,59].

For management use of different analgesics, including paracetamol and nonsteroidal antiinflammatory drugs, either alone or in combination with steroids and narcotics is necessary [54,56]. Many studies evaluated an influence of surgical techniques,closure techniques, use of drugs such as analgesics, corticosteroids, and antibiotics and laser application on pain intensity and duration.Some authors reported a correlation between operation time duration and analgesic use over the first 48 hours post surgery [58,60,61]. The longer duration of the surgery leads a longer tissue injury. In this way more mediators are released and therefore could be a reflection of the severity of pain, swelling and trismus [58]. In cases of secondary wound healing, the incidence of pain is lower, compared with primary wound healing [62-66].

2.2.2. Swelling and surgical edema

The swelling or surgical edema usually reaches a maximum level 2 to 3 days postoperatively and should subside by 4 days and resolve by 7 days [54]. Bello et al. [58] reported that risk of swelling might be associated with increasing age of the patient, while results of Akadiri et al. [62] showed that sex, weight, and body surface area are significant determinants of facial swelling. Mucoperiosteal flap designs may play also an important role in postoperative surgical edema development, thus those flaps which ensure a secondary healing, because of wound drainage, lead to lower incidence of swelling [63-66].

Patient comfort and postoperative swelling limitation may decrease by preoperative use of systemic corticosteroids and ice, postoperatively. Markiewicz et al. [67] showed that preoperative administration of corticosteroids produces a mild to moderate reduction in edema and improvement in range of motion after third molar surgery.

The role of the assistant during an operation should not be neglected in our opinion, thus, if the cheek or soft tissue retractors are manipulated with brute force, a transient barrier of normal lymph drainage may be breached causing unnecessary swelling.

2.2.3. Trismus

Trismus or difficulty opening the mouth, is often the result of surgical trauma and is secondary to masticatory muscle inflammation following lower third molar surgery. The patient may feel jaw stiffness with difficulty to brush, talk, or eat normally. The most common injured muscle is the medial pterygoid muscle, and reasons for its injury might include several factors such

as injury caused by a needle, swelling, hematoma, and inflammation. If the mouth stays open for too long, trismus may be expected [9]. So, its development is correlated with operation time [58,60,61]. In most cases, the trismus is temporary. Preoperative use of steroids may be helpful in reduction of trismus [54,57]. Postoperatively, patient mouth opening exercises should be performed leading to the preoperative level of function. Also, use of muscle relaxants such as chlorzoxazone (Parafon Forte tablets) is helpful in trismus management [58].

2.2.4. Infection (alveolar osteitis / alveolitis / dry socket, osteomyelitis)

Postoperative inflammatory conditions, including surgical site infections, abscess, alveolar osteitis or even osteomyelitis are complications after surgical removal of impacted teeth, with an estimated frequency of 1% to 30% [54]. Host bacteria within the operative sites, tooth position, operation procedure, surgical equipment and medical status of the patient are just some of many risk factors associated with these complications. One of important factor is flap design, especially in case of lower third molars. Although opinions are controversial, some authors [64] state that the modified triangular flap and primary wound healing leads to higher risk of the alveolar osteitis. Kirk et al. [66] felt alveolar osteitis was more common in cases of envelope flap and secondary wound healing. Alveolar osteitis or dry socket is complication characterized by postoperative pain in and around the extraction site, which increases in severity at any time between 1 and 3 days after the extraction accompanied by a partially or totally disintegrated blood clot within the alveolar socket with or without halitosis [67]. In some cases a blood clot fails to form in the socket. Bacteria and their products are mostly responsible for fibrinolysis of the blood clot, thus numerous studies examined influence of different antibacterial agents on dry socket development [68-71]. Results of the studies showed that pre- and postoperative rinsing the mouth with chlorhexidine [68-70] and application of chlorhexidine gel into the alveolus [71] may lead to decreasing incidence of dry socket. Metin et al.[70] concluded that the postoperative use of chlorhexidine is more effective.

Osteomyelitis, following surgery of impacted teeth is rarely seen.The disease is characterized by accumulation of an inflammatory exudate in the bony medullary cavity and beneath the periosteum, causing compression of the central (sinusoidal) and peripheral blood supply to the bone. Necrotic tissue promotes the proliferation of bacteria, which, without appropriate intervention, will result in incomplete healing and progression of disease [72]. Osteomyelitis is mostly associated with trauma (fracture related) and dentoalveolar infection [73]. However, it seems that atypic position of tooth may also play a role in osteomyelitis development [74]. Schoen et al. [73], state surgical extraction of impacted third molars in acute inflammation phase, may contribute to expansion of the abscess formation, thus, predisposing to osteomyelitis occurence. As we have mentioned before, fractures (mandibular and maxillary), may lead to osteomyelitis.

2.2.5. Bone or soft tissue hemorrhage

Postoperative bleeding is a risk in all surgical procedures including impacted teeth surgery. It can result from one or more causes. It is important to mention that in many cases intraoperative

bleeding may lead to postoperative bleeding and the risk of hemorrhage is lower in cases of primary wound healing by hermetically suturing the socket [63,75].

2.2.6. Delayed healing and wound dehiscence

Extraction of impacted teeth involves the manipulation of both soft and hard tissues, thus approach to the teeth means that a mucoperiosteal flap be created and osteotomy be performed. After extraction of the teeth the flap is usually placed in its previous position and sutured.This is primary wound healing. However, design of the flap may play an important role in wound healing [63-66,76,77]. Impacted lower third molars are the most common subjects of different studies including wound healing and flap designs. Different designs for the raising mucoperiosteal flaps to expose impacted lower third molars were presented by various authors, but the most common used designs are modified triangle flaps and the envelope / sulcular flap [65,66,76,77]. Clinical practitioners and authors are in opinion that modified triangle flaps give better results, being significantly less likely to develop dehiscence and thus secondary healing of the wound [63-66,76,77]. Jakse et al. [77] showed that the conventional sulcular flap design has a nearly 6-times higher risk of rupture of the primary wound closure than the modified triangular flap. Secondary healing might be responsible for longer periods of discomfort, continuous pain and possibly increased incidence of alveolar osteitis along with the loss of gingival attachment distal to the second molar [66]. However, secondary healing has some advantages such as reduction of swelling, pain and trismus after the surgery [63-66]. It is worth mention that every type of mucoperiosteal flap in the area of alveolar process that exposes the alveolar bone to the buccal cavity, may induce bone resorption, because of growing activity of osteoclasts [65].

3. Conclusion

The occurrence of the any complication mentioned in this chapter should be stated to the patient. In cases of the swallowing or aspiration of the extracted tooth patients must be referred immediately to an emergency department. Due to the fact that many of the mentioned complications may be of iatrogenic origin, the surgeon must be prepared for the mishaps and know how to manage them.

Author details

Çetin Kasapoğlu[2], Amila Brkić[1], Banu Gürkan-Köseoğlu[2] and Hülya Koçak-Berberoğlu[2]

1 Department of Oral Surgery, Faculty of Dentistry, Sarajevo University, Sarajevo, Bosnia and Herzegovina

2 Department of Oral and Maxillofacial Surgery, Faculty of Dentistry, Istanbul University, Istanbul, Turkey

References

[1] Jojić, B. & Perović, J.V.(1990). Oralna hirurgija (4th edition), Naučna knjiga, Beograd.

[2] Hupp, J.R, Ellis III, E. & Tucker, M.R.(2008) Contemporary oral and maxillofacial surgery (5th edition), Mosby Elsevier, St. Louis, Missouri.

[3] Alling C.C, Helfrick J.F & Alling R.D. (1993). Impacted Teeth. W.B. Saunders. Philadelphia.

[4] Ahlqwist, M. & Gröndahl, H.G.(1991). Prevalence of impacted teeth and associated pathology in middle- aged and older Swedish women. Community Dent Oral Epidemiol. Vol 19, No 2. pp. 116-119.

[5] Brown LH, Berkman S, Cohen D, Kaplan AL, Rosenberg M. A radiological study of the frequency and distribution of impacted teeth. J Dent Assoc S Afr. 1982 Sep;37(9):627-30.

[6] Knutsson, K., Brehmer, B., Lysell, L. & Rohlin, M. (1996). Pathoses associated with mandibular third molars subjected to removal. Oral Surg Oral Med Oral Pathol Oral Radiol and Endod. Vol 82, No 1. pp.10-7.

[7] Sasano, T., Kuribara, N., Iikubo, M., Yoshida A, et al. (2003). Influence of an angular position and degree of impaction of third molars on development of symptoms: Long term follow-up under good oral hygiene condition. Tohoku Journal of Experimental Medicine. Vol 200, No 2. pp.75-83.

[8] Gisakis, I.G, Palamidakis, F.D., Farmakis E.T.R, Kamberos, G. & Kamberos, S.(2011). Prevalence of impacted teeth in a Greek population. Journal of Investigative and Clinical Dentistry Vol 2, No2. pp.102–109.

[9] Kasapoğlu Ç, Gürkan-Köseoğlu B, Koçak-Berberoğlu H (2005). Gömük diŞler.Nobel ilaÇ. Istanbul

[10] Bataineh, A.B., Albashaireh, Z.S. & Hazza'a, A.M.(2002). The surgical removal of mandibular third molars: a study in decision making. Quintessence Int. Vol 33, No 8. pp. 613-617.

[11] Lysell, L. & Rohlin, M.(1998). A study of indications used for removal of the mandibular third molar. Int J Oral Maxillofac Surg. Vol 17, No 3. pp.161-164.

[12] Punwutikorn, J., Waikakul, A. & Ochareon, P.(1999). Symptoms of unerupted mandibular third molars. Oral Surg Oral Med Oral Pathol Oral Radiol Endod. Vol 87, No 3. pp.305-310.

[13] Ming-Yu Li (2012).Contemporary approach to Dental Caries.InTech, Croatia.

[14] Aznar-Arasa L, Figueiredo R, Gay-Escoda C. Iatrogenic displacement of lower third molar roots into the sublingual space: report of 6 cases. J Oral Maxillofac Surg. 2012 Feb;70(2):e107-15.

[15] Susarla SM, Blaeser BF, Magalnick D,Third molar surgery and associated complications. Oral Maxillofacial Surg Clin N Am 15 (2003) 177–186.

[16] Nusrath MA, Banks RJ. Unrecognised displacement of mandibular molar root into the submandibular space. Br Dent J. 2010 Sep 25;209(6):279-80.

[17] Esen E, Aydoğan LB, Akçali MC. Accidental displacement of an impacted mandibular third molar into the lateral pharyngeal space. J Oral Maxillofac Surg. 2000 Jan;58(1): 96-7.

[18] Ortakoğlu K, Okcu KM, Karasu HA, Günaydin Y. Accidental Displacement of Impacted Third Molar into Lateral Pharyngeal Space. Turk J Med Sci 32 (2002) 431-433.

[19] Ertas U, Yaruz MS, Tozoğlu S. Accidental third molar displacement into the lateral pharyngeal space. J Oral Maxillofac Surg. 2002 Oct;60(10):1217.

[20] Tumuluri V, Punnia-Moorthy A. Displacement of a mandibular third molar root fragment into the pterygomandibular space. Australian Dental Journal 2002; 47(1): 68-71.

[21] Patel M, Down K. Accidental displacement of impacted maxillary third molars. Br Dent J. 1994;177:57-9.

[22] Oberman M, Horowitz I, Ramon Y. Accidental displacement of impacted maxillary third molars. Int J Oral Maxillofac Surg.1986;15:756-8.

[23] Sverzut CE, Trivellato AE, Sverzut AT, de Matos FP, Kato RB. Removal of a maxillary third molar accidentally displaced into the infratemporal fossa via intraoral approach under local anesthesia: report of a case. J Oral Maxillofac Surg. 2009;67:1316-20.

[24] Dimitrakopoulos I, Papadaki M. Displacement of a maxillary third molar into the infratemporal fossa: case report. Quintessence Int. 2007;38:607-10.

[25] Gómez-Oliveira G, Arribas-García I, Alvarez-Flores M, Gregoire-Ferriol J, Martínez-Gimeno C. Delayed removal of a maxillary third molar from the infratemporal fossa. Med Oral Patol Oral Cir Bucal. 2010 May 1;15(3):e509-11.

[26] Gulbrandsen SR, Jackson IT, Turlington EG. Recovery of a maxillary third molar from the infratemporal space via a hemicoronal approach. J Oral Maxillofac Surg. 1987;45:279-82.

[27] Sverzut CE, Trivellato AE, Lopes LMF, Ferraz EP, Sverzut AT. Accidental Displacement of Impacted Maxillary Third Molar: A Case Report. Braz Dent J (2005) 16(2): 167-170.

[28] Kocaelli H, Balcioglu HA, Erdem TL. Displacement of a maxillary third molar into the buccal space: anatomical implications apropos of a case. Int J Oral Maxillofac Surg. 2011 Jun;40(6):650-3.

[29] Yalcin S, Aktas I, Emes Y, Atalay B. Accidental displacement of a high-speed handpiece bur during mandibular third molar surgery: a case report. Oral Surg Oral Med Oral Pathol Oral Radiol Endod 2008;105:e29-e31.

[30] Zhang Yan YP, Qi KM, Wang JQ, Liu, ZF. Anatomical structure of the buccal fat pad and its clinical adaptations". Plastic and reconstructive surgery 2002;109 (7): 2509–18; discussion 2519–20.

[31] Bouloux GF, Steed MB, Perciaccante VJ. Complications of third molar surgery. Oral Maxillofac Surg Clin North Am. 2007 Feb;19(1):117-28.

[32] Jensen S. Hemorrhage after oral surgery. An analysis of 103 cases. Oral Surg Oral Med Oral Pathol. 1974 Jan;37(1):2-16.

[33] Moghadam HG, Caminiti MF. Life-threatening hemorrhage after extraction of third molars:case report and management protocol. J Can Dent Assoc. 2002 Dec;68(11):670-4.

[34] Romeo U, Galanakis A,Lerario F, Daniele GM, Tenore G, Palaia G. Subcutaneous Emphysema During Third Molar Surgery: A Case Report. Braz Dent J.2011; 22(1): 83-86.

[35] Blackburn CW, Bramley PA. Lingual nerve damage associated with the removal of lower third molars.Br Dent J 1989;167:103-7.

[36] Valmaseda-Castellon E, Berini-Aytes L, Gay-Escoda C. Inferior alveolar nerve damage after lower third molar surgical extraction: a prospective study of 1117 surgical extractions. Oral Surg Oral Med Oral Pathol Oral Radiol Endod 2001; 92:377.

[37] Sanmarti-Garcia G, Valmaseda-Castellon E, Gay-Escoda C. Does computed tomography prevent inferior alveolar nerve injuries caused by lower third molar removal? J Oral Maxillofac Surg 2012 Jan;70(1):5-11.

[38] Pichler JW, Beirne OR. Lingual flap retraction and prevention of lingual nerve damage associated with third molar surgery: a systematic review of the literature. Oral Surg Oral Med Oral Pathol Oral Radiol Endod. 2001 Apr;91(4):395-401.

[39] Cakarer S, Can T, Cankaya B, Erdem MA, Yazici S, Ayintap E, Özden AV, Keskin C. Peripheral facial nerve paralysis after upper third molar extraction. J Craniofac Surg. 2010 Nov;21(6):1825-7.

[40] Giuliani M, Lajolo C, Deli G, Silveri C. Inferior alveolar nerve paresthesia caused by endodontic pathosis: a case report and review of the literature. Oral Surg Oral Med Oral Pathol Oral Radiol Endod. 2001 Dec;92(6):670-4.

[41] de Beukelaer JG, Smeele LE, van Ginkel FC. Is short term neurosensory testing after removal of mandibular third molars efficacious? Oral Surg Oral Med Oral Pathol Oral Radiol Endod. 1998 Apr;85(4):366-70.

[42] Oikarinen VJ, Malmström M. Jaw fractures. Suom Hammaslaak Toim. 1969;65(1): 95-111.

[43] Wagner KW, Otten JE, Schoen R, Schmelzeisen R. Pathological mandibular fractures following third molar removal. Int J Oral Maxillofac Surg. 2005 Oct;34(7):722-6.

[44] Wagner KW, Schoen R, Wongchuensoontorn C, Schmelzeisen R. Complicated late mandibular fracture following third molar removal. Quintessence Int. 2007 Jan;38(1): 63-5.

[45] Reitzik M, Lownie JF, Cleaton-jones P, Austin J. Experimental fractures of monkey mandibles. Int J Oral Surg. 1978 Apr;7(2):100-3.

[46] Cankaya AB, Erdem MA, Cakarer S, Cifter M, Oral CK. Iatrogenic mandibular fracture associated with third molar removal. Int J Med Sci. 2011;8(7):547-53.

[47] 47. Schön R, Roveda SIL, Carter B. Mandibular fractures in Townsville, Australia: incidence, aetiology and treatment using the 2.0 AO/ASIF miniplate system. British Journal of Oral and Maxillofacial Surgery 2001; 39: 145-8.

[48] Shah N, Bridgman JB. An extraction complicated by lateral and medial pterygoid tethering of a fractured maxillarytuberosity. Br Dent J. 2005;198(9):543-4.

[49] Bruno Ramos Chrcanovic, Belini Freire-Maia. Considerations of maxillary tuberosity fractures during extraction of upper molars: a literature review. Dental Traumatology. 2011; 27(5); 393-398.

[50] Rothamel D, Wahl G, d'Hoedt B, Nentwig GH, Schwarz F, Becker J. Incidence and predictive factors for perforation of the maxillary antrum in operations to remove upper wisdom teeth: prospective multicentre study. Br J Oral Maxillofac Surg. 2007 Jul; 45(5):387-91.

[51] Obinata K, Satoh T, Towfik AM, Nakamura M. An investigation of accidental ingestion during dental procedures. J Oral Sci. 2011 Dec;53(4):495-500.

[52] Hisanaga R, Hagita K, Nojima K, Katakura A, Morinaga K, Ichinohe T, Konomi R, Takahashi T, Takano N, Inoue T (2010) Survey of accidental ingestion and aspiration at Tokyo Dental College Chiba Hospital. Bull Tokyo Dent Coll 51, 95-101.

[53] Milton TM, Hearing SD, Ireland AJ (2001) Ingested foreign bodies associated with orthodontic treatment: report of three cases and review of ingestion/ aspiration incident management. Br Dent J 190, 592-596.

[54] Susarla SM, Sharaf B, Dodson TB. Do antibiotics reduce the frequency of surgical site infections after impacted mandibular third molar surgery? Oral Maxillofac Surg Clin North Am. 2011 Nov;23(4):541-6.

[55] Baqain ZH, Karaky AA, Sawair F, Khraisat A, Duaibis R, Rajab LD. Frequency estimates and risk factors for postoperative morbidity after third molar removal: a prospective cohort study. J Oral Maxillofac Surg. 2008 Nov;66(11):2276-83.

[56] Osunde OD, Adebola RA, Omeje UK. Management of inflammatory complications in third molar surgery: a review of the literature. Afr Health Sci. 2011 Sep;11(3):530-7.

[57] Malkawi Z, Al-Omiri MK, Khraisat A. Risk indicators of postoperative complications following surgical extraction of lower third molars. Med Princ Pract. 2011;20(4):321-5.

[58] Bello SA, Adeyemo WL, Bamgbose BO, Obi EV, Adeyinka AA. Effect of age, impaction types and operative time on inflammatory tissue reactions following lowerthird molar surgery. Head Face Med. 2011 Apr 28;7:8.

[59] Cotran RS, Kumar V, Collins T. Robbins Pathologic basis of disease. 6. W.B. Sanders Company, Philadephia; 1999. pp. 50–87.

[60] Pederson A. Inter-relationship of complaints after removal of impacted third molars. Int J Oral Maxillofac Surg. 1985;14:241–247.

[61] Garcia GA, Sampedro FH, Rey JH, Torreira MG. Trismus and pain after removal of impacted lower third molars. J Oral Maxillofac Surg. 1997;55:1223–1226.

[62] Akadiri OA, Okoje VN, Arotiba JT. Identification of risk factors for short-term morbidity in third molar surgery. Odontostomatol Trop. 2008 Dec;31(124):5-10.

[63] Khande K, Saluja H, Mahindra U. Primary and secondary closure of the surgical wound after removal of impacted mandibular third molars. J Maxillofac Oral Surg. 2011 Jun; 10(2):112-7.

[64] Koyuncu BO, Cetingül E. Short-term clinical outcomes of two different flap techniques in impacted mandibular third molar surgery. Oral Surg Oral Med Oral Pathol Oral Radiol. 2012 Aug 23. [Epub ahead of print]

[65] Karaca I, Simşek S, Uğar D, Bozkaya S. Review of flap design influence on the health of the periodontium after mandibular third molar surgery. Oral Surg Oral Med Oral Pathol Oral Radiol Endod. 2007 Jul;104(1):18-23.

[66] Kirk DG, Liston PN, Tong DC, Love RM. Influence of two different flap designs on incidence of pain, swelling, trismus, and alveolar osteitis in the week following third molar surgery. Oral Surg Oral Med Oral Pathol Oral Radiol Endod. 2007 Jul;104(1):e1-6.

[67] Markiewicz MR, Brady MF, Ding EL, Dodson TB. Corticosteroids reduce postoperative morbidity after third molar surgery: a systematic review and meta-analysis. J Oral Maxillofac Surg. 2008 Sep;66(9):1881-94.

[68] Alpaslan GH, Yamalik MK. The effects of chlorzoxazone on postoperative trismus following lower third molar surgery. Ankara Univ Hekim Fak Derg. 1988 Sep;15(1): 29-33.

[69] Blum IR. Contemporary views on dry socket (alveolar osteitis). A clinical appraisal of the standardization, etiopathogenesis and management: a critical review. Int J Oral Maxillofac Surg. 2002;31:309–317.

[70] Sridhar V, Wali GG, Shyla HN. Evaluation of the perioperative use of 0.2% chlorhexidine gluconate for the prevention of alveolar osteitis after the extraction of impacted mandibular third molars: a clinical study. J Maxillofac Oral Surg. 2011 Jun;10(2):101-11.

[71] Larsen PE. The effect of a chlorhexidine rinse on the incidence of alveolar osteitis following the surgical removal of impacted mandibular third molars. J Oral Maxillofac Surg. 1991 Sep;49(9):932-7.

[72] Metin M, Tek M, Sener I. Comparison of two chlorhexidine rinse protocols on the incidence of alveolar osteitis following the surgical removal of impacted third molars. J Contemp Dent Pract. 2006 May 1;7(2):79-86.

[73] Babar A, Ibrahim MW, Baig NJ, Shah I, Amin E. Efficacy of intra-alveolar chlorhexidine gel in reducing frequency of alveolar osteitis in mandibular third molar surgery. J Coll Physicians Surg Pak. 2012 Feb;22(2):91-4.

[74] Humber CC, Albilia JB, Rittenberg B. Chronic osteomyelitis following an uncomplicated dental extraction. J Can Dent Assoc. 2011;77:b98.

[75] Schoen R, Suarez-Cunqueiro MM, Metzger MC, Schmelzeisen R. Osteomyelitis of the mandible following third molar surgery: a regrettable consequence in a healthy patient. Quintessence Int. 2009 May;40(5):351-4.

[76] Lambade P, Lambade D, Dolas RS, Virani N. Ectopic mandibular third molar leading to osteomyelitis of condyle: a case report with literature review. Oral Maxillofac Surg. 2012 Jul 31. [Epub ahead of print]

[77] Carrasco-Labra A, Brignardello-Petersen R, Yanine N, Araya I, Guyatt G. Secondary versus primary closure techniques for the prevention of postoperative complications following removal of impacted mandibular third molars: a systematic review and meta-analysis of randomized controlled trials. J Oral Maxillofac Surg. 2012 Aug; 70(8):e441-57.

[78] Rosa AL, Carneiro MG, Lavrador MA, Novaes AB Jr. Influence of flap design on periodontal healing of second molars after extraction of impacted mandibular third molars. Oral Surg Oral Med Oral Pathol Oral Radiol Endod. 2002 Apr;93(4):404-7.

[79] Jakse N, Bankaoglu V, Wimmer G, Eskici A, Pertl C. Primary wound healing after lower third molar surgery: evaluation of 2 different flap designs. Oral Surg Oral Med Oral Pathol Oral Radiol Endod. 2002 Jan;93(1):7-12.

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