Orthodontic uprighting of severely impacted mandibular second molars

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The prevalence of impacted second molars is low, varying from 0% to 2.3%. The etiology of an impaction can involve systemic, local, and periodontal factors, as well as a developmental disruption of the tooth germ. A number of surgical and orthodontic treatment options have been suggested in the literature, including leaving the tooth in situ, removing the impacted second molar, orthodontic uprighting, and autotransplantation. Removal of third molars has been suggested as an adjunct for space creation. This article presents the treatment of a girl with bilateral severely impacted mandibular second molars as well as an ectopic maxillary left canine and severe crowding affecting both the maxillary and mandibular arches. Her treatment was successfully completed with fixed preadjusted edgewise appliances (0.022 × 0.028-in slot size) and MBT prescription (APC pre-coated Gemini Brackets; 3M Unitek, St. Paul, Minn), along with the removal of 4 first premolars. The maxillary left canine and the mandibular second molars were surgically exposed. The treatment mechanics show that even severely impacted second molars can be uprighted by routine straight-wire techniques, which are easy to apply. The center of rotation of the second molar lies in the bifurcation of the roots of this tooth, and this biomechanical property was used to its full advantage. The techniques applied comprised bracket repositioning, bypass of brackets, conversion of molar tubes to brackets, thermoelastic copper-nickel-titanium archwires, and a push-coil spring. Other orthodontic treatment mechanics, which require complex sectional or segmental techniques, auxiliaries, or artistic wire bending, that have been suggested in the literature were not used here. The third molars were not removed. (Am J Orthod Dentofacial Orthop 2013;143:116-24)

Impaction of permanent teeth is a relatively common occurrence that can involve any tooth in the dental arch. The frequency of impaction is highest for mandibular and maxillary third molars, followed by maxillary canines and mandibular second molars.1 The eruption of the permanent molars differs from that of other permanent teeth, since there are no preceding deciduous teeth. For permanent molars, the tooth germ develops from the backward extension of the dental lamina.2 Unilateral impaction of the mandibular second molar is more common than bilateral impaction. It occurs more frequently in the mandible, among male patients, and on the right side of the jaw. Impacted second molars are most often mesially inclined.3 The 3 main causes of second molar disturbances are an ectopic position of the follicle, obstacles in the path of eruption, and failure of the eruption mechanism.4 It is important to diagnose this condition early so that treatment can begin at the optimal time. It is thought to be ideal to treat this condition during early adolescence, when second molar root formation is still incomplete and before complete development of the mandibular third molars. Treatment at this time has been found to improve the outcome.5

The indications for treatment of impacted second molars include prevention of pericoronitis, increased risk of caries and periodontal disease, risk of resorption of adjacent teeth by the follicle, and cystic development of the follicle.6 Treatment modalities for impacted mandibular second permanent molars include orthodontic (with or without removal of third molars) and surgical repositioning (autotransplantation). Removal of the second molars to allow eruption of the third molars and autotransplantation of the third molars after extraction of the second molars have also been described in the literature.

Surgical repositioning of mesially impacted teeth, however, can be associated with unwanted side effects, such as ankylosis, replacement resorption, and loss of
tooth vitality. In a recent study, autotransplantation of third molars was successful in 11% of the patients.\textsuperscript{5} Orthodontically assisted guided eruption is thought to be the treatment of choice for impacted second molars, with a success rate of 70%.\textsuperscript{5} This procedure might be difficult if the tooth is caudal to the occlusion or horizontally positioned.

Several orthodontic treatment modalities have been suggested to guide the eruption of impacted second molars, including diverse spring designs often encompassing sectional or segmental mechanics.\textsuperscript{7} Other treatment mechanics such as the use of temporary cortical anchorage devices (mini-implants) in the retromolar region have also been suggested.\textsuperscript{8} Surgical treatment is often required as an adjunct; this can involve exposure of the second molars or removal of the third molars. Alignment of the impacted molar can sometimes be obtained without surgical assistance because the orthodontic uprighting involves a distal tipping movement, which creates space for the impacted molar. However, interference with the third molar cannot be excluded.

**DIAGNOSIS AND ETIOLOGY**

A 9-year-old female patient was referred to the orthodontic department of Guy’s and St Thomas’ NHS Dental Hospital Trust, London, United Kingdom, because of delayed eruption of the maxillary left central incisor. She was diagnosed with a Class I incisor relationship in the early mixed dentition with crowding affecting both the maxillary and the mandibular arches. Both maxillary deciduous canines were removed to relieve the crowding in the labial segment (Fig 1). On review 6 months later, the maxillary left central incisor had erupted, and both maxillary permanent canines were palpable high in the buccal vestibule. The crowding in both arches was confirmed, but orthodontic intervention was thought unnecessary at this stage.

Further review appointments confirmed the above diagnosis and did not lead to further intervention. Reevaluation at age 11 confirmed severe crowding in both arches, and a radiograph showed the ectopic position of the maxillary left canine and the mesial impaction of both mandibular second molars, with the left one horizontally impacted (Fig 2). All 4 first premolars were subsequently extracted to create space to allow for spontaneous alignment of the anterior teeth and crowding affecting both the maxillary and the mandibular arches. Both maxillary deciduous canines were removed to relieve the crowding in the labial segment (Fig 1). On review 6 months later, the maxillary left central incisor had erupted, and both maxillary permanent canines were palpable high in the buccal vestibule. The crowding in both arches was confirmed, but orthodontic intervention was thought unnecessary at this stage.

Six months later, the patient complained of “gaps in the front” of her teeth (Figs 3 and 4). A detailed clinical examination confirmed a Class 1 incisor relationship (British Standards Institute classification) on a mild Class II skeletal base with average vertical facial proportions.

The position of the ectopic maxillary left canine had not improved, and the position of both mandibular second molars was also unchanged. There was spacing in the maxillary and mandibular arches with potential crowding in the maxillary arch; the maxillary right canine was short of space but in a favorable position for spontaneous eruption. The left canine was still ectopic. Overbite was increased, and the mandibular centerline was deviated to the left by 1 mm. The incisors appeared slightly retroclined on clinical examination. There was a buccal crossbite of the maxillary right first molar, and the first molar relationship was nearly Class II on the left and complete Class II on the right. The maxillary left canine was subsequently surgically exposed, and a gold chain was attached. The canine was buccal, and a surgically repositioned flap design was chosen for the best possible outcome of the gingival margin.

The cephalometric analysis (Table) confirmed the clinical findings of a mild Class II skeletal base relationship with an increased ANB angle (5°). The Wits appraisal, however, suggested a moderate Class II skeletal pattern (+3.5 mm). The maxillary-mandibular plane angle of 27° and the lower facial height proportions (55%)
were within normal limits; this confirmed the clinical findings. The maxillary incisors were retroclined (100°). The mandibular incisor inclination (87°) was at the lower limit of the normal range. Although the incisors were technically Class I according to the British Standard Institute’s classification, they showed some features of a Class II Division 2 incisor relationship. The panoramic radiograph (Fig 5) showed a complete permanent dentition, except for the 4 previously extracted first premolars.

Relevant radiographic findings included the ectopic position of the maxillary left canine with the attached gold chain and a maxillary right canine that lacked space. In addition, the mandibular left second molar was horizontally impacted against the first molar, whereas the mandibular right second molar was mesially impacted against the first molar.

TREATMENT OBJECTIVES

The objectives of the orthodontic treatment were to (1) align the impacted teeth (ectopic maxillary left canine and mandibular second molars), (2) level the arches, (3) correct the crossbite, (4) reduce the overbite while maintaining the overjet, (5) improve the maxillary incisor inclination, (6) close the residual extraction spaces, (7) correct the molar relationship, and (8) coordinate the arches.

The orthodontic treatment mechanics included exposure of the ectopic maxillary left canine and attachment of a gold chain. In addition, the mandibular second molars were exposed, and maxillary and mandibular preadjusted edgewise appliances (MBT prescription: APC precoated Gemini Brackets; 3M Unitek, St Paul, Minn) were placed with headgear for anchorage reinforcement.

TREATMENT ALTERNATIVES

Treatment modalities for impacted mandibular second permanent molars include orthodontic alignment and surgical repositioning. In view of the patient’s age and the early stage of third molar development,
autotransplantation of the third molar after extraction of the second molar was not thought to be a good alternative. Surgical repositioning of the mesially impacted molar could be complicated by ankylosis, resorption, and loss of tooth vitality. Orthodontically assisted guided eruption would most likely be associated with the best outcome and could be achieved with several different biomechanical possibilities. The decision was made to use relatively simple orthodontic treatment mechanics: bracket repositioning, thermoelastic (heat activated) copper-nickel-titanium archwires (35°C; Ormco, Orange, Calif), bypass of brackets, push-coil springs, and conversion of the molar tubes to brackets. Other mechanics, which require the use of sectional or segmental techniques, complex auxiliaries, and artistic wire bending, were not used.

**TREATMENT PROGRESS**

At the start of treatment, the impacted and ectopic maxillary left canine was exposed (surgically repositioned flap with gold chin attached). A fixed preadjusted edgewise appliance (MBT prescription with a 0.022 ×
(0.028-in slot size) was placed in the maxillary arch with convertible bands fitted on all first molars (3M Unitek). Posterior pull headgear with a force of 300 g per side was worn a minimum of 12 hours per day. The maxillary left lateral incisor was not bonded until 6 months after the start of treatment to prevent contact of its root with the impacted canine. The maxillary left lateral incisor was bonded after the maxillary left canine was moved into a more favorable position with the attached gold chain.

Nine months into treatment, the mandibular teeth were bonded, and a 0.016-in nickel-titanium archwire was placed. At the same time, an 0.018-in nickel-titanium wire was placed in the maxillary arch along with bonding of the now more favorably positioned maxillary left canine.

Even after surgical exposure of the mandibular second molars, there was only a limited tooth surface available for bonding on the left. However, the molar tubes were placed at about 90° to the respective occlusal plane of the second molars to aid uprighting. An active nickel-titanium push-coil spring was placed between the mandibular left first and second molars to encourage distal tipping of the impacted teeth. To place the push coil, the first molar tube was converted to a bracket. These mechanics were also helpful in simultaneously creating space by pushing the molars distally.

Bracket repositioning became necessary as the position of the mandibular second molars improved. Bracket placement in the appropriate position was not possible in the beginning because of the position of the second molar and its residual soft-tissue covering. The decision was made for the wire to bypass the mandibular left first molar bracket. This increased the flexibility of the archwire and decreased the force, preventing unwanted side effects such as root resorption and bracket failure. The bite was temporarily opened by adding composite material to the posterior maxillary teeth to allow the mandibular teeth to rotate without occlusal interference.

Two months before debonding, it was necessary to use cross-elastics from the lingual aspect of the mandibular left second molar to the buccal aspect of the maxillary left second molar to correct the scissors-bite tendency. At the end of active treatment, circumferential retainers were used to maintain the tooth positions.

**TREATMENT RESULTS**

Overall, the orthodontic treatment achieved the planned occlusal and facial esthetic goals (Figs 6-8, Table). All impacted teeth, including the horizontally impacted mandibular left second molar, were brought successfully into occlusion. The alignment of the mandibular second molars did not necessitate removal of the third molars, and there was a slight overcorrection of the previously impacted mandibular left second molar. Both arches were well aligned with good incisal and buccal segment relationships and a mutually protected functional occlusion.

The overjet has been maintained, and the increased overbite corrected. The MBT torque prescription for the maxillary labial segment led to an improved inclination of the maxillary anterior teeth. The chances of occlusal stability have been improved by establishing good incisal and buccal segment relationships.

The maxillary left canine, which had been surgically exposed and brought into occlusion with traction via the attached gold chain, showed a higher gingival margin than the contralateral canine.
The overall superimposition of the cephalometric radiographs (Fig 9) showed downward and some forward growth of the maxilla and the mandible during treatment. Local superimposition on Björk’s structures (Fig 10) suggests that the maxillary molars have remained in their position during treatment, and that the maxillary incisor inclination was corrected as planned. The mandibular superimposition shows mesial movement of the mandibular molars into the extraction space; this corrected the molar relationship. There was some mild proclination of the mandibular incisors that contributed to the improvement of the interincisal angle, which measured 134° at the end of treatment.

The mandibular incisal edges occlude anterior to the centroids of the maxillary incisors. Circumferential retainers with acrylic labial segments were fitted to allow final occlusal settling but at the same time trying to prevent relapse of the maxillary left canine. The patient was pleased with the improvement in her appearance and is aware of the need to comply with the retention regimen and maintain excellent oral hygiene.

DISCUSSION

Various methods of molar uprighting have been described in the literature. When the molar is severely displaced, such as the ones described here, a continuous wire that uprights the molar is often thought to cause undesirable movement of the anchorage teeth such as tipping, rotation, intrusion, or extrusion of the adjacent teeth. Segmented mechanics have been advocated to prevent such side effects (T-loop spring), and sectional uprighting springs have been designed for this specific purpose: eg, the Sander spring. The placement of these adjuncts can be demanding on the operator and the patient. Trauma can occur to the mucosa of the buccal sulcus, depending on the anatomy of the patient’s vestibular depth. In our patient, we used an active nickel-titanium push-coil spring without showing any unwanted biomechanical side effects on the
surrounding dentition. We made use of the center of rotation of the mandibular second molars, which is located at the bifurcation of the roots. Pushing the molars distally resulted in tipping, simultaneously creating space by moving the molars distally. To easily place the nickel-titanium push-coil spring between the first and second molars, the first molar attachments (tubes) had to be converted; ie, the buccal cover had to be removed.

Most practitioners use banded attachments on second molars, but more recently posterior molar teeth are also often bonded, although bond strength for the latter is thought to be less than that for bands. It can be difficult to band posterior teeth, particularly when they are only partially erupted or are impacted. Bands are also thought to be disadvantageous from a periodontal point of view, when compared with bonds. Fitting of bands on the second molars was not possible for our patient after uncovering, because of the horizontal position of the second molars and the limited amount of tooth surface available. This problem was overcome by progressive repositioning of the bracket as the mandibular second molar became more accessible. We also refrained from removing the third molars, and the second molars uprighted without interference.

Aside from the above techniques, we initially also bypassed the archwire from the mandibular left first molar; this allowed us to use a rectangular wire that was annealed at the end and bent down posteriorly (cinched back). The force (F) delivered by the wire is expressed by the formula: $F = \frac{1}{2} \pi dr^4/l^3$, where $d$ is deflection of the wire, $r$ is radius of the wire, and $l$ is length. Therefore, bypassing a bracket results in increasing the effective length of the archwire, and the applied force levels subsequently decrease by the power of three. Conversely, the force levels increase as the diameter of the wire increases. As a result of bypassing the first molar bracket we were able to use a rectangular thermally activated archwire (0.016 × 0.022-in copper-nickel-titanium, 35°C; Ormco). The use of a long rectangular archwire instead of a short round wire served several purposes. It saved on the number of archwires used and the chair time. The first wire that was engaged into the second molar bracket was rectangular, and it bypassed the first molar. On the next appointment, this same archwire was then engaged into the first molar bracket, thereby saving the removal of an archwire, if a smaller wire had been used.

Bypassing the first molar bracket led to the reduction of the force levels and hence reduced the risk of inadvertent debonding of the second molar bracket, simultaneously allowing for some torque control during uprighting of the second molars. The use of a thermoplastic 0.016 × 0.022-in wire also eliminated the risk of permanent deformation during insertion of the archwire. A small round wire could have been used as an alternative here, but it would have been difficult to place because it had to be fully ligated into all brackets to be effective. Complete ligation would most likely lead to
permanent deformation of the wire, rendering it ineffective. An archwire of a smaller diameter would also have needed replacement at later appointments. Furthermore, the use of an annealed and cinched 0.016 × 0.022-in rectangular archwire prevented displacement of the wire during mastication.

This case report demonstrates that second molar uprighting can be undertaken by using routine straight-wire mechanics without creating unwanted biomechanical side effects. Segmented and sectional mechanics were not used, nor were auxiliary springs. No wire-bending skills were required for this technique, and orthodontic assistants could carry out all of these detailed procedures, thus contributing to an efficient team approach for patient management.

CONCLUSIONS

The management of impacted second molars is an orthodontic challenge. Although many orthodontic treatment mechanics encompassing different levels of
complexity have been described in the literature, routine straight-wire mechanics as presented here are a useful alternative.

REFERENCES