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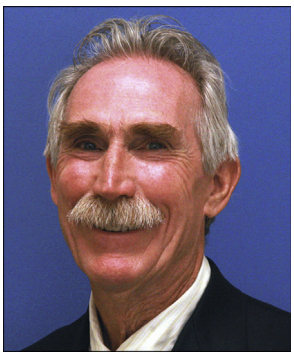
Journal of the World Federation of Orthodontists 9 (2020) S45–S53

Special Clinical Article

The management of mesially inclined/impacted mandibular permanent second molars



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ARTICLE INFO

Article history:
Received 7 September 2020
Accepted 7 September 2020
Available online 1 October 2020

Keywords:
Mandibular permanent second molar
Mesial impaction
Orthodontic uprighting

ABSTRACT

Mesially impacted mandibular second molars are a common occurrence in orthodontic practices, especially those using the lingual arch or lip bumper for alleviating anterior crowding. Horizontally impacted second molars, on the other hand, occur so infrequently that most practitioners have limited experience in treating such a patient. Because of this there is little consensus on the management of these cases. As opposed to vertically impacted molars that may be associated with ankylosis or other factors preventing eruption, the mesially angulated, horizontally impacted mandibular second molar usually has eruption potential, because its impaction is more commonly due to lack of space and/or abnormal eruption path. Hence, orthodontic uprighting shows the most promise and can commonly be done without extracting the third molar or surgically exposing the impacted second molar. Modern clinicians have at their disposal a myriad of biomechanical choices that can be used to successfully reposition these teeth and enable finishing with an optimal occlusion.

1. Introduction

The management of mesially inclined/impacted mandibular permanent second molars is an area of significant importance to orthodontists. However, there is little consensus on how to treat these uncommon anomalies. A survey of 12 esteemed clinicians elicited seven different treatment plans for a case with horizontally impacted second molars in a 12-year 9-month-old female patient (Fig. 1) [1]. In this regard Valmaseda-Castellon et al. [2] stated "the low prevalence of impaction of second permanent molars, and the difficulty of distinguishing between primary and secondary retention and impaction have been major factors underlying the lack of uniformity in the management of these eruption disturbances." This paper examines how low prevalence and proper diagnosis using clear terminology can impact our treatment decision on impacted mandibular permanent second molars.

2. Definitions/terminology

Suri et al. [3] discussed the many terms used to describe disorders of tooth eruption and pointed out the considerable confusion over their usage. To be consistent with several studies performed on prevalence and treatment outcomes the terms impaction, primary retention, and secondary retention will be used in this paper [2,4–7]. *Impaction* is defined as the failure of tooth eruption due to a physical obstacle in the eruption path, or an abnormal eruption path of the tooth [3,4,7,8]. Most impacted second molars occur in

Funding: The authors have not declared a specific grant for this research from any funding agency in the public, commercial or not-for-profit sectors.
Competing interest: The author have completed and submitted the ICMJE Form for Disclosure of potential conflicts of interest. None declared.
Provenance and peer review: Commissioned; Internally peer reviewed.
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2212-4438/$ – see front matter © 2020 World Federation of Orthodontists.
https://doi.org/10.1016/j.ejwf.2020.09.004

Fig. 1. Panoramic radiograph of a 12-year 9-month-old girl showing horizontally impacted second permanent molars.

the mandible [2,5]. Shpack et al. [9], who examined 165 impacted mandibular second molars, reported most (88%) were mesially angulated, with 8% vertical, and 4% angulated distally. Mesially angulated impactions have been reported to respond better to treatment than the other types [10,11]. *Primary retention* is the cessation of eruption *before* emergence, without a physical barrier in the eruption path and not due to abnormal position [3,8,12]. Primary retention is more common with upper second molars than lowers [5]. *Secondary retention* is the cessation of eruption *after* emergence without a physical barrier in the eruption path and not due to abnormal position. Ankylosis is probably the main etiologic factor although several phenomena have been found associated with secondary retention [8,13]. Secondarily retained permanent second molars seem to be the most difficult to treat [2,6].

Ectopic eruption, a term used universally to describe the entrapment of a mesially inclined first permanent molar behind the second primary molar during its initial eruption [14], but is not commonly used to describe a similar condition of the second permanent molar. *Inclusion* is infrequently used to describe a tooth that remains inside the bone [2]. *Retention* or *inclusion* have been used to indicate the molar before or after apical root closure, when the tooth was still able to erupt or not [7].

3. Etiologic factors

Becker [15] states “teeth normally erupt. In the absence, it must be assumed there is some pathologic cause. The key to success in resolving…tooth impaction, is to find the cause and if possible, eliminate it.” Andreasen et al. [12] pointed out three main causes for second molar disturbances: ectopic position, obstacles in the eruption path or failures in the eruption mechanism. The abnormal eruption of mandibular second molars appears to be related to genetics [4,16–18]. Craniofacial morphology including Class II malocclusion, reduced mandibular gonial angle, vertical condylar growth, and decreased distance from first molar to mandibular ramus were found to be associated with abnormal second molar eruption [19–21]. An abnormal eruption mechanism was considered by Palma et al. [4].

Insufficient space in the dental arches has been shown related to the impaction of lower second molars [4,10,18]. Evans [22] found that cases with impacted mandibular second molars have significantly more lower crowding compared with controls. Appliances such as the lingual arch or lip bumper which hold or further worsen the posterior arch length deficiency are also associated with mandibular second molar impaction [23–26]. The distal overhang

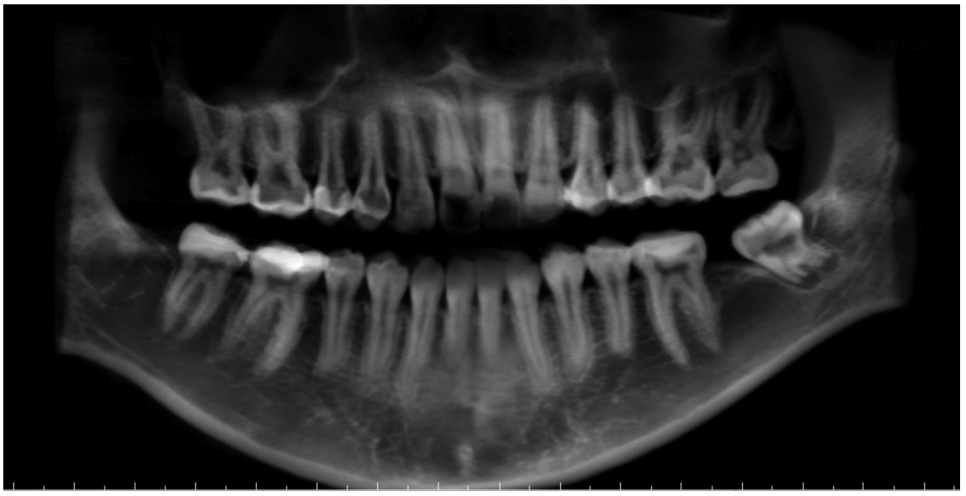

Fig. 2. Radiograph of a 22-year 3-month-old woman referred by her periodontist to correct the position of the mandibular left third molar. The permanent second molar had been extracted years earlier.

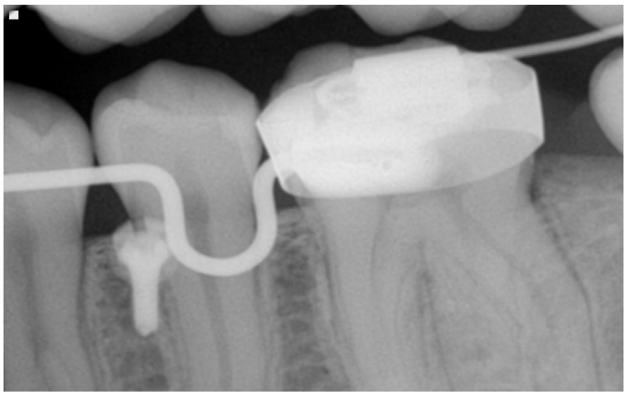

Fig. 3. A lingual arch supported by a sectional archwire bonded to a miniscrew placed between the roots of the first and second premolar was used for anchorage.

of bands cemented to first permanent molars may further prevent the proper eruption of the second molar.

Becker [13] cites a number of unusual anomalies associated with the failure of permanent molars to erupt: dentigerous cyst (increased intracystic pressure), ankylosis (usually subjective), invasive cervical root resorption, hooked or dilacerated root (cause or effect?) [4], primary failure of eruption (affects all teeth posterior to most anteriorly affected tooth) [27–29], pre-eruptive intracoronal resorption, and root encirclement of the inferior alveolar nerve. In regards to a molar not erupting due to ankylosis, Becker [13] states "ankylosis of an impacted tooth is often very casually determined on the empirical basis that the tooth has not responded to extrusive orthodontic forces…it is an entirely outcome-oriented, fall back designation. Unless you extract, the tooth ankylosis cannot be confirmed scientifically." Becker [30,31] reported on a large sample of failed cases of impacted teeth finding invasive cervical root resorption, pre-eruptive intra coronal resorption, inappropriate direction of traction and poorly designed auxiliaries, can all be associated with failure to resolve impaction.

In summary, vertically oriented infraoccluded molars are commonly due to primary or secondary retention, and these teeth may have limited eruption potential due to ankylosis or other factors. Mesially inclined impacted molars are impacted due to an abnormal eruption path and usually have eruption potential.

4. Incidence/prevalence

Impacted second molars have been reported to occur infrequently in the general population (0.03–1.7%) [18,32,33], but are more common (1.8%–3%) in the orthodontic population [9,17,18]. Some of the variation in prevalence may be due to the categorization of molars being either ectopic or impacted [5,33]. This is probably the reason the incidence of impaction (0.2%) was so low in the Bondemark and Tsiopa [5] study. Combining teeth described as ectopic (1.5%) and impacted (0.2%) would give an incidence of impaction at 1.7%. Mandibular second molar impaction is more common than maxillary second molars, or either maxillary or mandibular first molars [2,4,5,7]. Horizontally impacted second molars are rare. Monaca et al. [7] found only 7 of 161 impacted molars were horizontal. Fu et al. [33] observed only 5 of 125 impacted molars to be angulated at greater than 90%. Therefore, horizontally impacted molars may occur once in many thousands of patients meaning most practitioners might practice a lifetime without experiencing such a case. Hence the difficulty in formulating a treatment plan when such a case presents itself.

5. Clinical management

Several factors need to be considered in planning treatment.

5.1. Age, eruption status, and root development

The first is the age of the patient. Younger patients experienced better outcomes than adults, with treatment around the age of 14 reported to be optimal [7,34–37]. But although treatment in adolescence may be preferred, there are several case reports where horizontally impacted second molars were successfully uprighted in young adults [38–41]. Next is the eruption status of the impacted molar and the exposure, if any, of the clinical crown. If sufficient clinical crown is visible to bond to (4×4 m) surgical exposure may not be necessary. The angulation or inclination of the impacted molar does not seem to be as important a factor as it might appear [4,7]. Other than experiencing longer treatment times [33], horizontally impacted molars seem to respond as well as moderately inclined molars. The stage of root development of the second or third molar is a consideration if one is to consider either surgical uprighting of the impacted molar, or autotransplanting either the second or third molars [34,35,42,43]. Root anomalies such as dilaceration, root resorption or ankylosis may prevent an impacted tooth from being repositioned. Similarly the presence and position of third molars may influence treatment options such as autotransplantation or orthodontic uprighting.

5.2. Anchorage considerations

The source of anchorage is a major consideration in planning orthodontic treatment and the myriad of designs reported in our literature speaks to the boundless imagination of clinicians. Various types of springs, loops, and uprighting arches can be used successfully with only minor changes to the anchorage teeth [2,9,17,33,37,38,40,44–56]. For absolute anchorage, miniscrews can be used in the retromolar area, or more anteriorly between the roots of the molar and/or premolars for either direct or indirect

Fig. 4. (A–C) Another sectional archwire was used to align the third molar and protract it with an elastic chain.

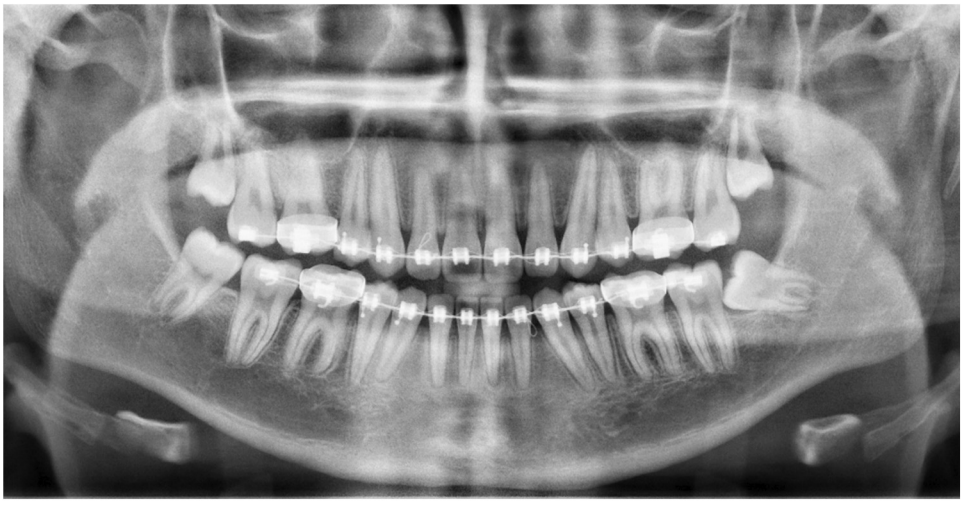

Fig. 5. Panoramic radiograph of a 16-year 7-month-old boy showing an impacted mandibular left third molar.

anchorage [9,11,39,41,57–61]. Miniplates have similarly been reported to provide an excellent source of anchorage [15,62]. The preferred biomechanical approach is often predicated on the experience of the clinician and the limited access in the area of the impacted tooth, especially in a younger individual. The degree of crowding or follicular collision may be a factor, as well as the financial status of the family and whether or not they choose to pursue orthodontics as a treatment option.

6. Treatment options

With some variations, there were four different treatment plans suggested for the management of horizontally impacted mandibular second molars in a 12-year 9-month-old patient [1]. Let's examine the indications, contraindications, benefits, shortcomings, and reported success rates of these different treatment plans.

6.1. Extract the third molars and surgically upright the impacted second molars

Surgical uprighting involves tipping the molar on its root apex through a gentle luxation movement. Pogrel [35] describes the surgical technique carried out under local anesthesia supplemented by intravenous sedation as needed. A buccal flap is created to the distobuccal line angle of the first molar and down into the buccal sulcus. Lower third molars are removed at this time. The distal soft tissues are reflected lingually and a lingual retractor placed over the distal bone in the second molar region to protect the lingual nerve. Bone is then removed with a bur distal to the second molar leaving the crown of the tooth exposed down to its greatest concavity. A straight elevator is then placed mesially and the tooth surgically tipped and elevated into the correct position.

Indications for surgical uprighting include an adolescent with open apices of the molar roots (one-half to two-thirds root

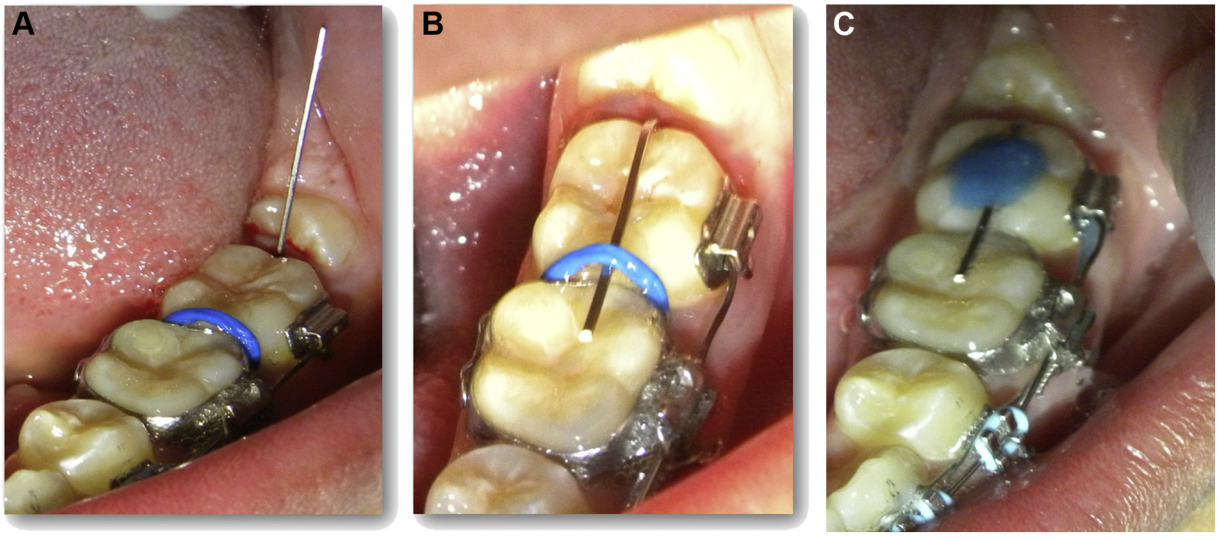

Fig. 6. (A) A rectangular NiTi arch wire is inserted down the distal surface of the anchor molar far enough to engage the mesial marginal ridge of the impacted tooth. (B) The wire is then bent forward 90° across the occlusal surface of the anchor tooth. A separator holds the wire in place for bonding. (C) The wire is then bonded to the occlusal surface of the molar.

Fig. 7. After 11 weeks of activation, the occlusal surface of the molar is now visible.

development preferable), no clinical crown of the impacted molar visible intraorally, a minor unfavorable axial inclination of the impacted molar, and no other orthodontic treatment needs [35,42]. Kravitz et al. [42] recommend an angle of inclination of less than 75° to the long axis of the first molar. The benefits of this approach are it simplifies or eliminates the need for orthodontic treatment and is highly successful with an experienced surgeon. Monaca et al. [7] reported a positive outcome in all 38 treated molars in which only a minor unfavorable axial inclination existed. The shortcomings are possible pulp necrosis, ankylosis, root fracture or resorption [34–36,63]. Pogrel [35] reported success in 21 of 22 cases, with eight cases developing asymptomatic pulpal calcification. None of the 21 cases developed either internal or external root resorption or developed periapical disease. One tooth was lost due to infection. Kravitz et al. [42] cited the displacement of the second molar into buccal crossbite as the most common undesirable side effect. Teeth horizontally impacted experience greater movement of the root apex and hence may have increased risk of complications. Teeth that undergo surgical uprighting/luxation prior to complete root formation show continuing eruption and root formation [35,36,64]. Divergent roots are reported to be a contraindication [7].

6.2. *Extract the second molars, allow mesial drift of third molars*

In reviewing the results of 43 cases treated conservatively, Valmaseda- Castellon et al. [2] found only approximately 50% of teeth reached an acceptable position. They concluded “if second molar eruption is questionable, it could be wiser to perform early extraction of the second molars and allow the third molars to replace them.” Horizontally impacted second molars appear so severe that they are often considered irretrievable. Hence extraction of these teeth is often recommended, with autonomous drift of the third molar observed and later orthodontic treatment a possibility to protract and align the third molar.

The indication for this treatment option is the family declining other treatment options such as orthodontic or surgical uprighting or autotransplantation. The presence of advanced caries or ankylosis of the second molar would be another indication for extraction. Although several authors suggest autonomous movement of the third molar seems to be best when the tooth bud of the third molar is in the “full crown” stage (no root) of development [65–67]. Richardson and Richardson [68] found the timing of second molar extraction has little effect on the final third molar position. The major benefit of this approach is that orthodontic treatment may be avoided. The major shortcoming is that orthodontic treatment may be required later to protract and align the third molar (Figs. 2–4). Overeruption of the opposing second molar also is a potential problem.

In the study by Monaca et al. [7] “second molar extraction was carried out when the tooth was not retrievable owing to severe abnormalities of their location and/or inclination.” No further explanation was given as to whether horizontal impaction may have fallen into this category. The eruption of third molars after the extraction of second molars has been the subject of numerous studies [67–75], Orton-Gibbs et al. [66] examined this phenomenon in 63 patients and found all third molars erupted; none became impacted [66]. They presented a summary table of studies reporting excellent or satisfactory position of mandibular third molars in 75% to 96% of cases. The exception was the study by Gooris et al. [76] who reported only 46% had a satisfactory contact with the first molar. Other studies however report a difference in the response between upper and lower third molars. De-la-Rosa et al. [65] found 96% of maxillary, but only 66% of mandibular third molars erupt in good position.

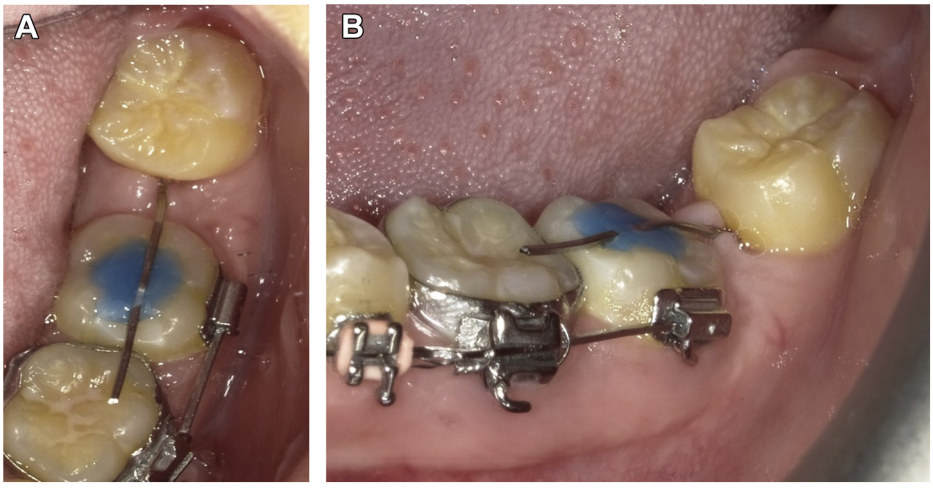

Fig. 8. (A, B) After 37 weeks of activation (during COVID-19 closure) the molar is now uprighted and can be bracketed for leveling and space closure.

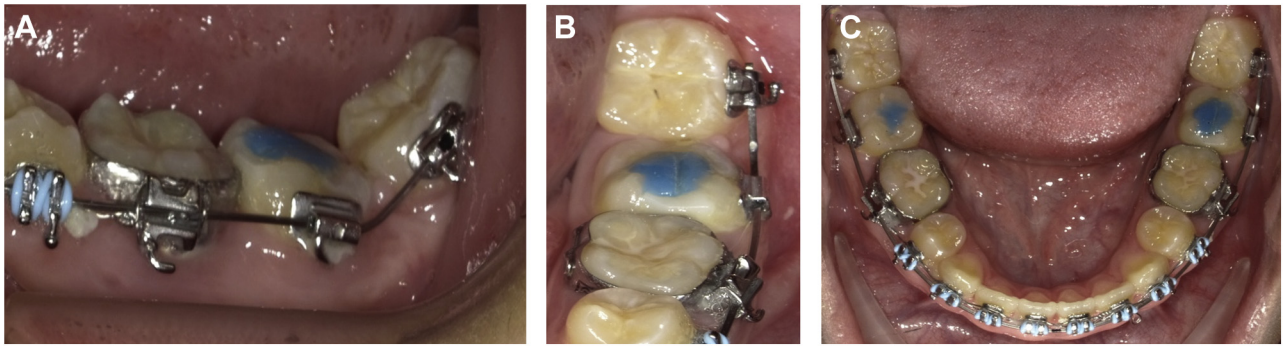

Fig. 9. (A–C) The molar is bracketed for leveling with a continuous archwire.

But these studies examined the extraction of second permanent molars for the relief of crowding, cases in which the axial inclination of the second molar was within normal limits. When impacted second molars are extracted, the response of the third molars does not seem to be as favorable. Monaca et al. [7] found "the extraction of first or second irretrievable molars performed to enable the mesial shifting of the subsequent molar was associated with a lower prevalence of a positive outcome (17/22 molars, 77%). Magnusson and Kjellberg [6] observed the extraction of the second molar replaced by the third molar to be the most common treatment, but the least successful (11%) of the treatment options. They further concluded "the few third molars that did erupt were all malpositioned" and "extraction of the second molar with no further intervention should be avoided."

6.3. Extract the impacted second molars and autotransplant the third molars

A third treatment option is to extract the impacted second molar and autotransplant either a maxillary or mandibular third molar into the second molar position. Indications for this choice of treatment are the family declines orthodontic treatment, advanced caries or ankylosis of the impacted second molar, and the root apices of the third molar are still open. The main benefit to this treatment approach is that no orthodontic treatment is necessary. The shortcoming is the success rate of this procedure. What do we know about the success of autotransplantation? Aside from being done by an experienced surgeon and performed at the correct stage of root development (ideally two-thirds to three-fourths root formation) success depends on what type of tooth is being harvested and into what position it is being repositioned to. Kvint et al. [43] studied 215 consecutive patients treated by one surgeon over a period of 15 years. The overall success of autotransplantation was 81% (175 of 215) with premolars showing the most success at 89% (68 of 76). Interestingly premolars transplanted to the maxillary incisor region showed 100% success (24 of 24). But the teeth we are concerned with in this article showed poorer results. The autotransplantation of maxillary or mandibular third molars to replace mandibular second molars had the worst prognosis (68%, 23 of 34) of all the teeth transplanted. If the family declines orthodontic treatment, it might be more prudent to extract the impacted second molar and allow the third molar to develop rather than attempt autotransplantation. In the case where the second molar needs to be extracted because of caries or ankylosis, with no third molar in that quadrant, autotransplanting a third molar from another quadrant might be desirable.

6.4. Extract the third molars, surgically expose the second molars and orthodontically upright

The most common and predictable approach reported to treating the impacted second molar is to orthodontically upright the tooth with possible extraction of the third molar and surgical exposure of the second molar. The reported success of surgical

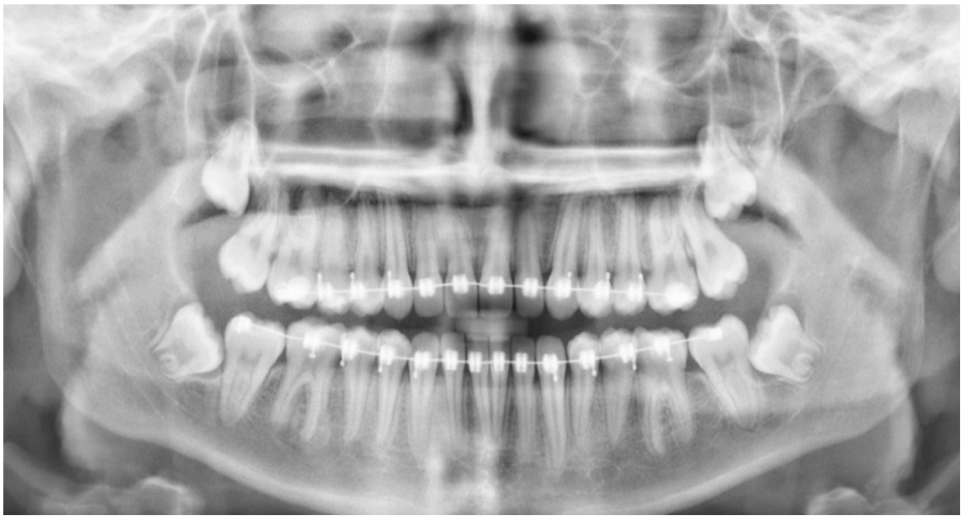

Fig. 10. Panorex taken after 17 months of treatment.

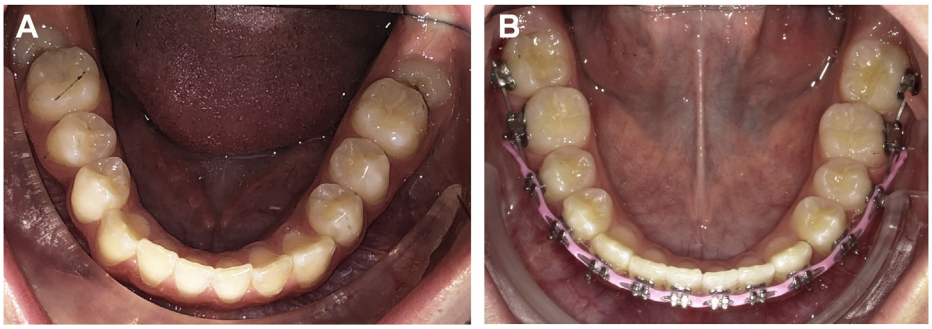

Fig. 11. (A) Pretreatment lower arch showing distal surface of impacted second molars. (B) After 17 months of treatment.

exposure and orthodontic uprighting varies from 68% to 75% [2,6,7]. Monaca et al. [7] found negative factors being total bone coverage, or impaction of the root apex with the inferior canal roof. Others have reported higher success rates with mesially inclined impacted second molars (Johnson E, 2020, personal communication) [33]. Monaca et al. [7] stated "orthodontic uprighting was applied to partially erupted molars impacted against the distal surface of the adjacent tooth, given the presence of sufficient space for the anchor device placement and dental distal movement to reposition the molar." But how is "sufficient space" determined? How much space is needed for anchor device placement? And how is sufficient space for molar distal movement determined?

To begin the uprighting and distalizing process one not even need to initially bond an attachment to the second molar [33,77]. Bach [77] described a method of using a straight section of a 0.014 × 0.025 copper NiTi wire placed vertically down the distal surface of the first molar to just clear the mesial marginal ridge of the impacted molar. The NiTi wire is then bent 90° anteriorly across the occlusal surface of the first molar and is stabilized with light cured composite (Figs. 5–9). Significant uprighting can occur with this approach following which attachments can be bonded to the tooth for further uprighting using one of many orthodontic methods.

How is sufficient space for dental distal movement determined? One way is to measure the distance from the distal of the first molar to the mesial of the third molar in relation to the mesiodistal width of the second molar. But this assumes the third molar is in the distalization path and that the third molar will not be distalized as the second molar distalizes. Neither of these may be the case.

6.5. *Does the impacted second molar need to be surgically exposed?*

As previously described, initial uprighting can be accomplished with little clinical crown exposed by using a vertically placed rectangular NiTi sectional wire. Or if there is at least a 4x4mm portion of the crown exposed, an orthodontic attachment can be bonded to the tooth for activation with various designed orthodontic systems. Surgical exposure is often not needed. Johnson (2020, personal communication) comments "orthodontists are incredibly buccal attachment oriented. Bonding to the buccal requires much more tissue removal. Minimal exposure and occlusal bonding are much easier on everybody."

6.6. *Does the third molar need to be extracted?*

Surgical exposure of the impacted second molar is most often performed in conjunction with extraction of the third molars. Valmaseda-Castellon et al. [2] stated "in cases of surgical exposure…lower third molar extraction in the same operation is recommended when there is posterior crowding in the dental arch, because the lower third molar could prevent lower second molar eruption." [3,5,36].

However, numerous articles suggest uprighting of the second molar is not hindered by the presence of the third molar [7,34,37,45,46,48,51,58,60,61,78,79]. The confusion over this is illustrated by Mah et al. [60] who state "in patient 3, the third molar extraction was not helpful in uprighting the second molar and not needed; in patient 1, the value of extraction was doubtful." But later in the article they state, "to avoid uncertainty, we routinely order third molar extraction when second molar uprighting is needed." Melsen et al. [46] suggest maintaining the third molars may even be beneficial by preventing distal displacement of the second molar crown and preventing space from opening anterior to the second molar. Treating without extracting the third molars and surgically exposing the second molars saves the family considerable expense as well as the morbidity associated with these surgical procedures (Figs. 1, 10, 11).

And what happens if following the extraction of the third molar, the second molar cannot be repositioned and needs extraction? The third molar could have been a replacement tooth. In this regard Monaca et al. [7] states "a more cautious approach is to postpone extracting the third molar until the repositioned second molar appears to be sufficiently stable." This approach is most indicated in an adolescent patient in whom the third molar is still developing distal to the impacted second molar. In an adult patient where the third molar may have erupted mesially and may be lying on top of the second molar, the extraction of the third molar or orthodontically uprighting it to provide access to the second molar, would be necessary [9,38,39,41,56].

7. Summary

Mesially impacted mandibular second molars are a common occurrence in orthodontic practices, especially those using the lingual arch or lip bumper for alleviating anterior crowding. Horizontally impacted second molars, on the other hand, occur so infrequently that most practitioners have limited experience in treating such a patient. Because of this there is little consensus on the management of these cases. Extraction of these teeth with or without auto transplantation of third molars is often suggested, but commonly presents poor results. Surgical uprighting is more successful in moderately tipped teeth and is mostly indicated in patients who decline orthodontic treatment.

As opposed to vertically impacted molars, which may be associated with ankylosis or other factors preventing eruption, the mesially angulated, horizontally impacted mandibular second molar usually has eruption potential, because its impaction is more commonly due to lack of space and/or abnormal eruption path. Hence orthodontic uprighting shows the most promise and

can commonly be done without extracting the third molar or surgically exposing the impacted second molar. Second molars can be uprighted initially with minimal clinical crown exposure, with the third molars providing little resistance to proper uprighting. The modern clinician has at their disposal a myriad of biomechanical choices that can be used to successfully reposition these teeth and enable finishing with an optimal occlusion.

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