ATLAS OF OPERATIVE ORAL AND MAXILLOFACIAL SURGERY

Edited by | Christopher J. Haggerty | Robert M. Laughlin

WILEY Blackwell

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Foreword

The explosion of new and modified surgical techniques and technological advancements of the maxillofacial region within recent years is the impetus for the generation of *Atlas of Operative Oral and Maxillofacial Surgery*. Christopher J. Haggerty and Robert M. Laughlin have created a contemporary, multidisciplinary reference source for students, residents, recent graduates and yes, experienced surgeons to refresh, update, and gain new knowledge as they contemplate their selection of Oral and Maxillofacial Surgery (OMS) approaches and procedures. This *Atlas* will prove to be an invaluable resource for recent OMS graduates preparing for their board certification examination and for those preparing for their recertification examinations. The readers will enjoy the atlas format, as the high yield clinical vignettes supplemented with over 1,000 color images quickly and concisely deliver pertinent information to the reader.

The editors and contributors comprehensively deliver the indications, contraindications, regional anatomy, procedure selection, post-operative management, complications and key points to the reader in an interesting and contemporary manner. This *Atlas* will become a staple of Oral and Maxillofacial Surgery and as such, will be located in conference rooms, offices, and student/resident backpacks as well as in the library. Like a manual of therapeutic drugs, it can be used as an immediate source of information and teaching. The *Atlas* includes a comprehensive review of oral and maxillofacial surgery procedures and is organized by section to include: dentoalveolar and implant surgery, odontogenic head and neck infections, maxillofacial trauma surgery, orthognathic surgery, temporomandibular joint surgery, facial cosmetic surgery, and pathology and reconstructive surgery. In addition to covering these core oral and maxillofacial surgery procedures, the *Atlas* also includes expanded scope maxillofacial surgery such as head and neck ablative surgery, microvascular surgery, advanced facial cosmetic surgery, reconstructive temporomandibular joint surgery and craniofacial surgery.

The review of key surgical procedures with their associated indications and contraindications will aid in procedure selection and improve surgical outcomes. Key surgical anatomy, techniques and surgical alternatives are knowledgeably described and applicable. Many techniques are in such detail that they read as a well thought out and described operative dictation. Patient follow-up details are discussed in the immediate and long-term postoperative periods. Case reports by expert contributors walk the reader through their favorite operative technique with steps, high resolution color illustrations, and photographs at surgery that depict incision locations, planes of anatomical dissection, and key pre, intra, and postoperative images. The *Atlas* can become a reference source during conversation when the resident and experienced surgeon discuss and compare a case in the *Atlas* with their own recent operative experience. Therein lies the birth of new knowledge, the modifications of surgical techniques, which improve patient outcome and advance scope for the student, instructor, and even the contributors to the *Atlas*. Elective and non-elective surgical techniques, not thought of just a few decades ago, are now commonplace in numbers that are sometimes difficult for a single practitioner to assimilate. In this day of advancing surgical techniques, with more and more subspecialization and cross over care between specialties, delivery of new surgical technique knowledge clearly requires this atlas format.

Four Decade History of Oral and Maxillofacial Surgery Growth and the Birth of Expanded Scope

Oral and maxillofacial surgery (OMS) has had remarkable advancement in the education of residents over the past 4 decades. By 1972, the specialty required a three-year residency, which included medicine and a core year of general surgery and other surgical specialties and anesthesia. At LSU, a 3–4 month rotation on Neurosurgery was begun and remains today a favorite experience by both OMS and Neurosurgery. By 1978, the length of training at LSU was extended to a 4-year program, mostly due to an increase in surgical scope and required numbers of inpatient and outpatient procedures and anesthesia experience. The word “competence” was bandied about by all specialties at that time and most specialties were trying to achieve some degree of competence with an increase in residency training and procedures. OMS was dominant in Orthognathic Surgery and Facial Trauma patient care and research as early as the late 70s and early 80s. In the late 80s, LSU and other institutions initiated the 6-year OMS-MD residency, an experience which had previously been used for many years at only a few institutions such as Harvard, Alabama, and Nebraska. The reason for seeking the integrated advanced standing MD program was to improve residency education and patient care, and delivery of that care that came with expanded scope.

Today, nearly half of U.S. oral and maxillofacial surgery residencies and nearly all of the European training sites offer OMS-MD training. The core year of general surgery, surgical specialists rotations, and anesthesia with at least 30 months of OMS training today is common to both the standard 4-year OMS residency and 6-year OMS-MD residency. This advanced level of surgical training and patient care validates oral and maxillofacial surgery as a major contributor to the surgical and medical management of head and neck patients. Simultaneously, in the late 80s there was an increase of OMS scope in cosmetic surgery, cancer and reconstructive surgery, and the treatment of cleft lip/palate following years of orthognathic surgery. The very surgical technique basis of orthognathic surgery served as a natural springboard into all three areas. In fact, significant contributions by OMS in all three of these areas soon followed. Fellowships in these areas soon followed in not only ENT and Plastic Surgery, but OMS as well.

The educational and surgical scope contribution by OMS on behalf of head and neck patients is unparalleled over the past 40 years, understanding that most surgical specialties that treat head and neck patients have also had significant success. Within the scope of OMS, several areas of advancement are recognized: 1) Even before the treatment of facial injuries during and after major wars, dentists, physicians with dental degrees and oral surgeons were destined to shape the future of today's OMS. Their experiences led to dramatic improvement of both functional and aesthetic aspects in primary and secondary correction of facial injuries. Understanding and recognizing the nature of war time facial fractures led to the development of elective surgical techniques by Obwegeser, Tessier, and other pioneers which are used today in orthognathic and craniofacial surgery. Most patients requiring correction of facial deformities today receive that correction within the private OMS practice or the OMS training centers. OMS offers several cleft and craniofacial surgery fellowships and a significant number of OMS are involved with accredited ACLP teams. 2) After the bloom and dominance by the OMS specialty with orthognathic surgery, facial aesthetic surgery was one of the first areas of expanded scope in the mid 80s. There is no doubt that OMS entrance into facial aesthetic surgery is a logical and orderly consequence following its success in orthognathic surgery and the success of transcutaneous techniques in facial trauma. The very nature of dental reconstruction and OMS education is unequaled in surgical education when assessing oral and facial aesthetic needs of patients. Throughout dental school and OMS training, facial balance and aesthetic needs are a part of daily education. Clearly, that is what orthognathic surgery and orthodontics are all about. Augmenting this education are head and neck anatomy with a cadaver dissection course, cephalometric evaluation courses, and the treatment of hundreds of patients in the dental school and hospital as a part of these dental specialty residencies. Several aesthetic procedures were already a daily part of orthognathic surgery such as facial implants, liposuction, and rhinoplasty. Facial aesthetic fellowship is now common, those approved by AAOMS and other organizations. 3) Thanks to the pioneering work by Drs. Adrian Hubbell and his mentor, John Lundy, an anesthesiologist, and others, intravenous drugs with outpatient sedation and general anesthesia techniques have been used with increasing frequency and safety in OMS offices for decades. This is the basis for much of the OMS surgery done in the U.S. OMS residency training today requires 5 months of general anesthesia as well as periodic BLS, ACLS, and ATLS certification to support the efficacy and safety of delivery of outpatient anesthesia. 4) OMS has long embraced a supportive if not active participating role in care of the oral and head and neck cancer patient. With all the advances in orthognathic surgery techniques as well as in preprosthetic surgery by the late 80s, before the age of dental implants, it was only reasonable to use those surgical experiences to begin performing excision of select cancer lesions and reconstruct with techniques already in use with secondary correction of facial injuries. Oral and Maxillofacial Surgeons have provided significant primary and secondary soft tissue and bony care and sometimes the majority of care of trauma patients during war time conflicts abroad. That experience was the origin of cancer reconstruction. Surgical specialties of the head and neck are indebted to Phillip Boyne (bone grafting research and techniques) and Robert Marx (soft and hard tissue reconstruction and HBO protocols). Today, OMS fellowships are offered in the resection of cancer, reconstruction, or microvascular techniques.

The following list is just a few of services/procedures germane to the specialty of Oral and Maxillofacial Surgery. Those where the specialty is a leader and has made significant contributions include: 1) osteointegration of dental and facial implants, 2) hyperbaric oxygen protocol of the head and neck area, 3) arthroscopy and reconstruction of the temporomandibular joint with total joint prostheses, 4) orthognathic and craniofacial surgery, 5) virtual surgical techniques in orthognathic and reconstruction surgery of the head and neck, 6) distraction of the facial bone, 7) implementation of bone plating techniques in facial trauma and facial deformity patients, 8) improved diagnostic techniques with surgical intervention on sleep apnea patients, 9) maxillofacial cone beam computed tomography, 10) reconstruction in the head and neck areas with soft and hard tissue flaps.

Acknowledgment

The growth of Louisiana Oral and Maxillofacial Surgery over the past 4 decades, as was seen in other states, is a testimony to the specialty growth across the U.S. Expanded scope in orthognathic and craniofacial surgery, pathology

and reconstruction of the head/neck areas, and TMJ reconstruction were led by LSU OMS chairs Jack Kent, DDS, G.E. Ghali, DDS, MD, FACS, Dan Lew, DDS, and program directors Mike Zide, DMD, Dale Misiek, DMD, Jon Perenack, DDS, MD, and David Kim, DDS, MD. As a result of their training, 25 former LSU residents and faculty have furthered their education with fellowship training in aesthetic surgery, cleft and craniofacial surgery, and head and neck oncologic/microvascular reconstruction. Many have generously contributed to the *Atlas*.

Continuing education is one of the hallmarks of LSU Oral and Maxillofacial Surgery. Multiple, yearly courses devoted to core and expanded scope topics are helpful to the OMS practitioner just as this *Atlas* should be. For those preparing for Board examinations or those wishing to review and update knowledge, the LSU OMS department has offered a week long full scope Review Course over 40 years and a 3-day Advanced Cosmetic lecture with hands on cadaver course for 20 years. To that extent I wish to thank those that contributed to the education of LSU trainees and so many practitioners. They include G. E. Ghali, DDS, MD, FACS, current chairman of LSUSM Oral and Maxillofacial Surgery at Shreveport and President of the American Board of Oral and Maxillofacial Surgery, Michael Block, DMD, for 30 years of research and dental implant leadership and education at LSU and on behalf of AAOMS Dental Implant Conferences; Michael Zide, DMD, a favorite teacher on daily rounds at Charity Hospital in New Orleans; Dale Misiek, DMD, Brian Farrell, DDS, MD, and Dan Spagnoli, DDS, PhD, for clinical direction to the LSU residents at New Orleans and Charlotte; and Jon Perenack, DDS, MD, for being a leader and teacher of facial aesthetic surgery in Louisiana. Further contribution to LSU OMS expanded scope came from Michael Kinnebrew, DDS, MD, Randall Wilk, DDS, MD, PhD, and John Neary, DDS, MD, FACS, current chairman of LSUSD Oral and Maxillofacial Surgery at New Orleans.

I wish to thank 4 past presidents of AAOMS, all from Louisiana: Jack Gamble, DDS, Ronald Marks, DDS, Dan Lew, DDS, and the most recent president, Eric Geist, DDS, who was also President of the American Board of Oral and Maxillofacial Surgery, who have contributed enormously to the educational, political, and patient care goals of the Oral and Maxillofacial Surgery specialty. Twenty contributors to the *Atlas* are graduates/faculty of LSU New Orleans or Shreveport Oral and Maxillofacial Surgery Residency Programs. I wish to congratulate, commend, and thank them and all contributors, but especially the two editors, Chris Haggerty, DDS, MD and Rob Laughlin, DMD, two of my former LSU Oral and Maxillofacial Surgery residents, for their creative contribution to the education of all surgeons, and most importantly, to the benefit of patient outcome.

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Christopher J. Haggerty

This surgical atlas would not have been possible without the hard work and efforts of so many. I would like to thank my family, friends, mentors, residents, and colleagues.

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Robert M. Laughlin

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Christopher and Robert

Part One

Dentoalveolar and Implant Surgery

CHAPTER 1

Anatomical Considerations in Dentoalveolar Surgery

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An understanding of the anatomical relations within the region of intervention is critical to minimize surgical complications. Radiographic imaging assists in the assessment of anatomical variation and allows for risk stratification and predictable treatment outcomes.

Mandible

Lingual Nerve

The lingual nerve provides sensation to the anterior two-thirds of the tongue. The lingual nerve is at risk for injury with the extraction of third molars and with procedures involving the floor of the mouth. Within the third molar region, the lingual nerve is located, on average, 3.0 mm apical to the crest of the alveolar ridge and 2.0 mm medially from the lingual cortical plate. In 17.6% of the population, the lingual nerve is at or above the crest of the alveolar bone. In 22% of the population, the lingual nerve contacts the lingual cortex adjacent to the third molar region. Within the second molar region, the lingual nerve is located, on average, 9.5 mm inferior to the cementoenamel junction (CEJ). Within the first molar and second premolar regions, the average vertical distances from the CEJ lingually are 13.0 mm and 15.0 mm, respectively. The lingual nerve begins to course toward the tongue between the first and second molar regions.

Inferior Alveolar Nerve

As the inferior alveolar nerve (IAN) descends from the base of the skull, it traverses the pterygomandibular space and enters the mandibular foramen approximately 1.5–2.0 cm inferior to the sigmoid notch. Within the corpus of the mandible, the course of the mandibular canal in the buccal-lingual dimension tends to follow one of three general patterns:

- Type 1: in the majority of the population (approximately 70%), the canal follows the lingual plate within the ramus–body region.
- Type 2: in 15% of the population, the canal initially runs within the middle of the ramus when posterior to the second molar, and then follows the lingual plate as it passes through the region of the second and first molars.
- Type 3: in 15% of the population, the canal is positioned in the middle to lingual third of the mandible along its entire course.

In addition:

- In approximately 80% of the population, the inferior alveolar artery courses above the nerve within the bony canal.
- Older patients have been shown to have less distance between the buccal cortex of the mandible and the lateral aspect of the canal.
- In relation to impacted third molars, the inferior alveolar canal is located:

    Lingual to the third molar in 49% of the population
    Buccal to the third molar in 17% of the population
    Inferior to the third molar in 19% of the population
    Interradicular in 15% of the population.

In general, the risk of exposure of the inferior alveolar canal during third molar removal is greater in patients with lingual, rather than buccal, canal positioning. Among molars in the posterior mandible, the distance from the buccal cortex to the canal tends to be greatest within the region of the second molar.

Mental Nerve

The mental foramen typically lies between the first and second premolars in line corresponding with a vertical reference from the infraorbital foramen. Variability in the vertical distance of the foramen may be problematic in edentulous mandibles with excessive alveolar bone resorption. The mental nerve courses superiorly before exiting the mental foramen. Additionally, the mental nerve commonly loops anteriorly (genu) before its exit from the mental foramen in approximately 48% of the population. The average length of the anterior loop (genu) is 0.89 mm with a range of up to 5.7 mm or more. However, only 5% of individuals have an anterior loop length longer than 3.0 mm and only 2% have an anterior loop length greater than 4.0 mm.

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Maxilla

Nasal Cavity

The palatal process of the maxilla contributes to the anterior three-fourths of the nasal floor. The posterior one-fourth of the nasal floor is comprised from the horizontal process of the palatine bone. Care must be taken during placement of anterior maxillary implants to avoid violating this region.

Maxillary Sinus

The maxillary sinus is the largest of the paranasal sinuses. It is pyramidal in shape with its apex oriented toward the zygoma. It lies within the posterior maxilla bounded by the infratemporal fossa, lateral nasal wall, and floor of the orbit. As a result of pneumatization, extensive variation exists; however, the average volume in adults is roughly 15 mL's. Additionally, the maxillary sinus cavity may occasionally be divided by septae. The maxillary sinus ostium is located along the superior aspect of the medial wall of the sinus and drains into the middle meatus of the nasal cavity.

Key Points

1. Panoramic indicators of inferior alveolar nerve proximity include darkening of the third molar root, interruption of the white line of the mandibular canal (see Figure 1.6 in Case Report 1.2), diversion or displacement of the mandibular canal (see Figure 1.3 in Case Report 1.1), abrupt deflection of the third molar roots, and abrupt narrowing of the tooth root.
2. Cone beam computed tomography (CBCT) scanners have aided greatly in the visualization and avoidance of neurovascular structures during dentoalveolar surgery and implant placement. (See Figures 1.1 and 1.2.)

Figure 1.1. 3D image depicting the inferior alveolar nerve coursing directly through an impacted lower wisdom tooth.

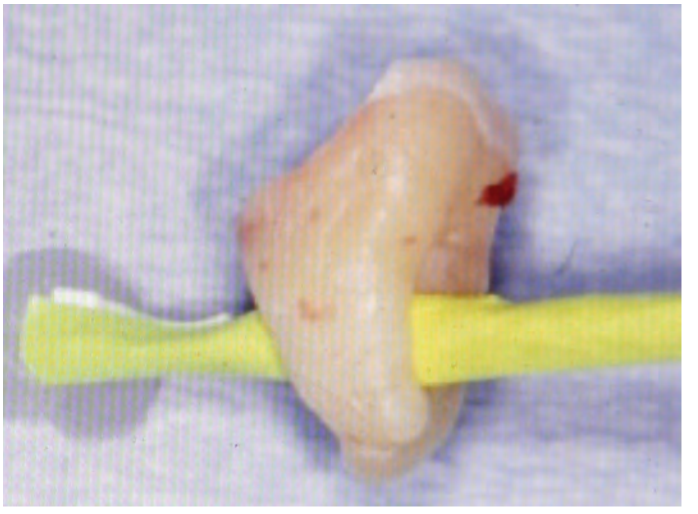

Figure 1.2. Lower wisdom tooth extracted from the patient in Figure 1.1. The yellow paper represents the location of the inferior alveolar nerve through the inferior third of the wisdom tooth.

Case Reports

Case Report 1.1. A 63-year-old patient presents with a chief complaint of pain, foul taste, persistent food impaction, and chronic localized infection to site #32. Based on the patient's age, nerve anatomy, and potential for permanent neurosensory damage, the decision was made to remove the coronal aspect (clinical crown) of the impacted tooth without extracting the root tips (i.e., a **coronectomy**). See Figures 1.3, 1.4, and 1.5.

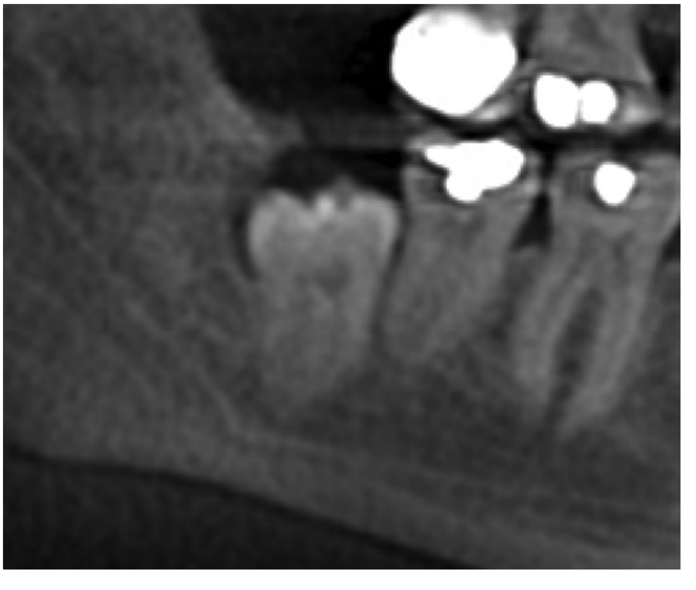

Figure 1.3. 2D film demonstrates impacted tooth #32 with diversion of the mandibular canal at the apex of the tooth.

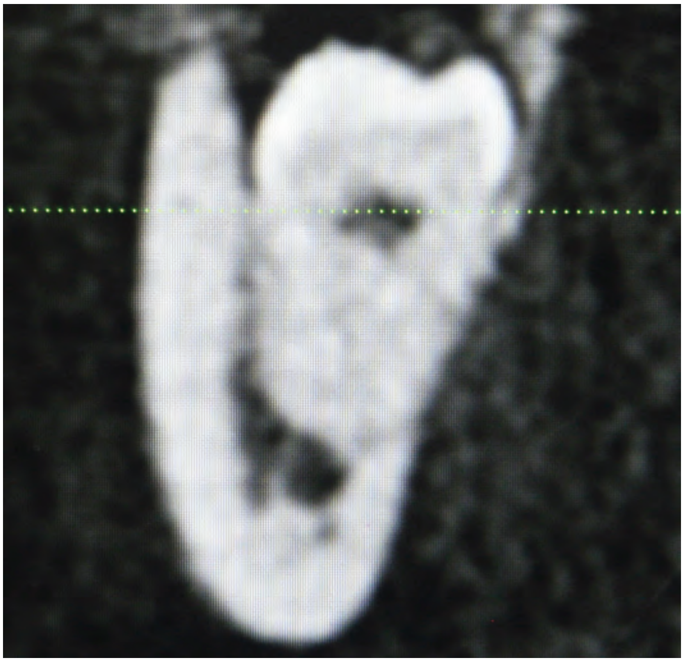

Figure 1.4. Cone beam computed tomography coronal view demonstrating the inferior alveolar nerve coursing through the apical third of tooth #32.

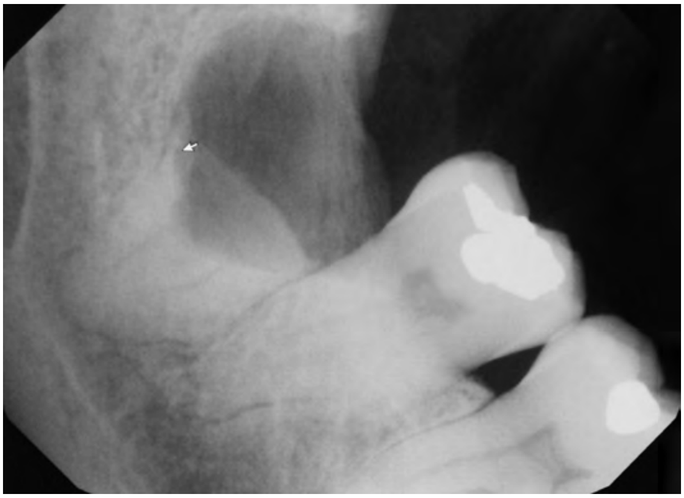

Figure 1.5. Periapical film demonstrating a coronectomy of tooth #32. Note that the entire clinical crown was removed by sectioning the tooth apical to the CEJ to ensure no residual enamel remained and the roots were trimmed 3–4 mm below the bony margin.

Case Report 1.2. A 57-year-old patient presents with a chief complaint of persistent local pain, referred pain, and documented deep probing depths to site #32. See Figures 1.6, 1.7, and 1.8.

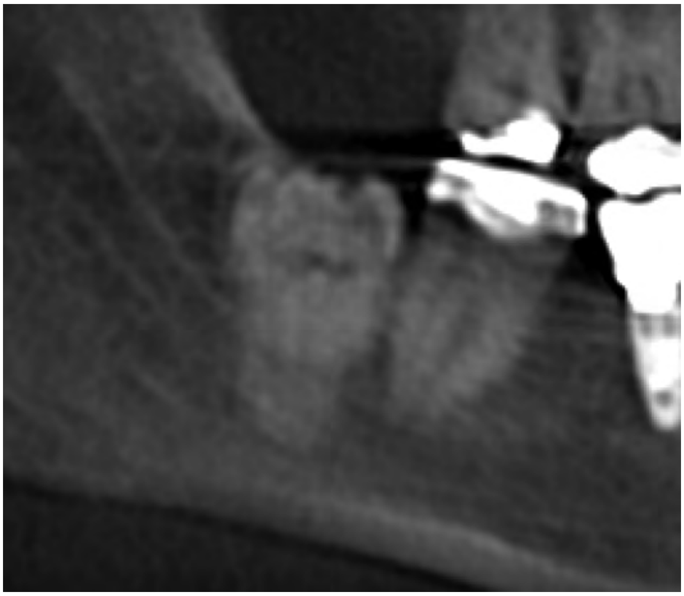

Figure 1.6. 2D film demonstrating interruption of the white lines of the mandibular canal.

Figure 1.7. Cone beam computed tomography coronal view demonstrating the inferior alveolar nerve coursing through the middle third of the third molar root.

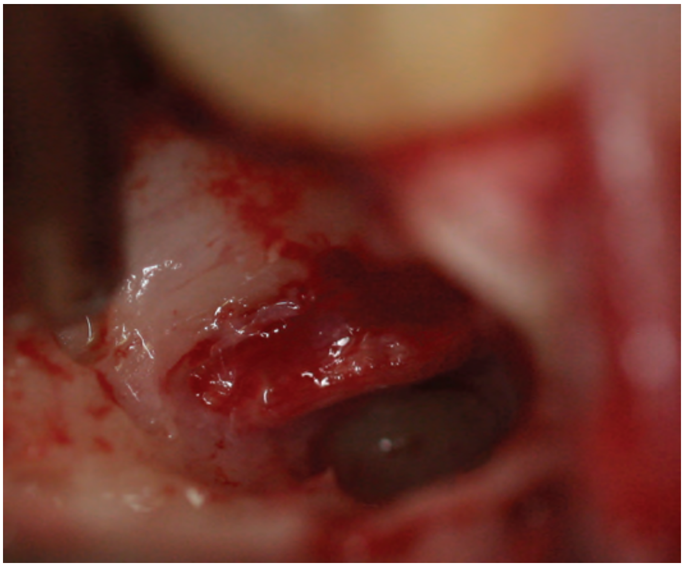

Figure 1.8. Tooth #32 extraction site demonstrating an intact inferior alveolar nerve along the lingual plate.

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CHAPTER

2 Exposure and Bonding of an Impacted Tooth

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A method of facilitating the eruption of severely impacted and/or malpositioned teeth with orthodontic guidance.

Indications

1. Appropriate arch length to accommodate the impacted tooth within the alveolar arch
2. Appropriate interdental space for the incorporation of the impacted tooth within the alveolus
3. Erupted or impacted tooth on the contralateral side of the arch to provide appropriate symmetry
4. Appropriately developed impacted tooth with no associated malformations or pathology

Contraindications

1. When repositioning impacted teeth will create a structural weakness in the roots of adjacent teeth
2. When other structures (i.e., adjacent roots, supernumerary teeth, and odontomas) are in the path of the anticipated distraction vector
3. Impacted teeth that appear malformed or associated with pathology

Technique

1. Local anesthesia is administered in the form of blocks and infiltration. Subperiosteal injection into the area of the anticipated mucoperiosteal flap will hydrodissect the tissue and aid in hemostatic flap reflection.
2. Primary teeth in the path of distraction and/or functioning as a space maintainer are extracted.
3. A crestal incision is created within the area of the edentulous space or extraction site of the retained deciduous tooth. Incisions are designed to bisect the attached tissue overlying the alveolar ridge. This will allow the impacted tooth to be distracted through keratinized tissue and will lead to optimal periodontium supporting the tooth.
4. A full-thickness mucoperiosteal flap is raised, with or without distal releasing incisions depending on the access needed to locate the impacted tooth (see Figure 2.6 in Case Report 2.1 and Figure 2.16 in Case Report 2.2).
5. The impacted tooth is frequently identified as an area with a bulge and/or by the identification of the dental follicle. Thin superficial bone overlying the impacted tooth can be removed with a periosteal elevator (see Figure 2.16 in Case Report 2.2). If significant bone removal is required to expose the clinical crown of the impacted tooth, a small round bur with copious irrigation is utilized.
6. Once the clinical crown of the impacted tooth is exposed, the dental follicle is removed with cautery (see Figure 2.7 in Case Report 2.1 and Figure 2.17 in Case Report 2.2). Cautery allows for quick and easy removal of the follicle and greatly adds to hemostasis.
7. If needed, local anesthesia containing a vasoconstrictor can be injected into the surrounding tissue and around the clinical crown of the tooth to aid in hemostasis.
8. A suction tip is placed at the tooth–bone interface to further enhance hemostasis and to aid in the creation of a dry field. A dry field is paramount to ensuring that the composite adheres and has a strong bond.
9. Once a dry field is established and maintained, the bracket is placed toward the incisal or occlusal tip of the impacted tooth in the position of the ideal vector for the distraction of the tooth into the space created by the orthodontist or within the space created by the extraction of the primary tooth.
10. Once the bracket is secured in the appropriate position, the chain attached to the bracket is tested with cotton pliers or pickups to ensure a strong bond between the composite and the impacted tooth. Excessive composite flange is removed with a round bur with copious irrigation.
11. The chain is secured to the orthodontic archwire with 4-0 silk sutures. Excessive chain links are removed in order to minimize slack within the chain (see Figure 2.11 in Case Report 2.1 and Figure 2.18 in Case Report 2.2) as excessive chain slack can lead to bracket detachment.

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12. The area is closed primarily with interrupted 4-0 chromic sutures (see Figure 2.13 in Case Report 2.1).

Postoperative Management

1. Analgesics are prescribed based on the invasiveness of the procedure.
2. Antibiotics are not routinely prescribed.
3. Patients return to their normal activities the next day.
4. Orthodontic traction should begin as soon as possible after exposure, typically between 5 and 21 days post exposure. Immediate traction is initiated for teeth that have been luxated to address ankylosis.

Complications

Early Complications

1. **Bleeding**: Often from not identifying bleeding tissue on closure. Alternatively, since most expose and bond patients are very young, this may represent an underlying, undiagnosed coagulation disorder.
2. **Bracket detachment**: From inadequate moisture control during the use of composite. It is important to reattach the bracket within 72 hours before extensive healing of the mucoperiosteal flap occurs.
3. **Infection**: Rare. Treated with antibiotics and oral rinses such as Peridex. If an abscess is identified on examination or with radiographs, an incision and drainage procedure is indicated.

Late Complications

1. **Bracket detachment**: Frequently due to an ankylosed tooth or excessive force by the orthodontist.
2. **Failure of tooth movement (ankylosed tooth)**: Treatment options include re-exposure of the impacted tooth with more aggressive bone removal, attempted luxation of the tooth with a dental elevator, and the creation of a bony tunnel through the alveolus to facilitate movement. Care should be taken during surgical exposure to avoid trauma to the cementoenamel junction (CEJ) and the periodontal ligament. Damage to these structures may result in potential periodontal defects and subsequent ankylosis. If the above fails, consider tooth removal and closure of the space via orthodontic means or with a dental implant.
3. **Periodontal defects**: Less likely with conservative flap elevation, the use of orthodontic brackets, conservative bone removal around only the clinical crown, and distracting the impacted tooth through attached keratinized gingiva. Utilizing a bonded bracket to engage the impacted tooth instead of ligating a steel wire around the CEJ will discourage periodontal defects and promote a more optimal periodontal result.

Key Points

1. Radiographs allow the operator to know the exact position of the impacted tooth, its labial or lingual-palatal position, any interferences caused by other structures (i.e., adjacent teeth roots, supernumerary teeth, or odontomas), and whether the tooth is malformed or associated with a pathologic condition. Radiographs should include any combination of orthopantomograms, periapical films, occlusal films, and/or cone beam computed tomography (CBCT) imaging. When utilizing periapical and occlusal films, it is important to understand Clark's rule (i.e., the SLOB rule, for "same lingual; opposite buccal").
2. Communication with the orthodontist is important prior to the ligation of the bracket. Having a clear concept of the overall orthodontic treatment plan and the eruption vectors will lead to more precise bracket placement and ideal treatment outcomes.
3. Some orthodontists prefer to have the expose and bond procedure completed several weeks prior to the placement of full orthodontics. In these instances, the impacted tooth is exposed and bonded, and the silk suture is tied around the teeth adjacent to the site where the tooth will be distracted. For example, for an impacted maxillary canine, the silk suture is tied below the CEJ of the adjacent lateral incisor.
4. The more vertically upright the impacted tooth is positioned, the higher the success rate for distraction into the alveolus and the less chance of ankylosis.
5. Incisions are always crestal. All incisions are designed to bisect the attached tissue overlying the alveolar ridge. This will allow the impacted tooth to be distracted through keratinized tissue and will lead to optimal periodontal support of the tooth. Incisions placed within alveolar mucosa may lead to the eruption of the impacted tooth through unattached tissue and compromise the periodontal support of the tooth once it is aligned within the alveolus.
6. Adequate clinical crown exposure and a dry field are keys to the success of the bonding of the composite to the impacted tooth. It is also paramount to select a composite specifically designed for orthodontic bonding.
7. The bracket should be placed so that when the chain is activated by the orthodontist, the vector of the chain pull coincides with the anticipated path of eruption of the impacted tooth. The bracket should also be placed close to the incisal or occlusal tip of the impacted tooth in order to give the orthodontist optimal control over the movement of the tooth.
8. Orthodontic traction should begin as soon as possible after exposure, but no later than 3 weeks post exposure. Immediate traction should be initiated for teeth that have been luxated to address ankylosis.

9. The technique described above is often referred to as the closed eruption technique because the technique involves full flap closure after exposure and bonding of the bracket to the impacted tooth. Alternatively, an open eruption technique can be employed. The open eruption technique is primarily utilized for palatally impacted maxillary canines when there is concern of adjacent root resorption from the vector of distraction from a closed technique. The open eruption technique involves creating an incision that bisects the attached mucosa and removing sufficient bone to expose the clinical crown of an impacted tooth just as in the closed eruption technique. Next, the flap is repositioned over the impacted tooth, and a perforation is created within the tissue overlying the impacted tooth's clinical crown. The tissue perforation is packed with a surgical packing (typically, a periodontal pack; Coe-Pak, GC American Inc., Alsip, IL, US) or an appliance (a cleat, bracket, or chrome steel crown), and the tooth is allowed to erupt autonomously to the level of the occlusal plane.

Case Reports

Case Report 2.1. Palatally positioned impacted teeth. A 14-year-old female presents with impacted teeth #6 and 11 and retained primary teeth c and h. The patient has been in full orthodontics for 9 months in order to align teeth and alleviate anterior crowding. (See Figures 2.1 through 2.13.)

Figure 2.1. Orthopantomogram demonstrating retained primary teeth c and h and impacted teeth #6 and #11.

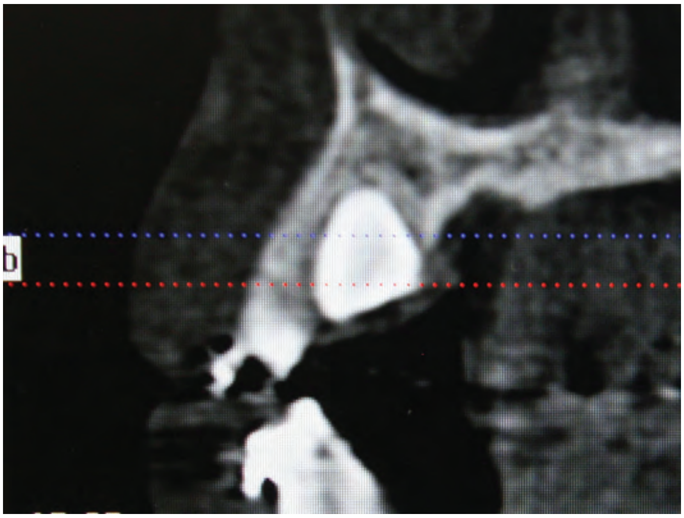

Figure 2.2. Cone beam computed tomography sagittal view demonstrating the palatal position of tooth #6.

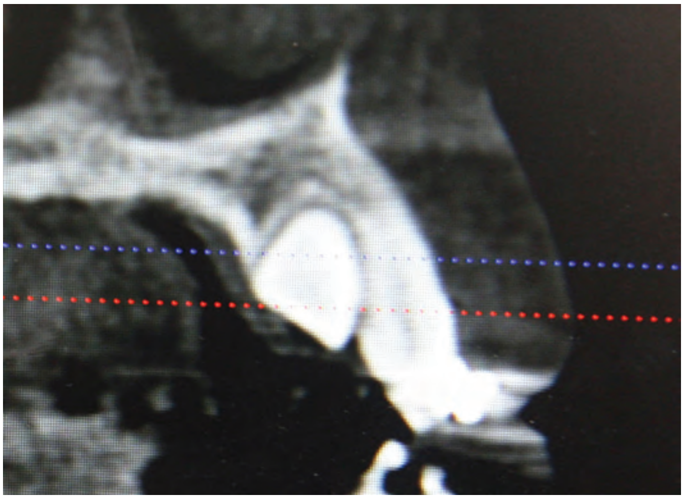

Figure 2.3. Cone beam computed tomography sagittal view demonstrating the palatal position of tooth #11.

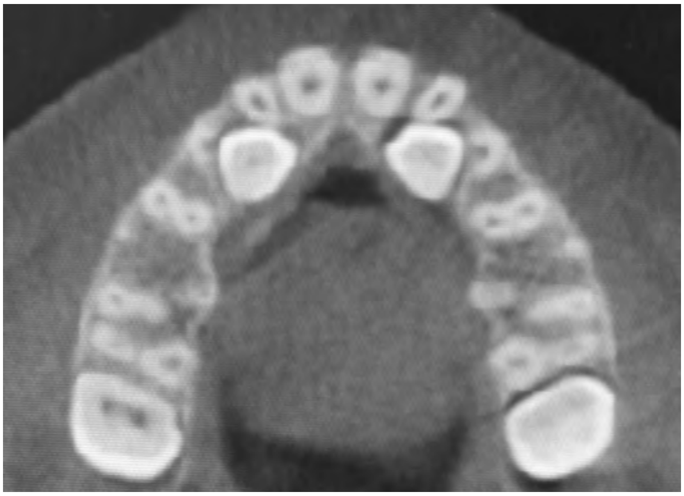

Figure 2.4. Occlusal view of impacted teeth #6 and #11.

Figure 2.5. 14-year-old patient in full orthodontics with c and h acting as space maintainers for impacted teeth #6 and #11.

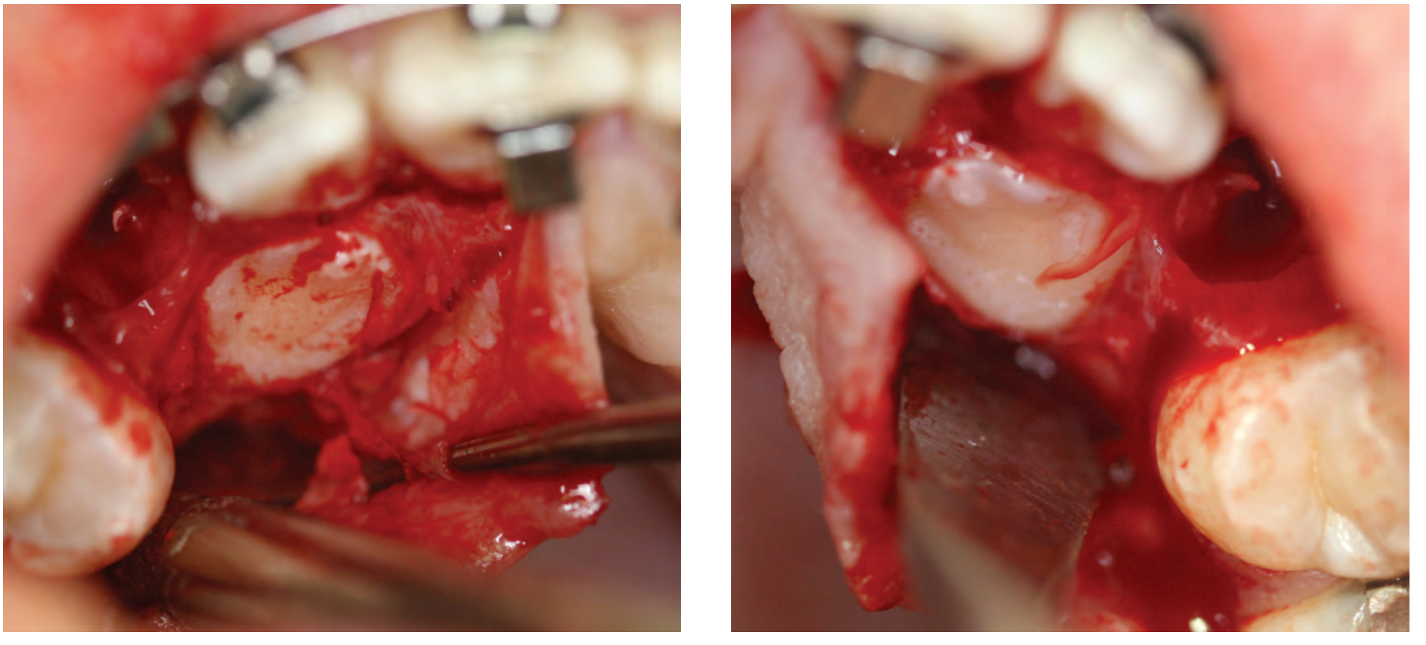

Figure 2.6. Extraction of primary teeth c and h. Crestal incision and reflection of full-thickness mucoperiosteal flaps to expose teeth #6 and #11. The flaps are not connected within the midline in order to preserve the integrity of the incisive canal and of its contents.

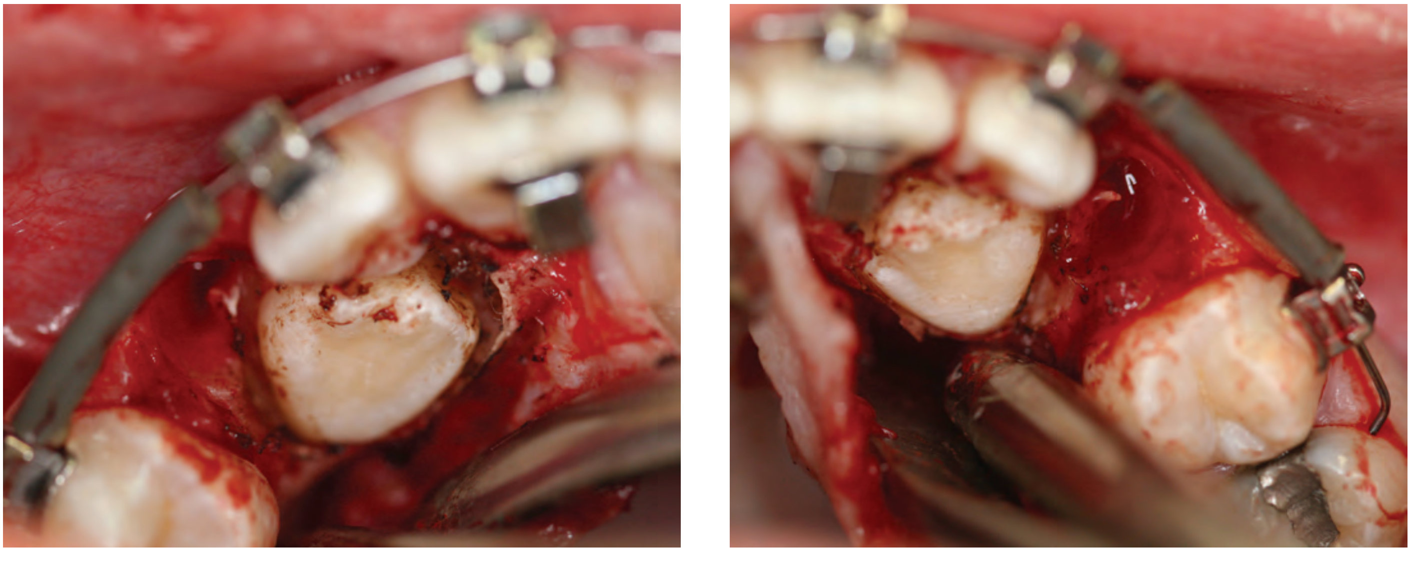

Figure 2.7. Removal of the dental follicles and surrounding bone to expose the clinical crowns of teeth #6 and #11.