OVERVIEW

Surgical Uprighting of Lower Second Molars

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(Editor's Note: In this regular column, JCO provides an overview of a clinical topic of interest to orthodontists. Contributions and suggestions for future subjects are welcome.)

Orthodontic correction of impacted lower second molars is challenging due to the limited access. Both nonsurgical[1-6] and surgical[7-15] treatment options have been reported. If the impacted molar is submerged deep below the soft tissue, surgical uprighting provides a safe and efficient solution with minimal tooth morbidity and a good long-term prognosis. Although the technique is most commonly applied to mesially angulated lower second molars, it can be used on other impacted teeth that have limited access or have failed to respond to standard bracket-and-chain methods.

As early as 1956, Holland first discussed surgical repositioning, which he referred to as "surgical orthodontics".[16] Peskin and Graber,[17] as well as Johnson and Quirk,[15] thoroughly reviewed surgical uprighting of lower second molars in the early 1970s. In 1995, Pogrel presented a landmark clinical study involving long-term observation of 22 surgically uprighted lower second molars.[18]

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TABLE 1
DIFFERENCES AMONG SURGICAL UPRIGHTING,
TRANSALVEOLAR TRANSPLANTATION, AND AUTOTRANSPLANTATION

	Definition	Teeth Commonly Involved	Risk of Loss of Vitality
Surgical uprighting	Repositioning within the dentoalveolus and within the socket	Lower second molars	Mild
Transalveolar transplantation	Repositioning within the dentoalveolus, but outside the socket	Upper canines	Moderate
Autotransplantation	Repositioning outside the dentoalveolus to a new location	Premolars	Higher

This overview provides a step-by-step guide to the procedure and the postsurgical orthodontic technique, with a discussion of case selection and potential complications.

Definitions

Surgical uprighting, usually performed by an oral surgeon, is the luxation of an impacted tooth within its socket, using a straight elevator. Prior to luxation, a minimal amount of buccal crestal bone is removed from around the crown, ensuring that the cementoenamel junction and root surfaces remain covered. The tooth is tipped superiorly and distally with the elevator until the occlusal surface is approximately level with the occlusal plane. Most important, the molar is repositioned within its socket and rotated on its root apices to preserve the apical vessels (Table 1).

Transalveolar transplantation is the surgical repositioning of an impacted tooth within the dentoalveolus, but away from its socket.[19] The crown and some of the root are uncovered, and the new surgical site is prepared by funneling the bone with a bur. This technique is commonly used to correct impacted canines located high within the maxilla.

Autotransplantation is the repositioning of a tooth from one site into an extraction site or a surgically prepared socket elsewhere in the mouth of the same patient.[20] Commonly used for premolars, this technique has been recommended to replace missing teeth or teeth with poor prognoses.

Because both transalveolar transplantation and autotransplantation move the impacted tooth away from its socket, they increase the likelihood of periodontal healing complications and the need for root-canal therapy after surgery. The greater the distance the root apex is moved, the greater the risk—particularly if the tooth is mature and the root apices are closed.

Etiology

Tooth impaction occurs in nearly 20% of the population.[21] In the permanent dentition, the lower and upper third molars are the most commonly affected, followed by the upper canines and lower second premolars.[22] Impaction of the lower second molars is relatively rare, occurring in only .06-.3% of the population,[23-25] but a higher incidence (2-3%) has been reported among orthodontic patients.[13]

Second-molar impaction occurs much more frequently in the mandible than in the maxilla, which may be attributed to the later development of the upper third molar.[24] These impactions tend to be unilateral[24]; Varpio and Wellfelt found more

on the right side,[24] Cho and colleagues more on the left.[26] Although both Bondemark and Tsiopa[27] and Bacetti[28] observed no differences according to gender, Varpio and Wellfelt noted a greater prevalence in males,[24] while Cho and colleagues found a greater prevalence in females.[26]

Three main causes of lower-second-molar impactions have been identified: ectopic positioning, obstacles in the eruption path (impacted third molars, supernumerary teeth, cysts, or tumors), and failure of the eruption mechanism (ankylosis or dilaceration).[21] Posterior crowding is thought to be the most common cause of mesially angulated lower-second-molar impactions,[29] in contrast to mesially angulated upper-first-molar impactions, which are typically associated with ectopic eruption paths.

Secondary causes also play a role. Hereditary factors may include systemic conditions or dental anomalies associated with impacted teeth.[30,31] Among iatrogenic risks, the orthodontist may inadvertently impact a lower second molar while attempting to increase mandibular arch length with a lip bumper or an Arnold appliance,[32] or during retraction of the mandibular dentition. Lower-second-molar impaction may be biologically related to other genetic variations—for example, patients with second-molar impactions have been shown to have a higher occurrence of morphological tooth anomalies such as root deflections, invaginations, and taurodontism.[33]

Close guidance along the distal root of the first permanent molar—a situation comparable to the upper canine moving down the distal root of the lateral incisor—is needed for successful eruption of the second molar.[34] At some point during development, the tooth bud of an impacted second molar tips mesially, and the crown erupts in a mesial direction, lodging against the distal prominence of the first molar. Unerupted second molars are also associated with delayed eruption and ectopic positioning of other teeth.[35] The adjacent third molar is seldom missing, however, which is noteworthy since insufficient arch length has been cited as the primary reason for lower-second-molar impaction.[24,33] To support this point, Caucasian patients with retrognathia have been shown to have a higher incidence of impaction.[33] A higher incidence (1%) may also exist among Chinese populations, presumably due to a larger tooth size.[26]

Diagnosis and Timing

Impacted second molars are typically diagnosed between 10 and 14 years of age. Due to their late presentation, they are seldom the primary reason for an orthodontic referral. As an asymptomatic pathology, failure of eruption is more likely to be a secondary finding during orthodontic treatment.[36] Clinical observation of one erupted lower second molar without the contralateral molar may alert the orthodontist. In a preadolescent patient, panoramic evidence of a lower-third-molar follicle positioned on top of the developing second-molar crown may provide early warning of a future impaction (Fig. 1).

The ideal time for surgical uprighting is during early adolescence, between 11 and 15 years of age, when the lower second molars are at one-half to two-thirds of their root development and the lower third molars have only partially developed (Fig. 2). Surgical uprighting prior to complete root formation of the lower second molars has been found to simplify the procedure and improve the long-term prognosis.[29]
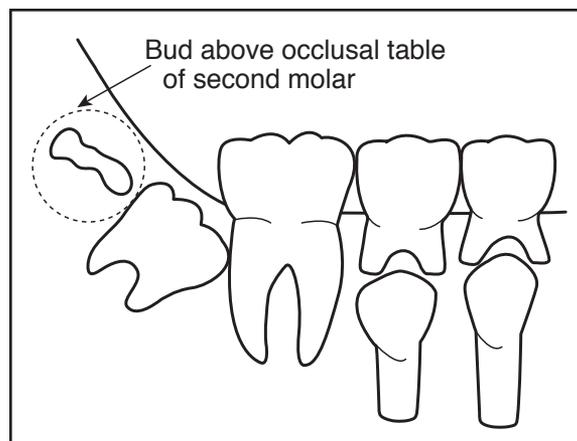

Fig. 1 In panoramic x-ray of preadolescent patient, third-molar follicle resting above occlusal table of developing lower second molar may warn of potential future impaction.

Fig. 2 Bilateral surgical uprighting in 15-year-old female, with orthodontic treatment initiated by patient's general dentist. A. At time of transfer, note influence of large lower third molars. B. Radiographic confirmation of successful wire insertion through second-molar tubes. Note lower-third-molar extractions. C. Nine months after surgery, showing root parallelism and bone healing.
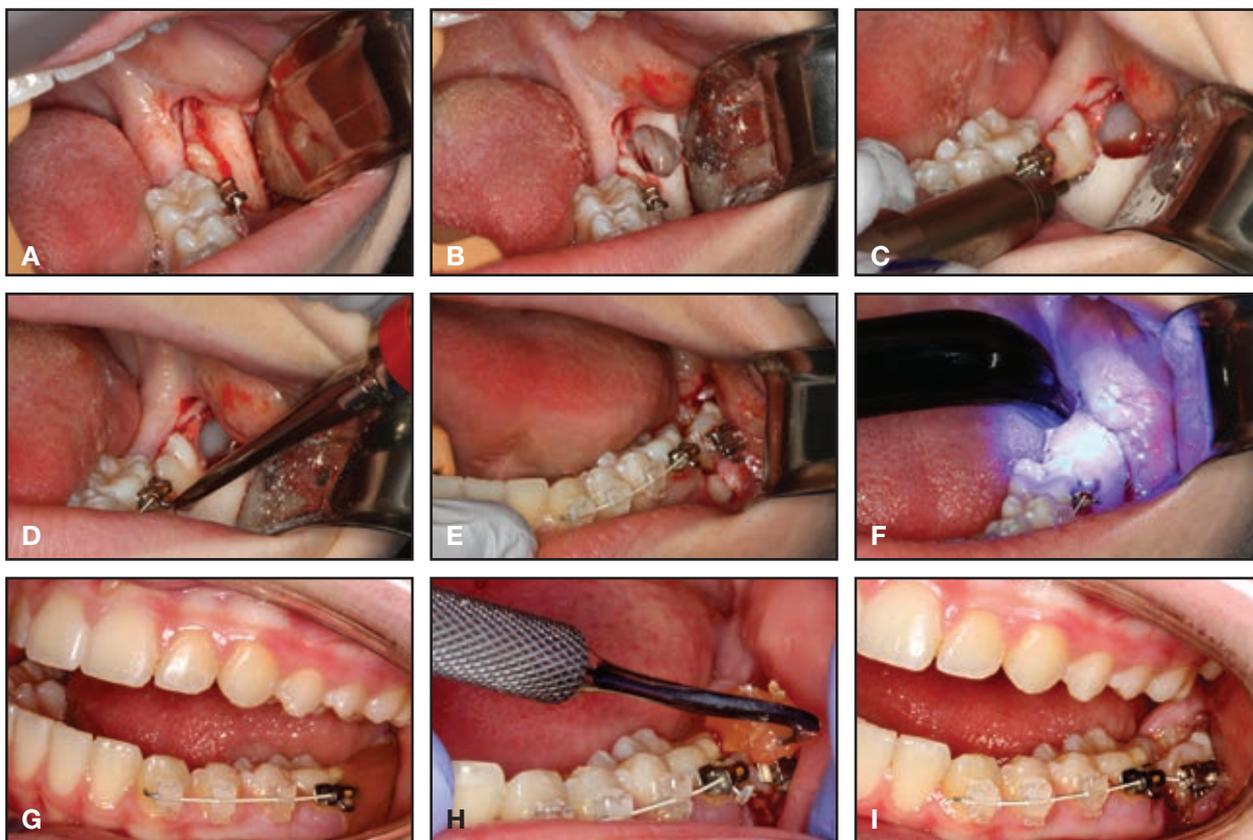
Fig. 3 Surgical uprighting in 14-year-old female. A. Third-molar incision and full-thickness flap performed by oral surgeon. B. Removal of third molar. C. Removal of buccal crestal bone. D. Luxation of impacted second molar. (Finger support on lingual aspect not shown for picture clarity.) E. Second-molar bracket etched and bonded. F. Light-cured wound dressing* placed occlusally and buccally for support. Vaseline on gloves eases handling of material. G. Occlusion checked to ensure elimination of vertical pressure from opposing teeth. H. At first orthodontic appointment, 14 days after surgery, wound dressing removed with scaler. I. .018" nickel titanium archwire inserted.

Surgical Technique

The procedure is demonstrated in a 14-year-old female patient.

Setup. Lower brackets are bonded, extending to the first molar on the affected side. This is an important step, because it allows for initial tooth alignment before the orthodontist has to thread an archwire through the bracket of the newly uprighted second molar.

Surgery. Surgery is usually performed on an outpatient basis under local anesthesia, supplemented by intravenous conscious sedation as appropriate. A standard third-molar incision is placed to expose the lateral border of the mandible. A full-thickness flap is extended from the distobuccal angle of the first molar, down into the buccal sulcus, and along the occlusal ridge beyond the distal bone of the third molar[12] (Fig. 3A). The adjacent third molar should be removed to facilitate repositioning of the second molar, as well as to avoid the need for a subsequent surgery (Fig. 3B).

Prior to uprighting, an electric handpiece is used with copious irrigation to remove bone over the crown and around the buccal crest of the second molar (Fig. 3C). A straight elevator is then placed mesial to the second molar on the buccal side to elevate the tooth and allow gentle expansion of the buccal bone. In a slow, controlled fashion, the second molar is tipped superiorly and distally into the proper position (Fig. 3D). The index finger of the surgeon's free hand is used to support the tooth from the lingual side during elevation.

The oral surgeon will bond the second-molar bracket immediately following luxation (Fig. 3E). Although surgeons familiar with molar uprighting often carry second-molar brackets in their offices, the orthodontist may prefer to provide the bracket. A light-cured wound-dressing material* is then applied over the second molar to stabilize the tooth and help keep the buccal tissue in place (Fig. 3F). The recommended dressing is composed of a dimethacrylate resin, which offers better flow, appearance, and setting time than the traditional Coe-Pak.**[37] Finally, the occlusion should be checked to ensure that the opposing teeth are not contacting the material and delivering undesirable vertical forces (Fig. 3G).

The patient may experience minimal discomfort with limited mouth opening for one to two weeks after surgery. Mild analgesics and prophylactic antibiotics are usually prescribed. Although postoperative infection is rare, 250mg or 500mg of penicillin adjusted by weight, four times a day for seven days, is suggested. A soft diet should be prescribed for one week to enable reattachment of the periodontal ligaments.

Orthodontics. The first orthodontic appointment is scheduled seven to 14 days following the surgery. The periodontal dressing is easily removed with a scaler (Fig. 3H); no anesthesia is required. An .014" or (preferably) .018" nickel titanium wire is then threaded through the second-molar bracket to provide stabilization and improve alignment (Fig. 3I). Because the tissue distal to the second molar is often swollen, impeding visibility of the second-molar bracket, the clinician should extend the wire slightly beyond the bracket and confirm successful wire insertion with a panoramic radiograph.

Routine orthodontic appointments are scheduled every six to eight weeks. A progress panoramic radiograph should be taken at every other appointment to assess root vitality and bone health. After six to nine months, new bone will have successfully redeposited mesial and distal to the second molar, and fixed appliances can be removed.

New Periodontal Bone Formation

An impacted lower second molar often presents with an acutely angled osseous topography along its mesial root. Though similar in appearance to an infrabony defect, this is not associated with periodontal pathology and therefore should not be referred to as a pocket or defect. Rather, the topography is a physiological adaptation of bone due to the tilted tooth position. The absence of pathogens is important, because a healthy periodontium has regenerative ability.

*Barricaid, registered trademark of Dentsply Caulk, Milford, DE; www.caulk.com.
**Trademark of GC America, Inc., Alsip, IL; www.gcamerica.com.

Following luxation, the periodontal ligament undergoes robust changes. Periodontal reattachment occurs as Sharpey's fibers splice the ruptured ligament. Regeneration of a new periodontal attachment occurs as a result of coronal growth of the periodontal ligament tissue up the mesial root.[38] In essence, new Sharpey's fibers embed into new cementum and bone along the mesial aspect of the uprighted molar. New bone forms as a result of the new periodontal attachment. Thus, surgical luxation of an impacted second molar takes advantage of the excellent wound-healing properties of the periodontium.

A fully erupted lower second molar that has tipped into an unrestored first-molar extraction site will also have an acutely angled osseous topography along its mesial root, but the mesial aspect of the erupted tooth will be associated with a loss of periodontal attachment due to plaque-induced inflammation.[39] New periodontal attachment will not occur in the presence of periodontitis. In this situation, orthodontic uprighting after surgical luxation can actually widen the osseous defect.

Indications

Indications for treating impacted lower molars include prevention of periocoronitis[10] or cystic development of the second-molar follicle[40]; establishment of a proper occlusion; avoidance of supra-eruption of the opposing upper second molar; and reduction of the risks of caries development at the first or second molar, loss of periodontal attachment, or resorption of the first-molar roots. Simply put, failure to correct an impacted lower second molar may lead to further complications that can affect the function and health of the adjacent or opposing teeth.

It can be challenging to determine whether surgical uprighting is more appropriate than extraction of the impacted second molar and substitution with the third molar. The primary disadvantage of third-molar substitution is that treatment is often extended because spontaneous third-molar drift is less predictable in the mandible (66%) than in the maxilla (96%).[41] Therefore, third-molar substitution should be reserved for cases involving second-molar caries or second molars that are either ankylosed or severely inclined.

On a panoramic radiograph, an ectopic lower second molar will be mesially angulated and in contact with the distal prominence of the first molar,[27] but the distal bone height will be normal. In contrast, an ankylosed second molar will be vertically positioned and submerged below the distal prominence of the first molar, with both mesial and distal bone heights lower than normal. An ectopic tooth has a physical barrier, whereas an ankylosed tooth typically does not. To further complicate matters, ankylosis presents similarly to another eruption disturbance referred to as primary retention—the cessation of eruption of a normally placed and normally developed tooth without a recognizable physical barrier in the eruption path.[27] Because unerupted upper second molars commonly display primary retention, a definitive diagnosis may be impossible to make before surgical exposure and orthodontic traction.

The angle of inclination between the lower first and second permanent molars, as measured from the intersecting long axes, should be less than 75°.[26,42] A larger angle of inclination—an increasingly horizontal position of the second molar—requires greater movement at the root apices. In essence, an angle of inclination greater than 75° necessitates a surgical technique more like transalveolar transplantation, which would increase the associated risks (Fig. 4).

Risks and Complications

The primary risks of any type of surgical repositioning are pulpal necrosis, external root resorption, and ankylosis. Although periodontal healing complications and the need for root-canal treatment are less likely after surgical uprighting,[11] particularly of immature permanent teeth,[43] such complicating factors as advanced age, complete root formation, and excessive inclination may contribute to an irreversible strain on the apical vessels.

The most common undesirable side effect is a displacement of the second molar into buccal crossbite (Fig. 5). This is probably caused by the
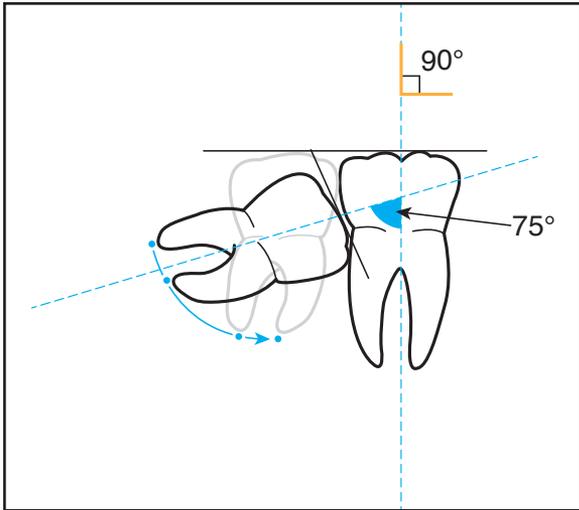
Fig. 4 Angle of inclination greater than 75° requires surgical procedure more like transalveolar transplantation.

rolling up-and-out vector of luxation from the straight elevator, but it may also result from the need to remove more buccal bone for access to a severely impacted tooth. If a second molar is displaced too far buccally, the lingual bone and thick soft tissue may make it impossible to correct the crossbite with conventional mechanics, since there is no biological mechanism for the enamel of the crown to resorb the surrounding lingual bone. In this situation, a second uncovering surgery may be required around the lingual aspect of the crown.

Conclusion

Surgical uprighting is a safe and reliable alternative to conventional orthodontic mechanics for uprighting of impacted lower second molars associated with crowding. The ideal case is an adolescent patient with two-thirds root development and an angle of inclination of less than 75°. Orthodontic treatment should commence one to two weeks after surgery, with a mandibular archwire extended through the second-molar bracket for stabilization. Relatively complete healing will occur in six to nine months, as distal bone returns to its normal height.
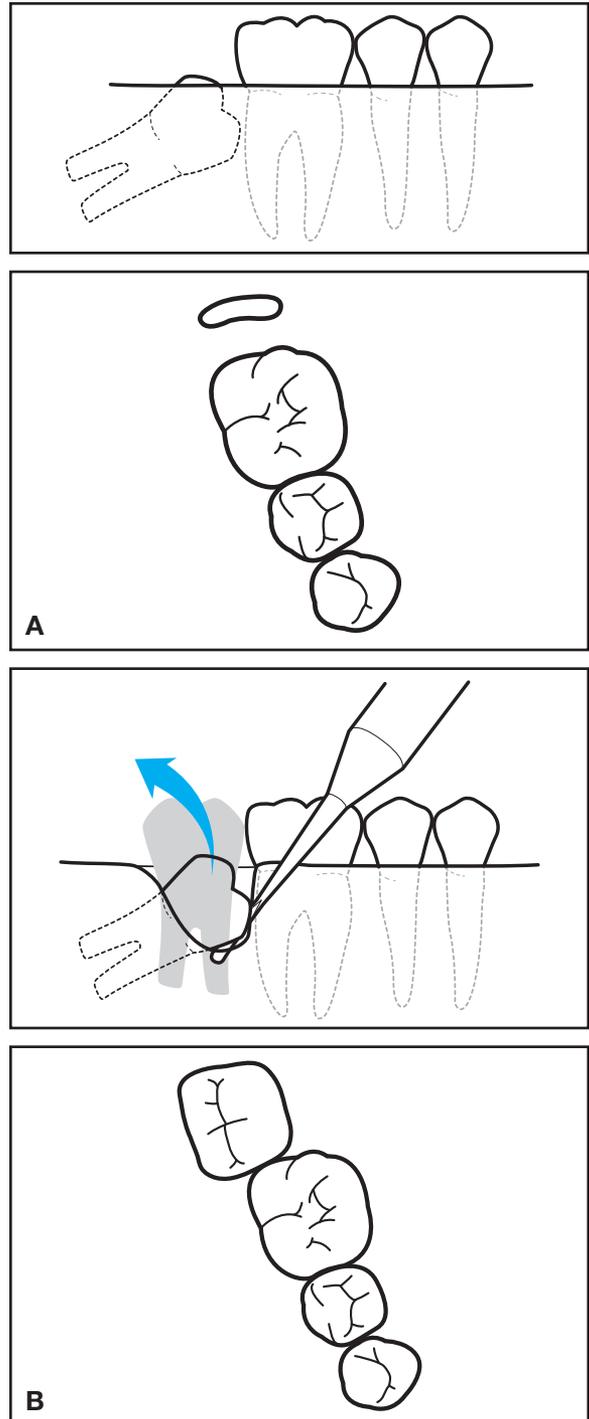
Fig. 5 A. Severely impacted lower second molar. B. Buccal displacement attributable to removal of additional buccal bone for access.

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