Management of Impacted Cuspids Using 3-D Volumetric Imaging

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Abstract

Management of impacted cuspids is a complex clinical problem involving proper assessment and interdisciplinary treatment planning. In this paper, we describe the use of 3-D volumetric imaging in the management of impacted cuspids and illustrate this application in case reports of maxillary and mandibular impacted cuspids.

Impacted cuspids are a relatively common occurrence and with the exception of third molars, the maxillary canine is the most frequently impacted tooth.[1,2] The mandibular canine is much less commonly a concern as it is 10 times less frequently impacted.[2-4] The prevalence of impacted maxillary canines ranges from 1 to 3 percent.[2,4-7] and is more often impacted palatally (85 percent) than labially (15 percent).[2-4] Impacted canines can lead to the resorption of neighboring permanent teeth, particularly the lateral incisors. Various degrees of resorption of the permanent incisors have been reported and it has been found to occur with approximately 12 percent of impacted maxillary canines.[8] Additionally, resorption can be difficult to diagnose with conventional methods, especially if the canine is located in a direct palatal or buccal position relative to the incisor roots.[9]

Clinical evaluation of impacted cuspids involves assessment of several factors that influence the overall treatment and prognosis (**Table 1**): confirmation of presence or absence of the cuspid, length and stage of root formation, size of eruption follicle, inclination of the long axis of the tooth, relative buccal-lingual position of the tooth, amount and quality of bone covering the tooth, proximity and resorption of roots of adjacent teeth, condition of adjacent teeth, local anatomic considerations (such as the mental nerve in the case of mandibular impacted cuspids and the type of mucosa covering the impacted tooth), and the overall stage of dental development.

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Assessment of these factors can be challenging with conventional radiographic methods, due to limitations of 2-D imaging. Superimposition of structures on the film can make it very difficult to distinguish details.[2] Distortion and projection effects are also encountered with conventional radiographs. Studies have shown that panoramic films alone fail to reliably differentiate the position of impacted maxillary cuspids from the palatal or buccal.[10] For these reasons, a combination of radiographic films is often used to supplement one another. One of these combinations uses the parallax method, wherein a second occlusal radiograph is taken with the x-ray tube shifted either horizontally or vertically relative to the first exposure.[11] A more effective combination uses a panoramic and an occlusal view wherein the occlusal view is taken with an additional 10 degree inclination.[11] The occlusal view is normally taken at 60 to 65 degrees to the occlusal plane, therefore this occlusal view is taken at 70 to 75 degree inclination.[11] Recently, computed tomographic scanning (CT) has been utilized as it is capable of providing more reliable information compared to conventional methods.[9,12] CT provides excellent tissue contrast, eliminating blurring and overlapping of adjacent teeth[2] and offers orthogonal views eliminating projection effects. Additionally superimposing structures can be selectively cropped from the image to allow for improved visualization. Despite its advantages, until now, the use of CT for location of impacted teeth and assessment of resorption has been restricted.[13] In recent years, 3-D volumetric imaging has been developed specifically for dentistry (see other papers in this issue for detailed descriptions). In addition to the advantages of CT, these technologies offer reduced cost relative to medical CT and significantly reduced radiation exposure. The absorbed dose from a dental volumetric imaging session is 50.3 µSv (Newtom 9000),[14] while that of a dental panoramic film ranges from 2.9-9.6 µSv[15] and a complete mouth series ranges from approximately 33 to 84 µSv[15] and 14 to 100 µSv,[16] depending upon variables such as film speed, technique, kVp, and collimation.

Surgical/Orthodontic Management

In order to begin applying orthodontic forces to impacted teeth, it is generally necessary to gain access by means of surgical intervention. Depending upon the degree of impaction, this may involve removal of soft tissue only or a combination of soft tissue and bone. A diagnosis and treatment plan is formulated based on data obtained by clinical and radiographic examination. It is not only necessary to provide access for hardware placement but is also important to consider the esthetic consequences of the surgical procedure, particularly when the impacted tooth is in a labial position.[17-20] In addition to establishing the appropriate access to reach the tooth, pre-surgical planning should include a periodontal diagnosis with attention to the width and thickness of keratinized gingiva. When the impacted tooth is exposed, approximately two thirds of the crown should be uncovered[21] taking care to avoid exposure of the cementoenamel junction.[19] In some cases, this may be accomplished by performing a simple gingivectomy. Where minimal keratinized tissue exists, an apically positioned flap may be indicated when a labial approach is utilized.

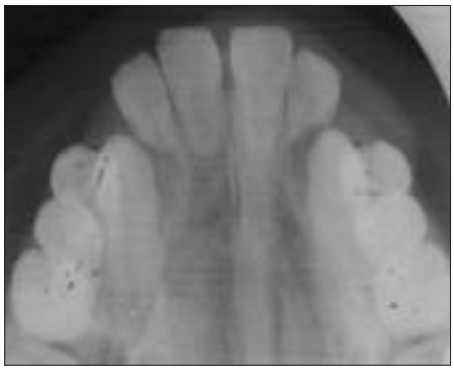
When the impaction is within the alveolus, an open or closed technique may be used, and consideration must be given to contiguous vital structures. In the closed technique, full-thickness flap reflection and ostectomy are performed to expose the crown, a button attached to a gold chain is bonded to the crown and the flap is replaced. As traction is applied to the chain, the tooth then erupts through the soft tissue. In the open technique, soft tissue and bone are removed and the crown remains ex-

Table 1

Ten Clinical Factors to Consider in the Assessment of Impacted Cuspids

1. Confirmation of presence or absence of cuspid
2. Length and stage of root formation
3. Size of eruption follicle
4. Inclination of the long axis of the tooth
5. Relative buccal-lingual position of the tooth
6. Amount and quality of bone covering the tooth
7. Proximity and resorption of roots of adjacent teeth
8. Condition of adjacent teeth
9. Local anatomic considerations
10. Overall stage of dental development

Figure 1.
Panoramic, periapical and maxillary occlusal radiographs.



posed, allowing a button or bracket to be bonded after healing. The open technique avoids potential difficulties in bonding during the surgical procedure, permits rebonding if necessary without surgical re-entry, and allows direct visualization of the tooth during initial movement.[22] The closed eruption technique may reduce post-operative discomfort and may have a more esthetic outcome than the more radical surgical exposure of the crown,[17] although the open or radical exposure technique has been reported to produce satisfactory outcomes.[23] Orthodontic treatment time may be reduced for the radical exposure technique, though differences between this method and the closed eruption technique are minimal and may not be clinically significant.[22,24] Regardless of the surgical modality, it is essential to utilize a minimally invasive procedure in order to reduce the risk of damage to adjacent vital structures. This goal can best be accomplished when the precise location of the impacted tooth is determined prior to performing the surgery. Post-operative attention to plaque control and close monitoring of periodontal conditions will optimize both functional and esthetic outcomes.[25]

The following cases illustrate the diagnosis, treatment planning, surgical intervention and orthodontic management of maxillary and mandibular impacted cuspids.

Cases

Case No.1: Bilateral Maxillary Cuspid Impactions

A 13-year-old Hispanic male presented for orthodontic treatment with a diagnosis of Class I malocclusion with bilateral unerupted maxillary cuspids. Clinical examination and panoramic, periapical and occlusal radiographs indicated that the impacted teeth were within the alveolus and resorption was evident on the apices of both lateral incisors. However, it was not possible to determine the proximity of the crowns to the buccal and palatal cortical bone (**Figure 1**). Volumetric imaging was then obtained, providing the additional data necessary to plan minimally invasive surgical intervention while avoiding contiguous vital structures (**Figure 2**). Buccal mucogingival flaps were reflected, ostectomy was performed over the crowns of the cuspids, dental follicles were enucleated and flaps were apically positioned with 4-0 gut suture to expose the crowns of the impacted teeth (**Figure 3**). Periodontal dressing was placed, the patient was asked to avoid contact with the sites, and acetominophen with codeine was prescribed for analgesia. Healing occurred uneventfully and in five days the dressing was removed. The sites were gently debrided and swabbed with 10 percent povidone iodine. Twelve days after the surgical exposure, orthodontic brackets were bonded to the maxillary dentition and force was initiated (**Figure 4a**). Additionally, the four maxillary incisors were bonded together on the lingual with composite resin (Transbond LR, 3M-Unitek, Monrovia, Calif.) to dis-

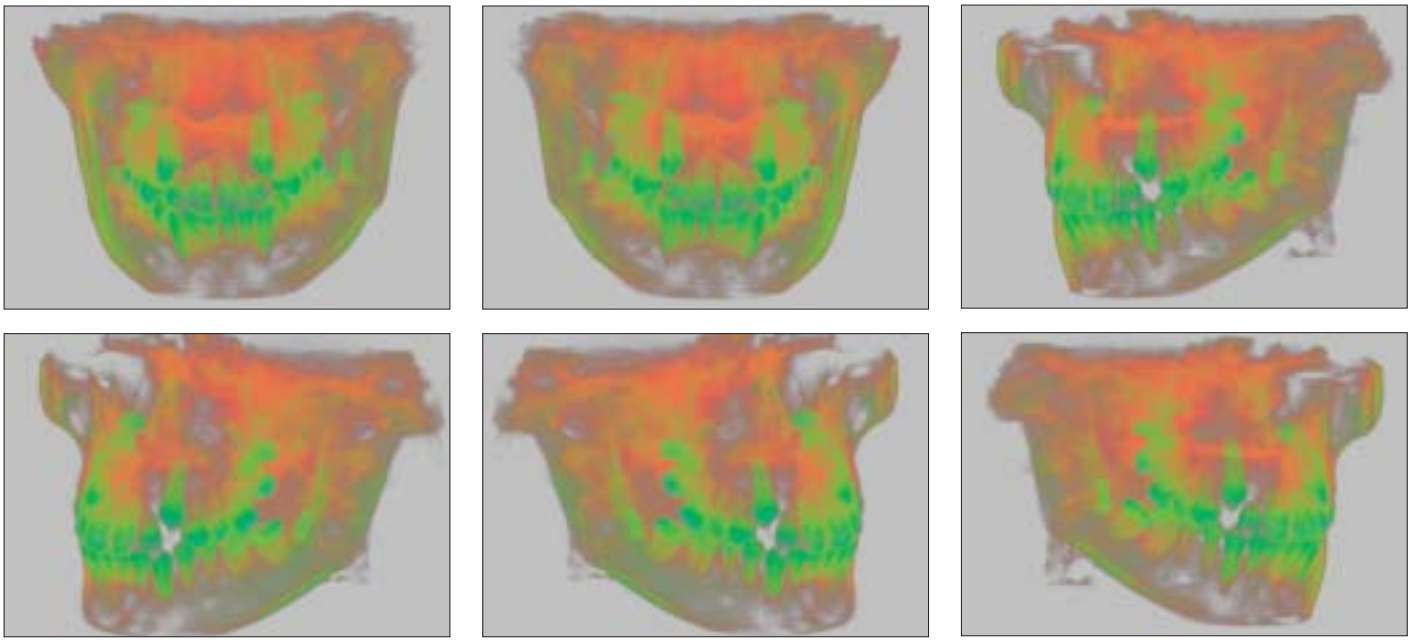


Figure 2. Volume rendered images of the impacted maxillary cuspids.

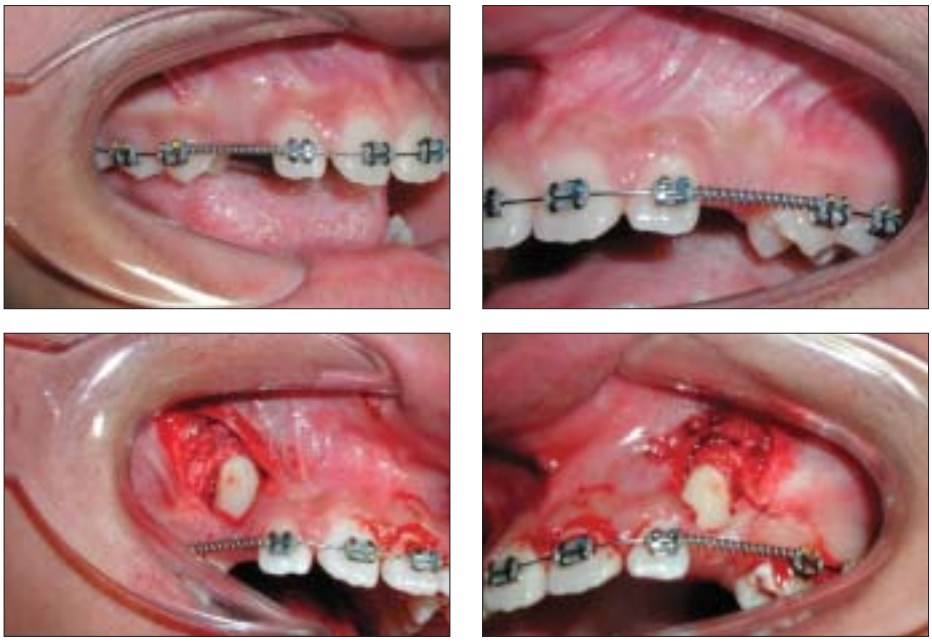


Figure 3. Surgical exposure of impacted cuspids.

tribute forces over the four incisors and prevent increased forces on the compromised lateral incisors. Subsequently, archwires were changed and orthodontic adjustments performed. The cuspids were successfully brought into alignment after four months of treatment (**Figure 4b**) and treatment is nearing completion at eight months (**Figure 4c**). Follow-up periapical radiographs of the lateral incisors showed no further root loss (**Figure 5**).

Case No. 2: Impacted Mandibular Cuspid.

An 11-year-old Hispanic male presented for orthodontic treatment with a diagnosis of Class II malocclusion with an unerupted mandibular right cuspid (**Figure 6**). Clinical examination also revealed significant mesial tipping

Figure 4. Orthodontic appliances and alignment of cuspids.

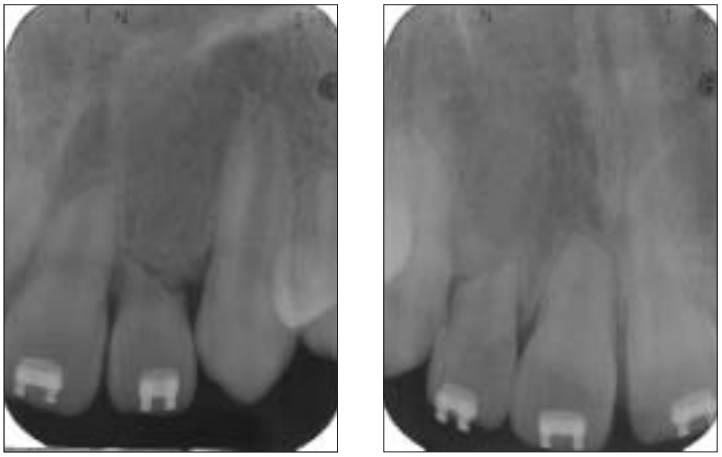


Figure 5. Follow-up periapical radiographs of cuspids.

of the mandibular right first and second premolars. Two-D radiographs indicated that the mandibular right cuspid was impacted in a distoangular orientation (**Figure 7**). Volumetric imaging was performed in order to more precisely determine the orientation of the impacted tooth and its proximity to adjacent tooth apices and the mental foramen (**Figure 8**). The patient and parent were advised of possible post-operative paresthesia due to proximity of the tooth and dental follicle to the mental foramen. Although within the alveolus, the crown of the cuspid was buccal to the apex of the first bicuspid. Therefore a buccal flap was reflected, ostectomy performed, the dental follicle drained and enucleated, and the crown of the cuspid was exposed. After bonding a gold button and chain, the soft tissue flap was replaced with 4-0 vicryl sutures, a mandibular removable orthodontic appliance was inserted, and the chain was tied to a spring on the appliance. Since the impacted cuspid crown was in close proximity to the apices of the premolars, it was decided to move the cuspid away from this area prior to placement of fixed appliances. Additionally, the mesial angulation of the premolars and the less-than-ideal condition of the first molar on the right side (stainless steel crown and endodontic treatment) left limited options for biomechanical therapy. The patient and parent were advised that the appliance must not be removed for the next five days. Ibuprophen 800 mg was prescribed for analgesia. After five days, the sutures were removed and healing was uneventful with minimal discomfort and no paresthesia. The appliance was adjusted at one- to two-week intervals over a period of five weeks until the cuspid crown was well away from the apices of the premolars. Fixed orthodontic appliances were placed in the mandible and archwires were placed (**Figure 9**). At this time, the mandibular right molar fractured vertically and was removed. Four months later, the cuspid is nearing alignment into the arch and the second molar is being brought into the position of the first molar (**Figure 10**).

Summary and Conclusions

Management of impacted cuspids is often extremely challenging for both the orthodontist and the surgeon. It is

Figure 6. Clinical photographs of unerupted cuspid and mesial tipping of premolars.

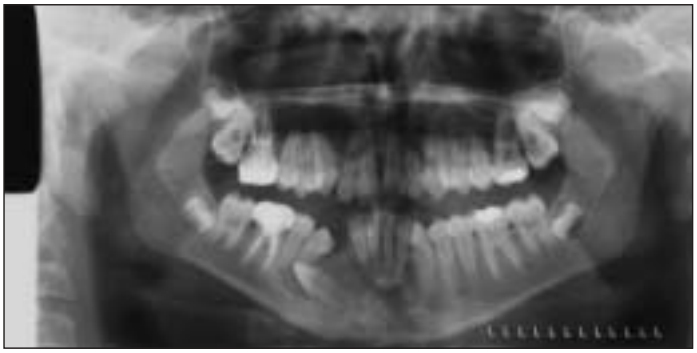


Figure 7. Panoramic image of impacted cuspid and tipped premolars.

not only necessary to formulate a treatment strategy that will allow movement of the teeth into ideal positions, but also essential to expose the teeth with minimal adverse effects on contiguous structures. In some cases clinical examination and palpation provide sufficient information to properly plan the surgical approach; in others, a combination of various 2-D radiographic images and clinical examination may be adequate.[26]

For many patients, however, the additional information obtained from 3-D imaging is invaluable in planning an effective surgical procedure that minimizes the risk of damage to contiguous vital structures. CDA

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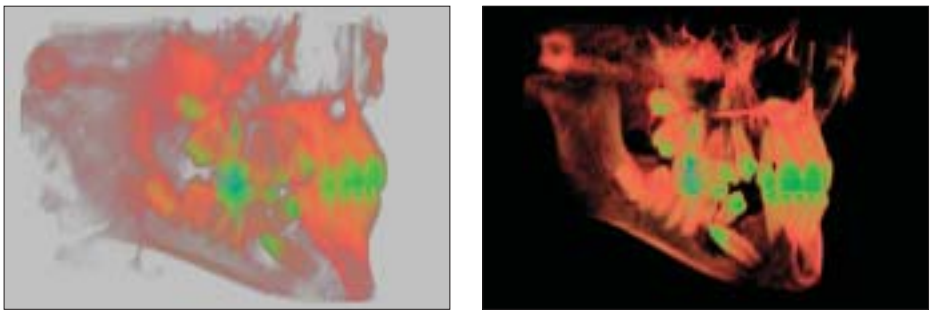

Figure 8. Volume rendered image of the impacted mandibular cuspids.

Figure 9. Orthodontic appliances.

Figure 10. Alignment of the cuspid.

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