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Oral Maxillofacial Surg Clin N Am 19 (2007) 23–43

ORAL AND
MAXILLOFACIAL
SURGERY CLINICS
of North America

General Technique of Third Molar Removal

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The most commonly performed surgical procedure in most oral and maxillofacial surgery practices is the removal of impacted third molars. Extensive training, skill, and experience allow this procedure to be performed in an atraumatic fashion with local anesthesia, sedation, or general anesthesia. The decision to remove symptomatic third molars is not usually difficult, but the decision to remove asymptomatic third molars is sometimes less clear and requires clinical experience. A wide body of literature (discussed elsewhere in this issue) attempts to establish clinical practice guidelines for dealing with impacted teeth [1]. Data are beginning to accumulate from third molar studies, which hopefully will provide surgeons and their patients with evidence-based guidelines regarding elective third molar surgery [2–6]. The association of periodontal pathology and occlusal caries with asymptomatic third molars has been studied previously. Twenty-five percent of patients with asymptomatic third molars were found to have increased periodontal probing depths and attachment loss, increased periodontal pathogen colonization, and increased levels of inflammatory mediators [7–9]. Shugars and colleagues [10] examined a group of patients with at least one fully erupted third molar and found that 28% had caries in at least one third molar tooth. It is currently recommended that the indications for elective therapeutic third molar removal be based on good clinical science. Accordingly, patients and the community at large should be adequately informed [11].

Once the decision is made to remove impacted third molars, a classification system based on clinical and radiographic findings becomes a tool for predicting the difficulty of removal. Accessibility significantly influences the degree of difficulty of removal of a third molar. The ease with which the tooth can be removed is also influenced by the degree of surgical exposure, the ability to create a pathway for tooth delivery, and the ability to gain purchase (natural or surgically prepared) on the tooth. A classification system is a useful tool to categorize the degree of impaction and plan a surgical approach that facilitates removal and minimizes morbidity.

Classification systems of impacted teeth

Most classifications of third molar impactions are based on the analysis of periapical—or more commonly, panoramic—radiographs. The initial determination that should be made is the angulation of the third molar to the long axis of the second molar. The mesioangular impaction, which accounts for approximately 43% of all mandibular impacted third molars, is one in which the third molar is mesially tilted toward the second molar [12]. Such impactions are generally considered the least difficult to remove (Fig. 1A).

An exaggerated mesial inclination results in a horizontal impaction (Fig. 1B), which is considered more difficult to remove than a mesioangular impaction and accounts for approximately 3% of all mandibular impactions [12]. The vertical impaction, in which the long axis of the impacted tooth runs parallel to the long axis of the second molar, is seen in approximately 38% of all mandibular impactions (Fig. 1C) [12]. It is considered

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doi:10.1016/j.coms.2006.11.012

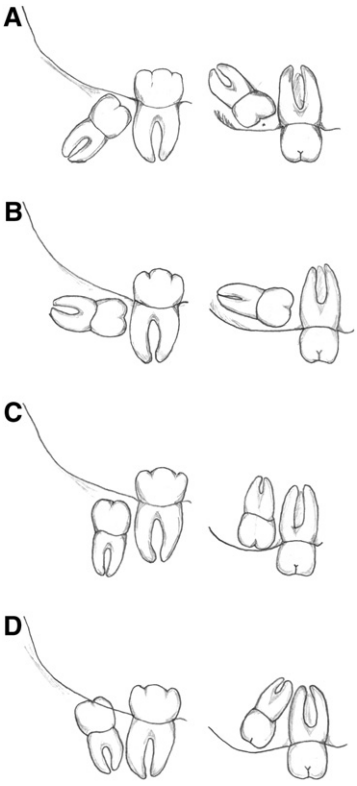

Fig. 1. Angulation classification system for impacted third molars. (*A*) Mesioangular lower and upper third molar impactions. (*B*) Horizontal lower and upper third molar impactions. (*C*) Vertical lower and upper third molar impactions. (*D*) Distoangular lower and upper third molar impactions.

more difficult than a mesioangular or horizontal impaction.

The distoangular impaction, in which the long axis of the impacted tooth is inclined distally (Fig. 1D), occurs uncommonly and accounts for approximately 6% of mandibular impactions but is considered the most difficult impaction to remove [12]. The path of removal of this tooth is into the ramus and requires more extensive bone removal for its successful delivery. Erupted lower third molars also frequently are found with a distoangular inclination. Most mandibular third molars are also angled toward the lingual (in lingual version) because the lingual cortical plate progressively thins from anterior to posterior. Impacted mandibular third molars may be in buccal version, however, and rarely in a transversely oriented position. A transversely oriented unerupted tooth can be further evaluated with an occlusal film to disclose the position of the third molar in the coronal plane, but surgical exposure also rapidly allows determination of the tooth position [12].

The Pell and Gregory classification relates the position of the impacted mandibular third molar to the ramus of the mandible in an anterior-posterior direction [13]. When the mesiodistal diameter of the third molar crown is completely anterior to the anterior border of the ramus, it is considered a class 1 relationship (Fig. 2A). Such a tooth can be angled in a mesial, distal, or vertical direction. The likelihood for normal eruption is best for a class 1 tooth with a vertical angulation. In a Pell and Gregory class 2 relationship, approximately one half the mesiodistal diameter of the mandibular third molar is covered by the ramus of the mandible (Fig. 2B). The distal aspect of the crown of teeth in this position is covered by bone and soft tissue. Teeth so positioned are particularly susceptible to caries and pericoronitis.

A Pell and Gregory class 3 relationship involves an impacted mandibular third molar that is located completely within the ramus (Fig. 2C). The accessibility of a class 3 impaction is such that it should be considered the most difficult tooth to remove. A mandibular third molar in a class 1 relationship should not be difficult to

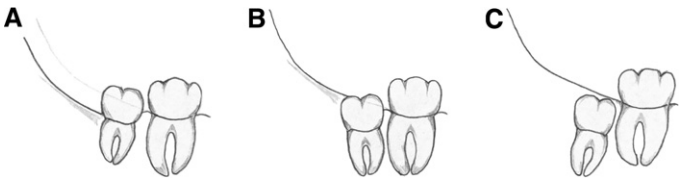

Fig. 2. Pell and Gregory classification based on relationship to the anterior border of the ramus. (*A*) Class 1 impaction, in which mandibular third molar has sufficient room anterior to the anterior border of the ramus to erupt. (*B*) Class 2, in which half of the impacted third molar is covered by the ramus. (*C*) Class 3, in which the impacted third molar is completely embedded in the ramus of the mandible.

remove, whereas a class 2 relationship would be more difficult than a class 1 relationship but less difficult than a class 3 relationship.

The vertical relationship of the occlusal surface of the impacted mandibular third molar to the occlusal plane of the second molar tooth is also described by the Pell and Gregory classification. The degree of difficulty in removing a mandibular third molar increases as the depth of the tooth below the occlusal plane of the second molar increases. As the depth of the impaction increases, the accessibility decreases and elevation, sectioning, and purchase point preparation become increasingly difficult. In a class A impaction, the occlusal surface of the third molar is at the same level as the occlusal plane of the second molar (Fig. 3A). In a class B impaction, the occlusal plane of the impacted tooth is between the occlusal plane and the cervical line of the second molar (Fig. 3B). A class C impaction results when the occlusal surface of the impacted third molar is below the cervical line of the second molar (Fig. 3C).

These classifications are used to determine the degree of the impaction and develop a plan for the removal of impacted third molars. A mesioangular impaction with a class 1 ramus and class A depth relationship would be the easiest type of impaction to remove (Fig. 4A). A distoangular impaction with a class 3 ramus relationship and a class C depth (Fig. 4B) would involve a difficult surgical procedure.

The classification system based on the dental procedure codes that are used by insurance carriers is also relevant for review [14]. These codes are based on clinical and radiographic interpretation of the tissue overlying the impacted maxillary or mandibular third molar. A D7220 is the removal of an impaction whose height of contour is above the alveolar bone and covered by soft tissue only—a soft tissue impaction (Fig. 5A). Such a removal is accomplished by incision and reflection of a soft tissue flap and elevation and is considered simple. A D7230 is the removal of an impaction whose superficial contour is covered by soft tissue and whose height of contour lies beneath the surrounding alveolar bone—a partial bony impaction (Fig. 5B). Such teeth are removed after a soft tissue flap, some bone removal, and possibly tooth sectioning. Surgeries coded D7230 are considered intermediate in difficulty in the spectrum of impacted third molar removal. When an impacted third molar is covered with soft tissue and bone, its removal is coded D7240—full bony impaction (Fig. 5C). Such teeth require soft-tissue flap elevation followed by removal of overlying bone and, frequently, sectioning of the tooth for removal. These impactions are considered the most difficult to remove. An additional code, D7241, can be used for complete bony impactions with unusual surgical complications (eg, root aberrations, proximity to anatomic structures, internal or external resorption) that make the removal of such teeth even more difficult than regular full bony impactions.

Root morphology also influences the degree of difficulty for removal of an impacted third molar. Limited root development leads to a ''rolling'' tooth, which can be difficult to remove. Such teeth are easier dealt with by sectioning in multiple planes before any mobility is obtained. A tooth with one-third to two-thirds root development is easier to remove than a tooth with full root development. Such teeth typically have a wide periodontal ligament, and ample space exists between the roots and the inferior alveolar nerve (IAN). Similarly, third molars with conical and fused roots are easier to remove than third molars with widely separated and distinct roots. Roots with severe curves, however, are more difficult to

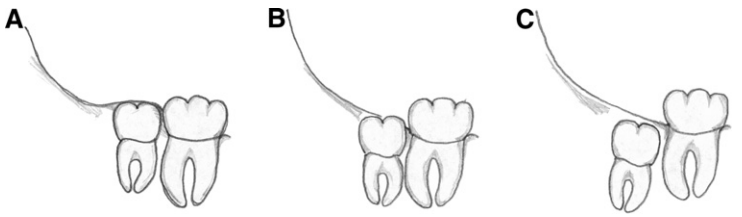

Fig. 3. Pell and Gregory classification based on relationship to the occlusal plane. (*A*) Class A impaction, in which the occlusal plane of the impacted tooth is the same as the second molar. (*B*) Class B, in which the occlusal plane of the impacted third molar is between the occlusal plane and the cervical line of the second molar. (*C*) Class C, in which the occlusal plane of the impacted third molar is below the cervical line of the second molar.

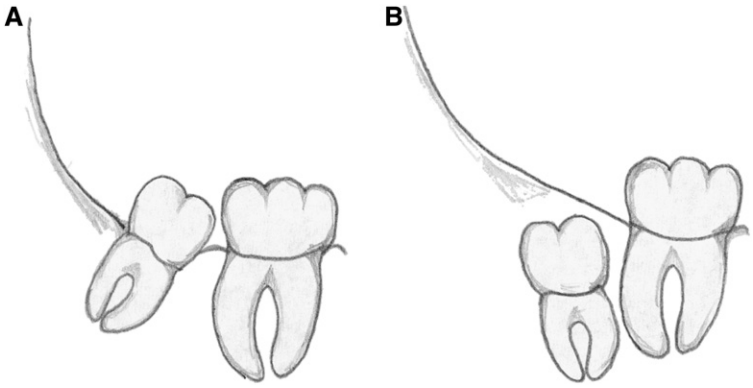

Fig. 4. Examples of combinations of angulation, anterior ramus, and occlusal plane classifications. (*A*) A mesioangular impaction with a class 1 ramus and class A depth relationship—an easy third molar impaction. (*B*) A distoangular impaction with a class 3 ramus and a class C depth—a difficult impaction.

remove than less curved or essentially straight roots. Roots that curve in the same direction as the pathway of removal break less often than roots that curve in a direction opposite to the pathway of removal. Roots with a mesiodistal diameter that is greater than the tooth diameter at the cervical line must be sectioned longitudinally (Fig. 6). Despite a Pell and Gregory classification of 1A, teeth that are erupted and functional often have a narrow periodontal ligament space, which makes elevator placement and mobility more difficult to achieve. Conversely, unerupted teeth with follicular sacs (younger patients) require less bone removal as a result of the wide periodontal ligament and a large coronal cavity secondary to the follicle [12].

When considering bone density, young patients are considered to have less dense bone than patients older than 35 years of age [12]. The more dense the bone, the less the degree of bony expansion during luxation and the more time required for its removal with a bur. The space between the distal surface of the second molar and the mesial surface of the impacted third also has an impact on the ease of removal of the third molar. The closer the third molar is to the second molar, the more difficult the surgery becomes. Large restorations, crowns, and root canal therapy in second molar teeth also pose additional risks of damage to the second molar if elevation forces or drilling vectors are misdirected. In cases in which crowns or large restorations exist in proximity to impacted or erupted third molars slated for removal, informed consent should be explicit regarding possible damage to an adjacent tooth.

The relationship of the mandibular third molar roots to the IAN must be considered when surgical removal is contemplated. Surgical planning and proper informed consent depend on detailed knowledge of the positional relationships in this area. The more intimate the relationship of the inferior alveolar neurovascular bundle to the roots of the tooth, the more likely nerve damage is to occur. Patients must have an understanding of the potential consequences of IAN damage, and

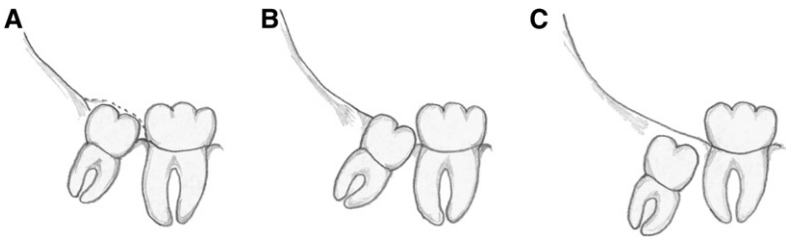

Fig. 5. Classification based on dental procedural codes. (*A*) A soft tissue impaction (D7220). (*B*) A partial bony impaction (D7230). (*C*) A full bony impaction (D7240, D7241).

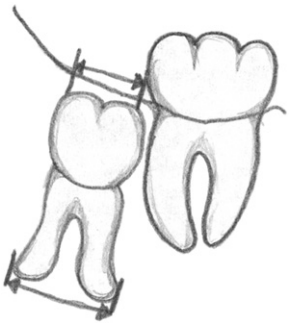

Fig. 6. If an impacted tooth—or an erupted tooth—is wider at the distal of the roots than at the crown, it must be sectioned for removal.

options such as leaving the tooth alone and coronectomy should be considered in cases in which the likelihood of IAN damage is significant [15].

The angulation classification system, the Pell and Gregory vertical relationship system (A, B, or C), and the Healthcare Common Procedure Coding System (HCPCS) coding classification also can be used for maxillary third molars. Classifying by angulation results in four types of maxillary impacted third molars (see Fig. 1A–D). Vertical maxillary impactions account for 63% of maxillary impacted third molars, whereas distoangular and mesioangular impactions account for 25% and 12%, respectively [12]. Horizontally impacted maxillary third molars are rarely encountered and, along with other angulations, account for less than 1% of impacted third molars [12]. Maxillary vertical and distoangular impactions are the easiest to remove because little bone overlies either of these presentations. In the case of mesially impacted maxillary third molars there is less access to the tooth and more bone removal is required for exposure and delivery. The bone overlying the distal aspect of this type of impaction is thicker and requires more extensive removal. Most maxillary third molars are buccally inclined, and this position often can be confirmed by palpation. If a maxillary impacted third molar is palatally inclined, it is more difficult to remove because of more extensive bone coverage and decreased accessibility.

The Pell and Gregory A, B, C classification used in the mandibular third molars applies equally to maxillary third molars (Fig. 7A–C). Root morphology (thin, erratically curved, divided), proximity to adjacent teeth, density of overlying bone, relationship to the floor and posterior wall of the maxillary sinus, follicle size, and periodontal ligament space also play a role in determining the difficulty of the removal of a maxillary third molar impaction [12].

Bur technique

Armamentarium

An important part of third molar surgery is organization and a systematic removal strategy. The initial component of organization is having the proper instrumentation at the disposal of the surgeon at the initiation of the surgical procedure. The necessary instrumentation ideally should be contained in cassette, which allows for organization, cleaning, processing, sterilization, and transportation to the operating setting (Fig. 8). The instrumentation most commonly used for third molar removal is summarized in Box 1. Some variation in the basic set is expected because of operator preference. A properly functioning high-speed drill is a necessity. Air-driven power equipment tends to be more reliable in most cases of high-volume usage, and a Hall air drill (Linvatec, Largo, Florida) is considered one of the most popular drills.

The choice of bur is also subject to great variation. A #8 round bur is satisfactory for gross bone removal. A fissure bur lends itself better to

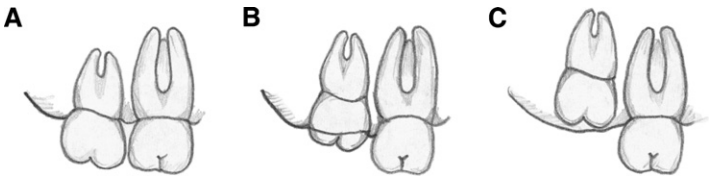

Fig. 7. Pell and Gregory classification based on the relationship to the occlusal plane applied to maxillary third molars. (*A*) Class A, in which the occlusal plane of third molar is level with that of the second molar. (*B*) Class B, in which the occlusal plane is between the occlusal plane of the second molar and its cervical line. (*C*) Class C, in which the occlusal plane of the impaction is below the cervical line of the second molar.

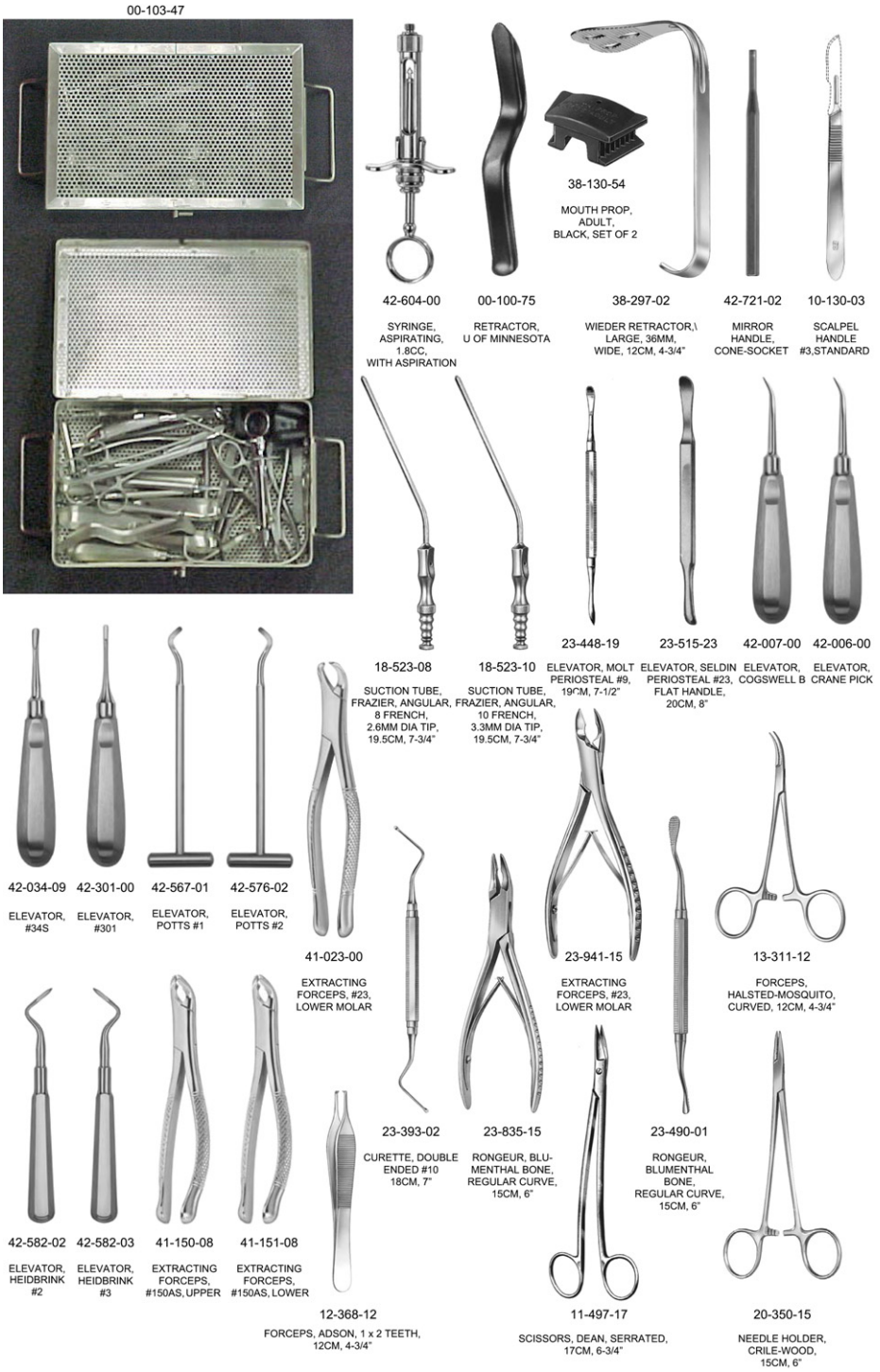

Fig. 8. A cassette system for impacted third molars. (*Courtesy of* KLS Martin LP, Jacksonville, Florida; with permission.)

Box 1. Third molar impaction/extraction tray

- Aspirating syringe
- Adult mouth prop
- Minnesota retractor
- Sweetheart retractor
- Dental mirror
- Frazier suction: 8 Fr and 10 Fr
- Scalpel handle #3
- Periosteal elevator #9
- Seldin retractor
- Elevators

#301
#34
Potts #1 & #2
Cogswell B
Crane pick
Heidbrink root tip #2 & #3

- 150 serrated forceps
- 151 serrated forceps
- Cowhorn forceps #23
- Double-ended curette
- Blumenthal end-cutting rongeur
- Side-cutting rongeurs
- Miller-Colburn bone file
- Curved mosquito hemostat
- Crile-Wood needle driver
- Dean scissors
- Adson pickup with teeth
- Martin tooth-grasping forceps

trough development and tooth sectioning. There are tapered and straight fissure burs with rounded tips (eg, SS White, Lakewood, New Jersey, 1702L #30030), which combine the aforementioned tasks efficiently (Fig. 9). The fissure bur should be 1.5 mm in diameter and at least 7 mm in head length. The narrow diameter of the surgical bur allows a straight narrow sectioning of the tooth. A #301 elevator can be placed in the sectioned tooth and the tooth fractured easily. The head of the bur should be at least 7 mm in length so that an adequate depth of cut can be made before the wider shank (2.5 mm) engages the tooth.

Sterile saline is satisfactory for irrigation. It can be dispensed by syringe or automatically by devices attached to the drill and driven by a pump. If the irrigation solution is dispensed by a pump device, one should remember that all usage must be followed by a plain water flush before autoclaving to prevent salt build-up and clogging of the dispensing tip. A headlight, fiber optic wands, and fiber optic attachments to retractors, drills, or suction tips augment illumination provided by the standard dental or operating room lighting.

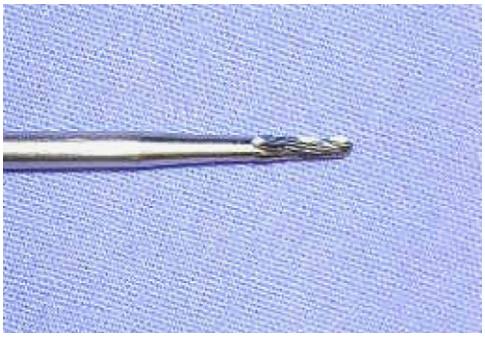

Fig. 9. Surgical bur with ideal length of 7 mm and diameter of 1.5 mm with a rounded end for gross bone removal (SS White, Lakewood NJ, #30030).

Technique

Several common steps apply to the removal of all impacted teeth. Adequate flaps must be reflected for accessibility, overlying bone must be removed for exposure, exposed teeth may be sectioned, sectioned teeth are delivered, and finally the wound must be closed. These procedures are outlined initially as they apply to third molar removal in general, and then a discussion of specific situations involving different classifications of impactions is presented. Infiltration anesthesia placed in the area overlying third molar impactions is used in addition to block anesthesia. Accessibility is a key issue in removal of impacted teeth. A full-thickness mucoperiosteal flap must be elevated to allow for visualization and placement of retractors, drilling equipment, elevators, and forceps. The lower third molar incision most commonly used is an envelope flap that extends from the mesial of the first molar to the ramus with lateral divergence of the posterior extension to avoid lingual nerve injury. An alternative incision that allows for increased exposure and less trauma to the reflected tissue is a three-cornered flap. With this flap an anterior vertical releasing incision at the distal aspect of the first or second molar is made. In either flap design the incision must be full thickness. The extent of the

flap reflection should be limited to the external oblique ridge laterally. Reflecting beyond this point leads to increased dead space and more edema. The flap must be raised in a subperiosteal plane without tears. A Minnesota retractor is placed just lateral to the external oblique ridge and stabilized against the lateral surface of the mandible. The retractor should be held by a few fingers at its distal end so that it can be toed out laterally without the hand holding it blocking the vision of the operator. The need for bone removal with a drill or periosteal elevator can be established at this point.

After the need for and extent of bone removal is determined, a hand piece with adequate speed and torque is used to remove bone from the occlusal aspect of the tooth. Buccal and distal bone removal is performed down to the cervical line of the impaction. This bone removal should be in the form of a trough and should not involve the full thickness of the lateral cortical plate of the mandible. Only enough buccal cortical bone should be removed as is needed for access for elevating, sectioning, and purchase point placement. After initial bone removal the tooth should be elevated with a #301 elevator. If the entire tooth as a unit can be elevated slightly at this juncture it lessens the chance of fracturing a root tip and finding it nonmobile when an attempt to recover it proceeds. With respect to upper third molar teeth, the overlying bone in the maxilla is typically thin and usually can be removed with a Potts elevator, periosteal elevator, or chisel using hand pressure.

When sufficient access is obtained, the need for sectioning of an impacted tooth can be determined. Several key points should be mentioned regarding tooth sectioning in general. When it is determined that a tooth should be sectioned vertically (as in the case of a mesioangular impacted lower third molar), the line of sectioning generally should be determined and then moved approximately 1.5 to 2 mm more anterior than initially felt necessary. This adjustment helps prevent inadvertently sectioning the tooth too distally, which often occurs as a result of the obstructing position of the second molar. The cut through the tooth should proceed to just short of the lingual surface to protect the lingual nerve. Vertical cuts should be placed carefully so that the line of sectioning does not angle from the perpendicular. If the sectioning line varies from the perpendicular, there are cases in which the segments are wider at the bottom (in the case of the horizontal impaction) than at the top and elevation is hindered (Fig. 10). Purchase points also can be placed at the sectioning stage. A Crane pick or Cogswell B elevator is used to elevate teeth that have purchase points placed. The purchase points should be deep enough and placed in a substantial enough portion of tooth structure so that elevation of the segment occurs rather than fracture. It should be remembered that a Cogswell B elevator has a smooth surface at the tip and is less likely to cause a fracture when used to engage the purchase point. A Crane pick is flat surfaced at the four sides of the tip and frequently causes fracturing when placed in a purchase point and force applied. When adequate bone has been removed and the tooth is sectioned into manageable segments, the tooth is delivered with elevators. The #301, Crane pick, and Cogswell B elevators serve this function well. Paired, sharp pointed elevators such as the Cryer or Winter elevators are capable of applying extreme force, and their use can be avoided if the drill is used to prepare an unimpeded pathway for delivery of the sectioned tooth. Excessive force can result in unfavorable root fracture, buccal or lingual bone loss, damage to the adjacent second molar, or even fracture of the mandible. Because impacted teeth have never sustained occlusal loading, their periodontal ligament space is wider and less tenacious, and they can be easily displaced if appropriate bone is removed and elevation forces are applied in a proper direction. Most impacted maxillary third molars are easily elevated with a #301 elevator after removal of overlying bone. A Potts elevator can

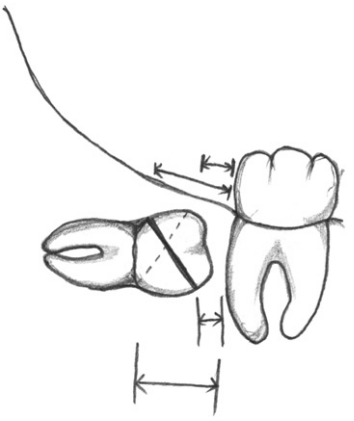

Fig. 10. Incorrectly sectioning the crown (broken line) leaves a segment that is bigger at the bottom than the top, and removal is blocked.

be used after initial elevation provides an entry point for this elevator. The Minnesota retractor or periosteal elevator always should be placed distal to the impacted maxillary third molar on final elevation so that it cannot be displaced under the flap and into the infratemporal fossa. Although not popular in the United States, a Laster retractor is an ideal retractor because it engages the tuberosity, provides excellent access, and prevents displacement of the tooth.

After the third molar is removed the socket must be debrided of all particulate bone and remaining tooth pieces. Careful irrigation under the reflected flap prevents retention of debris in this area, which can complicate healing. A rongeur, bone file, or bur can be used to smooth any sharp or rough edges of bone. All follicular fragments should be removed with a curette and mosquito hemostat. Primary closure of lower third molar sites is recommended, and although resorbable sutures suffice, some surgeons prefer nonresorbable sutures, which provide greater and longer lasting tensile stress and encourage patients to return for a postoperative visit for suture removal. The benefit of routine follow-up for third molar patients was recently questioned by Sittitavornwong and colleagues [16], however. Some surgeons are proponents of tight suturing to assist in hemostasis, whereas other surgeons believe that loose suturing leads to less edema and allows for drainage of the wound. Frequently, upper third molar sites do not require suturing because the wound is held in proper position by gravity and the surrounding soft tissues.

The specific technique for tooth sectioning varies depending on the angulation of the impacted lower third molar. In the case of the mesioangular impaction, the crown is exposed and a buccal and distal trough is created. Some mesioangular impactions can be removed simply by placing a purchase point in the mesial portion of the tooth at the cervical line and elevating with a Crane pick or a Cogswell B elevator. In other cases the distal aspect of the crown is sectioned or the distal and mesial root portions are sectioned and the distal segment of the tooth is delivered, after which the remainder of the tooth is elevated with a #301 elevator (Fig. 11A–C).

In the case of a horizontal impaction, adequate bone is removed to allow for exposure and the crown is sectioned from the roots in a vertical plane, with care taken not to allow the cut to drift distally and create a segment of crown that is larger at the bottom than at the top (see Fig. 10). At times the crown section resists delivery, and this process can be helped by sectioning the crown segment in a longitudinal fashion (Fig. 12A). After removing the crown, the roots can be elevated with a purchase point at the superior aspect of the upper root with elevation of both roots simultaneously or the delivery of each root individually after sectioning (Fig. 12B). In all cases of sectioning the cut should be kept within the tooth structure to prevent damage to the lingual tissues or the inferior alveolar canal.

Vertically impacted mandibular third molars can be removed by several techniques depending on the depth of the impaction, the root development, and the age of the patient. When dealing with a young patient, when the bone is somewhat flexible and root development is incomplete, the tooth often can be exposed with the creation of a buccal and distal trough followed by elevation without sectioning. A purchase point is helpful in these situations (Fig. 13A). In cases in which simple elevation is not possible, the distal aspect of the crown can be sectioned and removed followed by the elevation of the remainder of the crown and root structure if the roots are fused (Fig. 13B). If the root formation is complete and divergent, it may be best to section the mesial and distal roots, with removal of the distal root followed by the mesial root (Fig. 13C). The operator should attempt to preserve as much of a "handle" as possible because dealing with small segments that have not been luxated is where most difficulty is encountered in third molar removal. A deep, vertically impacted third molar below the cervical line of the second molar and fully covered with bone can present a difficult challenge for the surgeon. In such cases the tooth should be exposed, a buccal and distal trough created, and the tooth elevated en mass with subsequent sectioning of the crown in a horizontal fashion. The roots can be elevated in one piece or sectioned and delivered as separate units with the elevation of the distal root preceding that of the mesial (Fig. 13D). It is important to maintain as much root structure as possible to serve as a "handle" for elevation.

Distoangular mandibular impactions are considered by most surgeons to be the most difficult third molar impactions to remove. The pathway of delivery for an elevated distoangular impaction is into the vertical ramus of the mandible. The goal of the technique for removal of these teeth is to create an adequate buccal and distal trough around the full crown of the tooth to a depth

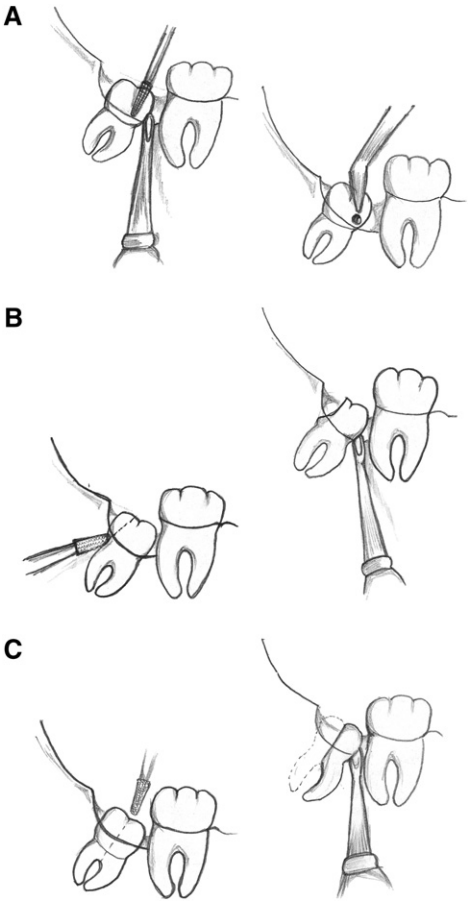

Fig. 11. Mesioangular mandibular impaction removal. (*A*) Buccal and distal trough created and tooth elevated distally with a #301 elevator or a purchase point and a Cogswell B elevator. (*B*) Distal portion of crown sectioned and removed followed by elevation of the mesial crown segment and roots. (*C*) Sectioning the roots with elevation of the distal segment followed by elevation of the mesial segment.

below the cervical line. At this point elevation of the tooth should be attempted. If some movement is obtained, the distal portion of the crown or the complete crown can be sectioned in a horizontal fashion from the roots and removed. The sectioned crown may have to be sectioned again if inadequate space is available for its removal. It is preferable in this case to section the tooth segments further as needed rather than to remove more bone. The remaining root segment along with the mesial portion of crown, in cases in which the distal portion has been eliminated as a first step, can be elevated and removed (Fig. 14A). Additional sectioning of this fragment also may be necessary to create segments that are of a size that can be removed from the bony cavity created. Additional sectioning of tooth is preferable to additional bone removal at this point because preservation of the structural integrity of the lower jaw is maintained. If the complete crown has been removed, the remaining root segments can be dealt with as a single unit. If tooth sectioning is required, the distal root should be elevated before the mesial root (Fig. 14B).

Throughout this article, no mention or recommendation has been made by the author (SEF) for Cryer, Winter, or Cogswell A elevators. These instruments have the ability to create significant forces, and unless they are cautiously applied they can damage the teeth or bone with potential unexpected tooth, alveolar, or mandibular fracture. A sharp, pointed elevator such as a Cryer or a Winter can be useful in removing bone in the furcation that is retaining a root fragment, but

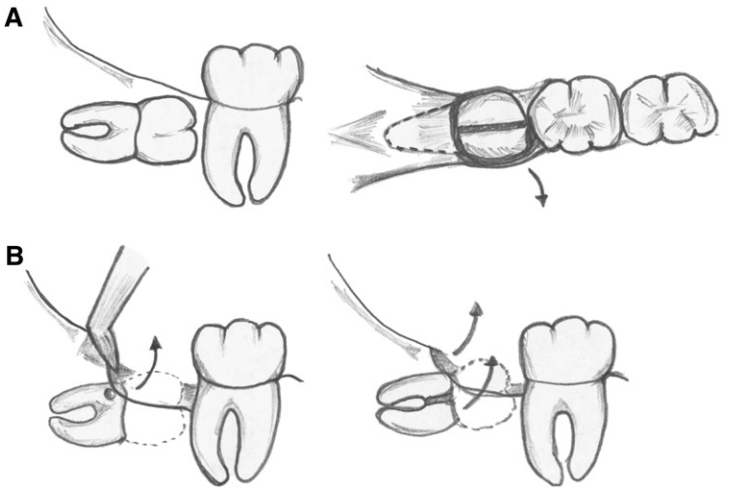

Fig. 12. Horizontal mandibular impaction removal. (*A*) The crown is sectioned from root and removed as a unit or may need to be sectioned longitudinally for removal. (*B*) Elevation of roots with a purchase point and a Cogswell B elevator. Roots may need to be sectioned into two pieces and removed separately, with upper followed by lower.

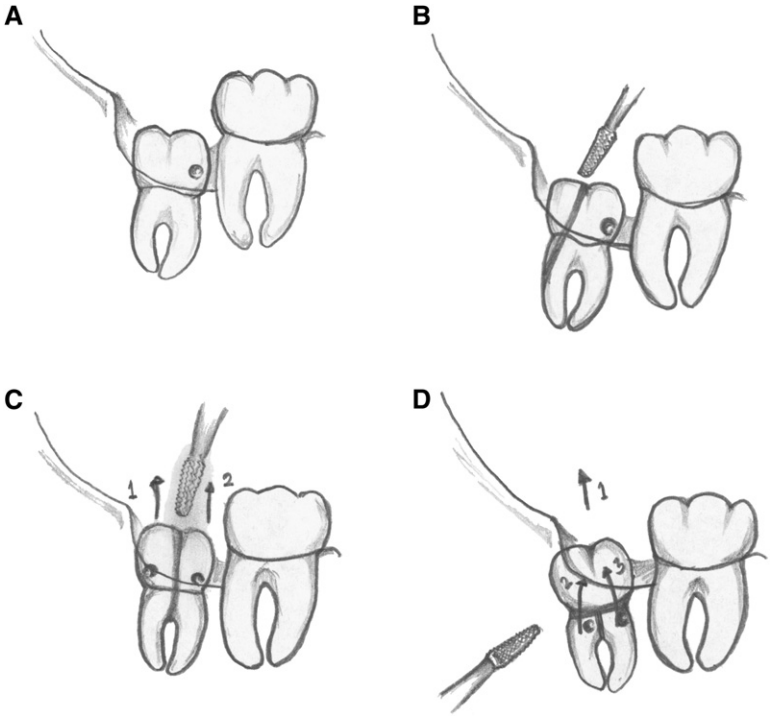

Fig. 13. Vertical mandibular impaction removal. (*A*) Buccal and distal trough created and purchase point placed and elevation with a #301 elevator or a Cogswell B elevator. (*B*) Distal crown segment sectioned and removed followed by a purchase point in the roots for elevation with a Cogswell B or a #301 elevator. (*C*) Tooth and root units split and removed distal followed by mesial with purchase points for Cogswell B and #301 elevators as required. (*D*) Crown removed horizontally and roots split for removal distal followed by mesial with purchase points for Cogswell B and #301 elevators as required.

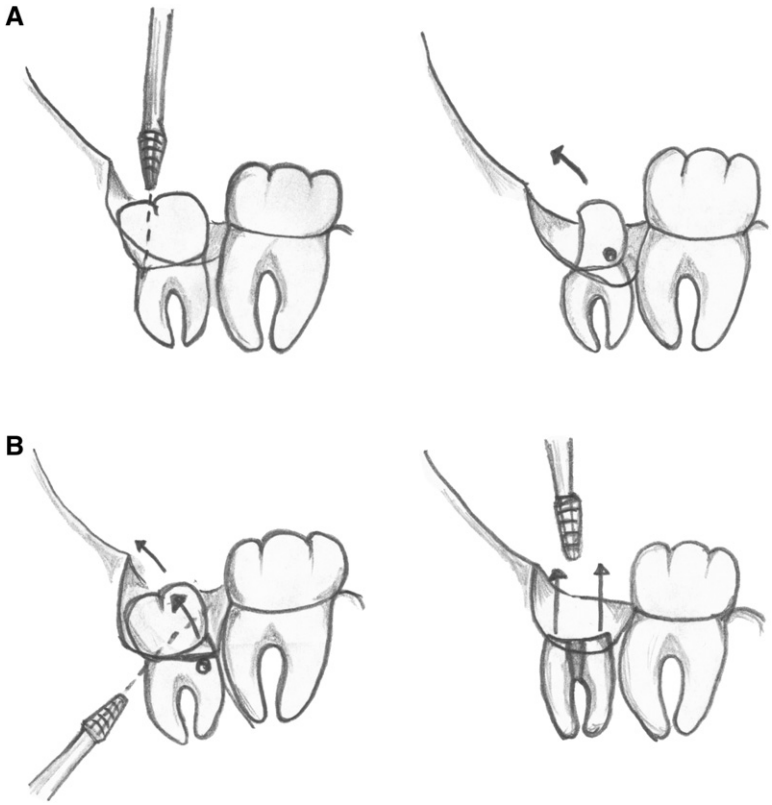

Fig. 14. Distoangular mandibular impaction removal. (*A*) Buccal and distal trough created and distal portion of crown sectioned followed by a purchase point in the mesial of the remaining tooth structure followed by elevation. (*B*) Crown sectioned horizontally and removed followed by sectioning of the remaining roots and elevation of each root independently.

a root fragment so elevated is pushed against an intact wall of bone and is more likely to fracture or defy removal than it would if removed in a mesial direction with the assistance of a well-placed purchase point as needed (Fig. 15). The use of a Cogswell A or other broad elevator between the buccal surface of the impacted tooth and the external oblique ridge to loosen or elevate a tooth or root segment is a common practice in third molar removal. This technique places the external oblique

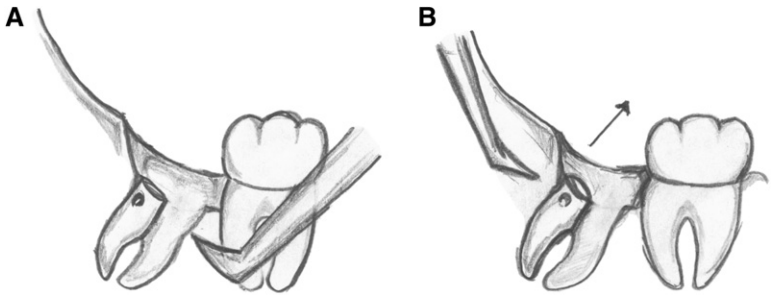

Fig. 15. (*A*) Elevation of a remaining root fragment with a Cryer- or Winter-type elevator in a distal direction removes intraseptal bone but forces the root against the intact distal socket wall, where it resists removal. (*B*) A well-placed purchase point in the distal of the root fragment allows a Cogswell B or Heidbrink elevator to guide the root mesially, where it meets no resistance to removal.

ridge, one of the buttresses of the mandible, and the lingual plate at risk for fracture. If such a fracture is unrecognized, a substantial late-presenting sequestrum or immediate lingual nerve injury is a possibility. Delicate instruments can be used to remove impacted third molars if adequate exposure, bone removal, and sectioning are performed. The author (SEF) is of the opinion that a #301 and Heidebrink root tip elevator are preferred instruments for impacted tooth removal if adequate site preparation has been completed.

In the case of maxillary third molar impactions, the envelope flap usually suffices but a vertical release at the distal aspect of the first molar frees the flap for extensive elevation if visualization of the tooth is impaired. Basic principles of flap design should be maintained, with the flap broader at the base than the apex, elevation of full-thickness mucoperiosteum, and wound closure over solid bone. A Minnesota retractor is used to retract the cheek and flap while protecting the flap and allowing visualization. If the incision is carried over the tuberosity and released in its full length, palatal retraction rarely is needed. Maxillary bone is much thinner and the underlying tooth usually can be exposed by removing this bone with a periosteal, Potts, or #301 elevator. Dense bone may require a hand piece and round bur, but this is rare. Sectioning of maxillary third molars should be avoided and considered only as a last resort because small segments can be displaced into the sinus or infratemporal fossa. The elevation of an impacted maxillary third molar is initially with a #301 elevator, and further elevation and delivery can be obtained with a Potts elevator. A Minnesota or Seldin retractor should always be placed below the cervical region of the crown before significant elevation to prevent displacement of the tooth into the infratemporal fossa. An end-cutting rongeur, a hemostat, and a Martin tooth-grasping forceps (KLS Martin, Jacksonville, Florida) (Fig. 16) are useful in the removal of teeth or fragments after adequate elevation.

Once impacted tooth removal has been completed, the remaining bony cavity can be curetted to remove any remnants of the follicle. The socket should be irrigated with saline and inspected. With respect to lower third molar teeth, if the IAN is visualized, it should be documented as intact or damaged in the operative note. If the lingual nerve is visualized, its condition also must be recorded appropriately. The upper third molar site is inspected for bony fragments, soft tissue, and the presence or absence of maxillary sinus communication. Sinus precautions should be prescribed if such an opening is recognized or suspected. The avoidance of forceful nose blowing and the prescription of antibiotics and nasal decongestants are mandatory to facilitate closure of the oro-antral communication.

Lingual split technique

The lingual split is a technique that was first described by Ward in 1956 [17]. The technique continues to be popular in the United Kingdom but has not gained wide acceptance in the United States. The technique involves the use of a chisel and mallet to remove or displace the lingual plate of bone adjacent to lower third molar teeth. A small amount of buccal bone is often removed to facilitate exposure of the crown and provide a point of application for a dental elevator. Although tooth division is usually not required, it

Fig. 16. Martin tooth-grasping forceps. (*Courtesy of* KLS Martin LP, Jacksonville, Florida; with permission.)

usually can be achieved with the chisel. Several minor modifications to the original technique have been reported [18,19]. Although the lingual split technique is well suited to patients receiving sedation or general anesthesia, it is generally not well suited to surgery conducted purely under local anesthesia.

The reported potential for temporary and permanent altered sensation of the lingual nerve after lingual split may be partly responsible for the technique's lack of popularity. The exact cause and timing of lingual nerve injury is not well understood and may be multifactorial. Although the original technique describes a full-thickness lingual mucoperiosteal flap, the ideal instrument for the elevation and subsequent retraction of this flap is more controversial. Most studies that evaluate lingual nerve injury are retrospective, involve small sample sizes, or are poorly controlled for multiple confounding variables and should be interpreted with some caution. Temporary lingual nerve injury has been reported to vary from 0.8% to 20%, whereas permanent injury has been reported to vary from 0% to 1% [20–23]. Although elevation of a lingual flap is an integral part of the lingual split technique, Robinson and Smith [24] recommended avoiding a lingual flap with the lingual split technique to reduce the frequency of lingual nerve injuries. One should remember, however, that lingual nerve injury is also known to occur with the standard bur technique (no lingual flap) with an incidence of 0% to 1.1%, although the duration of the altered sensation and the percentage of permanent injuries is often not stated [6,25–30]. Some surgeons advocate the use of a lingual flap in association with the bur technique to reduce the potential risk to the lingual nerve from the bur. With the use of a lingual flap, temporary and permanent lingual nerve injuries have been reported to vary from 1.6% to 8.3% and 0% to 2%, respectively [22–24, 31]. Others have found no difference in the incidence of lingual nerve injury with a bur technique regardless of whether a lingual flap is used [32]. When comparing the morbidity of lingual split to the bur technique with a lingual flap, Absi and Shepherd [33] found a greater incidence of lingual nerve injury with the bur technique, although the difference was not statistically significant. Middlehurst and colleagues [34] also found a greater incidence of nerve injury with the bur technique when comparing lingual split to the bur technique. A comprehensive review of the literature and meta-analysis by Pichler and Beirne [35] comparing lingual split, bur technique with lingual flap, and bur technique without lingual flap found an incidence of temporary nerve injury of 9.6%, 6.4%, and 0.6%, respectively. The incidence of permanent nerve injury was reported as 0.1%, 0.6%, and 0.2%, respectively. Although the lingual split technique seems to result in an increased incidence of temporary lingual nerve injury, the incidence of permanent nerve injury seems to be less than with the bur technique. It seems prudent to avoid a lingual flap with the bur technique because of the reported threefold increase in the incidence of permanent nerve injury. Differences between studies in the technique of flap elevation, choice of periosteal elevator, and retractor makes direct comparisons of morbidity difficult. It is the opinion of the author (GFB) that careful elevation of a lingual flap with an appropriate sharp periosteal elevator and placement of a suitable retractor are key factors in reducing the incidence of lingual nerve injury. Additional factors thought to influence the incidence of nerve injury include age, surgical time, perforation of the lingual plate, nerve exposure, and surgeon experience [36].

Armamentarium

Box 2 contains a list of instruments necessary for performing the split technique.

Technique

When removing a lower right third molar, the surgeon must stand on the right side of the patient. Removal of the lower left third molar

Box 2. Lingual split technique armamentarium

- Aspirating syringe
- Adult mouth prop
- Sweetheart retractor
- 3-mm chisel
- 5-mm chisel
- Mallet
- Scalpel #3
- Periosteal elevator #9
- Freer periosteal elevator
- Hovell's retractor
- Laster retractor
- Dental elevators (Coupland, Cryer, Warwick James)

necessitates that the surgeon stand on the left side of the patient. This is in contrast to the bur technique, which is usually performed with the surgeon standing on the same side of the patient for all third molar teeth. The surgical technique remains relatively constant regardless of the Pell and Gregory classification of the impaction. Description of the technique as it applies to a Pell and Gregory 1C impaction follows (Fig. 17). Modifications of technique for different impactions are described as needed. One should remember that occasionally a bur may be needed to facilitate tooth division or bone removal.

A rubber mouth prop is placed between the teeth on the side of the mouth contralateral to the surgery. A standard approach to anesthetize the inferior alveolar, lingual nerve, and long buccal nerve is used. An incision is made from the retromolar area to the mesial aspect of the first molar or the distal aspect of the second molar, depending on whether an envelope incision or a triangular flap is used. The latter approach involves a vertical buccal relieving incision on the distal aspect of the second molar and is preferred by the author (GFB) because it allows better retraction and improved visibility. The buccal flap is raised in a subperiosteal plane using a #9 periosteal elevator. The flap should be extended just slightly beyond the external oblique ridge to prevent excessive dead space beneath the flap. A 2-0 silk retraction suture is placed through the apex of the triangular flap. The suture should be clamped with a heavy hemostat 6 to 8 inches from the flap, which is then allowed to rest on skin of the cheek, where it serves to keep the flap retracted. Attention is then directed to raising a lingual flap, which must be done carefully to maintain a subperiosteal plane. A sharp and slightly curved periosteal elevator, such as a #9 or Freer periosteal elevator, is well suited to this procedure. The flap should be raised along a broad length before proceeding deeper. This latter approach reduces the tension placed on the lingual nerve, which adheres to the periosteum. The flap should extend from the mesial of the second molar to the lingual aspect of the anterior ramus. The inferior aspect of the pterygomandibular raphe and superior constrictor muscle together with a small portion of the mylohyoid muscle are included in this flap. One should remember that the lingual nerve enters the sublingual space by passing between the superior constrictor and mylohyoid muscles; at this location the nerve is immediately beneath the periosteum and at risk from trauma.

After lingual flap elevation, a left or right Hovell's retractor (depending on which side of the mandible is being operated) is placed beneath the flap and allowed to sit passively. The buccal flap, previously secured with the silk suture, is retracted in part from the weight of the heavy hemostat. The first finger and thumb grasp the 3-mm chisel while the second or third finger is placed on the first molar or alveolus to stabilize the instrument. The blade of the chisel is kept vertical, with the bevel facing posteriorly, and a vertical cut is made at the mesial aspect of the third molar (Fig. 18). This cut must extend from

Fig. 17. Mesioangular mandibular impaction with a Pell and Gregory class 1C relationship.

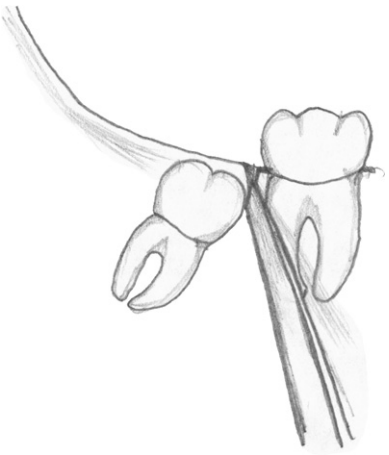

Fig. 18. A 3-mm chisel and mallet used to place a vertical cut through the lateral cortex adjacent to the mesial aspect of the crown. Inferior extent must extend sufficiently to expose an adequate amount of the tooth for application of an elevator, such as a Coupland #1 or straight Warwick James elevator.

the crest of the alveolar bone superiorly to a point inferiorly that allows buccal exposure of sufficient tooth to place an elevator either mesially or buccally, depending on the type of impaction present. A 5-mm chisel is then used to create a horizontal cut from the inferior aspect of the previously made vertical cut to the distobuccal aspect of the third molar (Fig. 19). The bevel should be kept facing superiorly for this osteotomy cut. The superior aspect of the buccal cortex adjacent to the third molar is delivered and exposes a portion of the third molar crown and provides a mesial or buccal point of elevation/access (Figs. 20 and 21). The most difficult and crucial aspect of the lingual split follows. The 5-mm chisel is then positioned with the edge of the blade located just posterior to the distolingual aspect of the crown of the third molar. The chisel edge should lie just lateral to the lingual cortex, and the cutting edge should be kept parallel to the sagittal plane (Fig. 22). The handle of the chisel should be approximately 45° to the horizontal. Positioning the chisel meticulously helps ensure that when the chisel is struck with the mallet, the cutting edge penetrates the superior aspect of the alveolus just inside the lingual cortex and results in displacement of the cortex lingually (Fig. 23). The anterior aspect of the fractured lingual cortex usually extends as far as the mesial of the third molar,

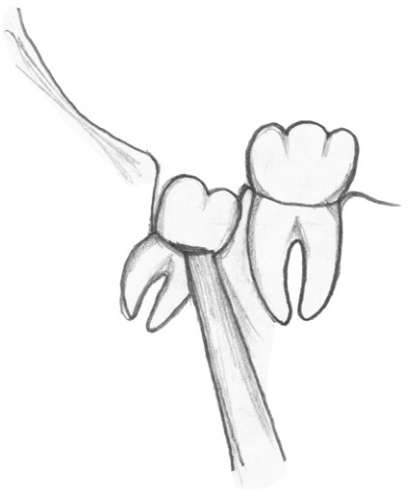

Fig. 19. A 5-mm chisel and mallet used to place a horizontal cut parallel to the cervix of the tooth. This buccal osteotomy should extend the full mesiodistal width of the crown to allow placement of a Coupland elevator between the buccal aspect of the tooth and the lateral cortex.

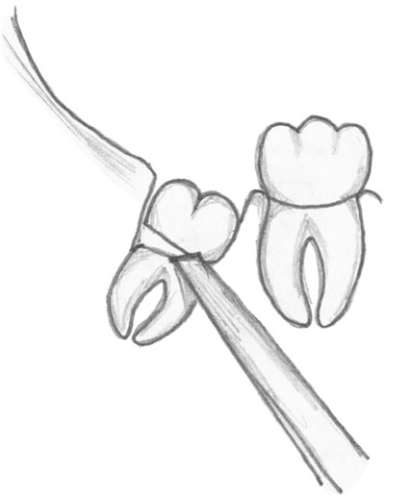

Fig. 20. The buccal ostectomy progresses in a distal direction until the complete mesiodistal width of the crown is exposed.

whereas the posterior aspect may extend up to 1 cm distally. The posterior extent of the fracture is limited by the natural bony lingual concavity behind the third molar. When the chisel blade is originally positioned for the osteotomy, the cutting edge can be rotated from parallel to the sagittal plane to shorten the posterior extent of the fracture. The inferior extent of the fracture typically involves the mylohyoid ridge (Fig. 24).

The classification of the impacted lower third molars has some influence on the applicability of the lingual split and any modifications that are needed, including the additional use of a bur for

Fig. 21. After completion of the buccal osteotomies, the crown of the impacted tooth is completely visible, with good access for application of elevators.

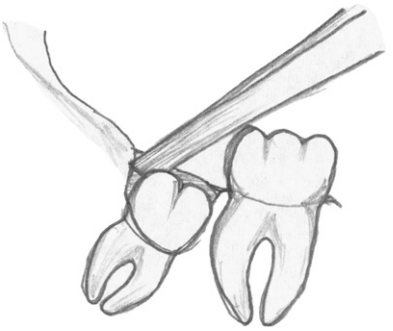

Fig. 22. The 5-mm chisel positioned just inside the lingual cortex and a single strike of the mallet is often all that is required to complete the lingual osteotomy.

either bone removal or tooth sectioning. With respect to the Winter classification, distoangular impactions may limit accessibility to the distolingual bone behind the tooth, making placement of the chisel for the final osteotomy difficult. This difficulty may result in a poorly controlled bone split. It may be prudent to remove the crown or distal part thereof to allow proper chisel placement. Decoronation can be completed with a bibeveled chisel or bur, but removal of the distal portion of the crown is best completed with a bur. The author (GFB) prefers a bur for all sectioning because it provides optimal control of the sectioning. With respect to the Pell and Gregory classification, class III and C lower third molars provide the greatest challenge as they do for removal with the bur technique. Class III teeth, located almost entirely within the ramus, may

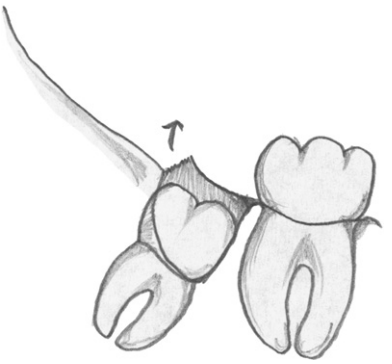

Fig. 23. The lingual cortex has been fractured lingually to provide a lingual path for removal of the impacted third molar.

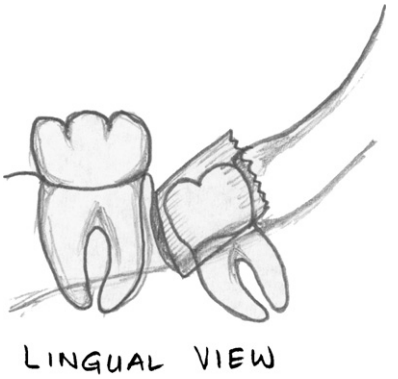

Fig. 24. Viewed from the lingual aspect, the extent of the lingual cortex fracture can be seen. The inferior aspect is often attached to the mylohyoid muscle, which must be dissected free before removal of the bone.

present a problem in initiating and controlling the final and most important osteotomy of the lingual plate. If bony morphology at the distal aspect allows placement of the chisel just inside the lingual cortex without facilitating propagation of the fracture up the ramus, then the procedure can continue as usual. When the bony morphology makes a controlled split unlikely, the bur technique should be used. Class C teeth that are deeply located are less of a concern and still can be managed with the lingual split technique (Fig. 25). The initial buccal exposure of the crown is readily achieved with the chisel, but when this is inadequate, a bur can be used to gain further access.

Mesioangular and horizontal impactions are also readily removed with the lingual split technique. Although the surgical procedure previously described can be applied without modification, a variable quantity of bone may overlie the most superior portion of the tooth, particularly distally. This bone should be removed before the lingual splitting osteotomy, because only then can the surgeon visualize the distolingual bone and correctly place the cutting edge of the 5-mm chisel immediately lateral to the lingual plate, resulting in a predictable lingual split (Figs. 26 and 27).

After completion of the lingual osteotomy, a dental elevator is used to displace the third molar toward the lingual space (Figs. 28–30). The need for tooth sectioning at this point is rare. When required, the sectioning is best performed with a bur after the lingual split has been completed and elevation of the tooth attempted. When sectioning is required, it may involve

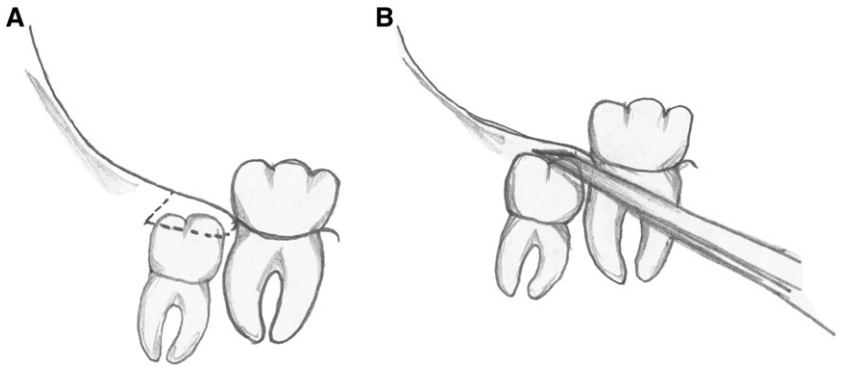

Fig. 25. (*A*) With vertical mandibular impactions (Pell and Gregory classes B and C) it is necessary to remove bone overlying the occlusal surface of the tooth. This procedure may be completed before or after removal of the buccal cortex. (*B*) The thin overlying bone has been removed with a chisel after the buccal osteotomy was completed, which often can be completed without the mallet using hand pressure alone.

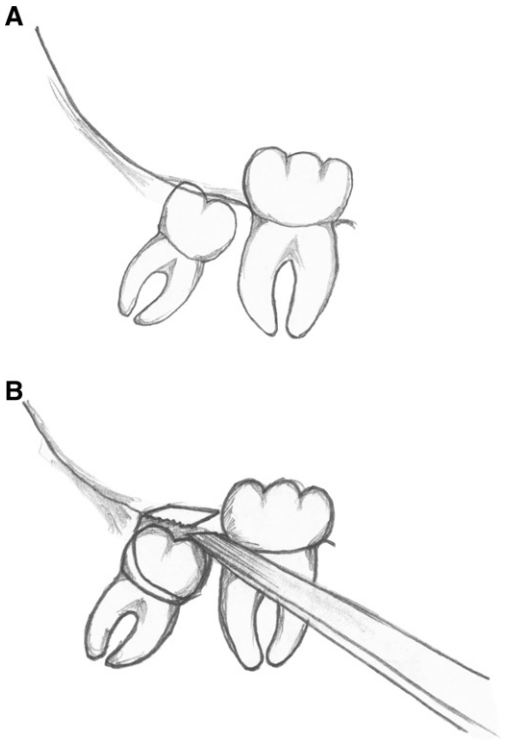

Fig. 26. (*A*) With mesioangular mandibular impactions a variable amount of overlying bone must be removed. (*B*) The overlying bone has been removed with a chisel after the buccal osteotomy has been completed. Note that the inferior extent of the buccal osteotomy does not have to extend to the inferior extent of the tooth but only as far as is needed to obtain a buccal point of application for luxation before displacing the tooth lingually.

removal of the crown or separation of individual roots. It is typically difficult to predict the need for and the type of tooth sectioning required because a complete fracture of the entire lingual plate often suffices for all types of impacted third molars. It has been the author's (GFB) experience that the two most common reasons for use of a bur are (1) failure to gain adequate buccal or superior exposure of the unerupted tooth and (2) an unfavorable relationship between the roots and the IAN. The IAN is almost invariably located laterally with respect to the roots of the third molar, however, and is less likely to be traumatized when the tooth is displaced lingually. Occasionally the preoperative radiographic appearance suggests an intimate relationship between the IAN and roots or clinically the angulation of the tooth seems to suggest that the roots may be lateral to the IAN. Removing the crown with a bur in combination with the lingual split allows the crown to be removed lingually and the roots elevated away from the IAN. One should remember that the tooth can be sectioned with a bi-beveled chisel, but the split can be less predictable and may result in tooth displacement that was not anticipated.

Once the tooth is removed, the fractured lingual cortex can be removed. Often the inferior extent of the fractured lingual plate is attached to the mylohyoid muscle, which is then removed with a periosteal elevator. The bony edges of the socket are smoothed with a rongeur and bone file. Failure to address areas of bony prominences adequately undoubtedly leads to patient discomfort, potential future bone exposure, and possible injury to the lingual nerve. Copious irrigation

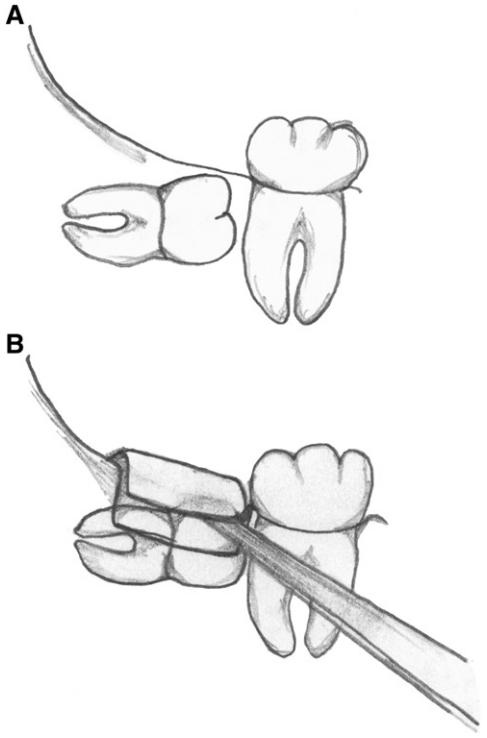

Fig. 27. (*A*) With horizontal impactions a significant amount of overlying bone may need to be removed. This approach occasionally may necessitate the use of a bur. (*B*) Adequate removal of buccal and occlusal bone provides a point of elevation and exposes the distolingual aspect of the tooth.

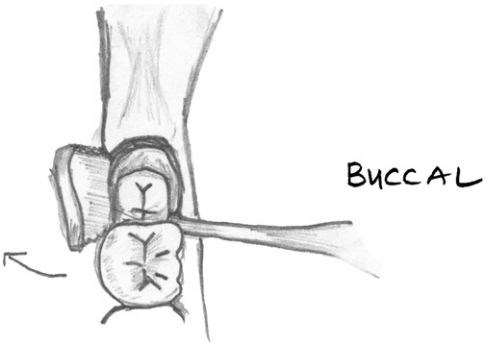

Fig. 29. Occlusal view illustrates use of a Coupland elevator buccally to displace the tooth lingually.

with saline should be used to ensure that all bony splinters, which may otherwise migrate or cause infection, are removed from the wound. After the wound is inspected for hemostasis and the retraction suture removed, the wound should be closed primarily with 3-0 catgut.

Although the lingual split technique only describes removal of lower wisdom teeth, a technique using chisels for the removal of impacted maxillary third molars also is detailed for completeness. A small mouth prop is placed between the teeth on the side contralateral to the surgical procedure. Local anesthesia of the greater palatine and posterior superior alveolar nerves is obtained in

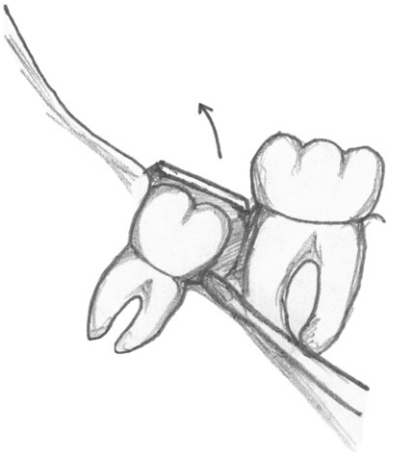

Fig. 28. Coupland #1 or straight Warwick James used to engage mesial aspect and provide initial mobility.

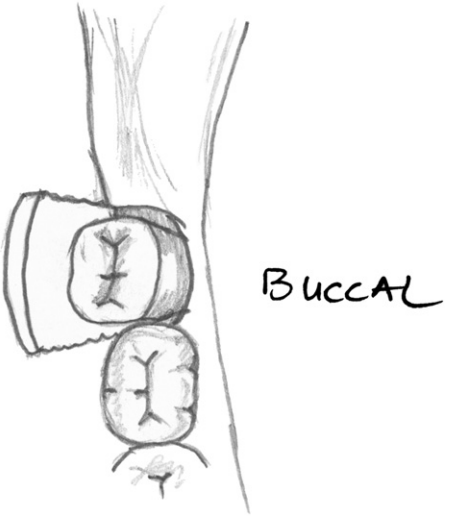

Fig. 30. Occlusal view illustrates displacement of the tooth lingually for easy retrieval.

the usual manner. An oblique incision is made from a distopalatal position extending obliquely over the tuberosity toward the distobuccal aspect of the second molar before being extended into the vestibule. This oblique incision allows easy closure of the wound, often without the need for suturing. The buccal flap is then elevated to include the maxillary tuberosity. A Laster retractor can be readily positioned with the small cup-shaped tip firmly engaging the tuberosity. This retractor also protects the cheek and, by engaging the tuberosity, effectively prevents displacement of the third molar tooth into the infratemporal fossa. The retractor is held in the left hand while the surgeon stabilizes the chisel with the other hand. The chisel is held parallel to the occlusal plane and the cutting edge positioned adjacent to the distal aspect of the erupted second molar at the occlusal aspect of the alveolar process with the bevel facing toward the cheek. The assistant uses the mallet to repeatedly "tap" the chisel, which results in removal of a thin length of buccal bone from the distal second molar to the tuberosity. The chisel is positioned slightly superiorly and the process repeated. When sufficient bone has been removed, a Cryer or Warwick James elevator is positioned to engage the mesial aspect of the crown of the third molar and the tooth is displaced buccally. The soft-tissue follicle is removed carefully with a sharp curette and curved hemostat. Sharp bony areas are smoothed with rongeur or bone file before copious irrigation of the wound with saline. The wound is primarily closed with one or two 3-0 catgut sutures in the vestibular part of the incision.

Acknowledgments

The authors wish to thank Dr. Deepak Krishnan for supplying the line drawings for the article.

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