CASE REPORT

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Non-invasive Approach to Uprighting Impacted Mandibular Second Molars: A Case Report

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ABSTRACT

Uprighting impacted mandibular second molars (MM2) remains a clinical challenge due to anatomical constraints and biomechanical complexity. This case report presents a simplified biomechanical approach using straight wire mechanics and auxiliaries to upright impacted MM2. While traditionally managed with complex surgical and orthodontic interventions, this method demonstrates a less invasive alternative within the scope of specialist orthodontic practice. The aim is to demonstrate the effectiveness of straight wire mechanics in uprighting mesioangularly impacted MM2 without additional adjunctive procedures. A 16-year-old female patient presented with Class II division 2 incisor relationship, convex and hyperdivergent skeletal profile, gummy smile, bilateral mesioangular MM2 impaction, increased overjet, severe crowding, and traumatic bite. Treatment involved fixed appliances on an extraction basis, followed by uprighting the impacted MM2 using straight wire mechanics. The treatment process was documented through clinical photographs and radiographs. After 11 to 36 weeks of uprighting treatment, the impacted MM2 were successfully uprighted using only straight wire mechanics, without requiring mini implants, surgery, or cantilevers. The outcome included stabilised functional occlusion with Class I incisor, canine, and molar relationships, maintaining normal overjet and overbite. The patient did not complain of discomfort during the uprighting period. The straight wire mechanics can effectively upright mesioangularly impacted MM2 in complex cases without additional adjunctive procedures. While these mechanics offer a simplified alternative, the complexity of diagnosis and execution warrants management by an orthodontist. Further research, including larger case series, is recommended to validate the widespread applicability of this technique in various clinical scenarios.

Keywords: *Class II malocclusion; Impacted molar; Minimally invasive; Molar uprighting; Straight wire mechanics*

INTRODUCTION

Impaction of mandibular second molars (MM2) presents a significant challenge in dental practice, affecting approximately 0.65% to 1.36% of the population (Fu *et al.*, 2012; Cassetta *et al.*, 2013). This condition, while relatively rare, can lead to substantial complications if left untreated, including periodontal problems, dental caries, and occlusal disturbances. The aetiology of MM2 impaction is multifactorial, encompassing issues such as insufficient arch length, abnormal eruption paths, excessive tooth size, or inadequate mandibular growth (Cassetta *et al.*, 2014). These factors can result in various types of impactions, with mesioangular impaction being the most common (Sawicka *et al.*, 2007).

Traditionally, the management of impacted MM2 has fallen within the realm of orthodontic specialists, often requiring complex treatment modalities. These may include intricate wire-bending techniques (Shapira *et al.*, 1998), temporary anchorage devices (TADs) (Hsiao, 2002; Giancotti *et al.*, 2004), surgical interventions (Padwa *et al.*, 2017), or even molar extractions in severe cases (Magnusson & Kjellberg, 2009). Such approaches, while effective, present several drawbacks. They often necessitate advanced training and specialised equipment, invasive, costly, and time-consuming, potentially deterring patients from seeking treatment.

The complexity of treating impacted MM2 is further compounded in cases of Class II malocclusion. These patients frequently present with additional challenges, such as severe crowding, high mandibular plane angles, and increased overjet (Sonis & Ackerman, 2011). The interplay of these factors demands a comprehensive treatment approach that addresses not only the impacted molar but also the overall occlusal relationship and facial aesthetics.

In recent years, there has been a growing trend towards minimally invasive dentistry across all specialties. This paradigm shift emphasises the conservation of tooth structure, patient comfort, and simplified treatment protocols. However, the application of minimally invasive principles to the management of impacted MM2 has been limited, particularly in the context of general dental practice.

This case report presents the application of a non-invasive technique for uprighting impacted MM2 using straight wire mechanics. The approach described herein utilises readily available materials and leverages biomechanical principles to provide an effective and conservative solution within the orthodontic setting. This technique offers a valuable alternative to more invasive methods, potentially reducing treatment complexity and increasing patient acceptance of the treatment.

The case presented involves a 16-year-old female patient with a Class II division 2 incisor relationship, complicated by bilateral mesioangular MM2 impaction. The treatment protocol demonstrates how straight-wire mechanics can be employed to address not only the impacted molars but also the associated malocclusion, without resorting to additional adjunctive procedures, such as TADs or surgical intervention. This case report aimed to demonstrate the feasibility of managing complex orthodontic cases, specifically impacted MM2, within an orthodontic setting using a non-invasive technique readily adoptable by orthodontists. The following sections detail the case presentation, treatment methodology, and outcomes, providing a comprehensive overview of this non-invasive approach to uprighting impacted MM2.

CASE REPORT

A 16-year-old female, accompanied by her mother, attended our orthodontic clinic complaining of crowded upper teeth and a deep bite that obscured her lower teeth, causing an unpleasant smile. She had no known medical illness or allergies and had never had any orthodontic intervention done previously.

On examination (Fig. 1), the patient exhibited a symmetrical facial profile with a moderate Class II skeletal pattern and an average lower anterior vertical dimension. There was evidence of vertical maxillary excess on smiling, resulting in a gummy smile. The patient had competent lips with good muscle tone, an average lip length, an obtuse nasolabial angle, and a pronounced labiomental fold. Temporomandibular joint palpation revealed no significant findings. The patient reported no history of any habits, past or present.

Fig. 1 Pre-treatment extraoral and intraoral photographs.

Intraorally, all permanent teeth had erupted except for the third molars. The patient demonstrated good oral hygiene, with only slight calculus accumulation on the upper right first molar. The periodontium appeared healthy, with no caries present. The mandibular arch exhibited severe crowding of 12 mm, with the lower lateral incisors displaced lingually and the MM2s impacted in a mesioangular direction. Similarly, the maxillary arch showed severe crowding of 10.5 mm, with the upper canines erupted buccally. In occlusion, the patient presented with a Class II Division 2 incisor relationship, characterised by retroclined upper incisors and an increased overjet of 5 mm. Additionally, there was a 100% increased complete and traumatic overbite, with no visibility of the lower incisors. The upper and lower dental midlines were coincident. On the right side, the canine and molar relationships measured a quarter unit and a half unit Class II, respectively. In contrast, the left side displayed a quarter-unit Class II for the canine and a Class I for the molar.

Radiographic findings from a dental panoramic radiograph (Fig. 2) confirmed the presence of all permanent teeth, including the third molars, in the final stage of crown formation. The degree of impaction was determined by the intersection between the occlusal surface of the MM2 and the occlusal surface of the mandibular first molar (MM1), about 44.6° on the right side and 65° on the left. Both root structures and alveolar bone height appeared normal, with no pathological abnormalities detected.

The pre-treatment cephalometric analysis (Fig. 2; Table 1) disclosed a Class II skeletal pattern (ANB 5.3°) with a retrognathic mandible (SNB 73.8°) and a hyperdivergent skeletal pattern (MMPA 35.4°). The lower anterior face height ratios were within the average ratio. The mandibular incisors were of average inclination (L1-MnP 88.2°), while the maxillary incisors were retroclined (U1-MxP 96.9°), and the inter-incisal angle was increased (IIA 139.6°). The upper and lower lips were normal according to the Malay soft tissue cephalometric norm, with the upper lip posterior to the E plane (ULE -0.80 mm, LLE 1.08 mm). The obtuse nasolabial angle (NLA 109.9°) supported the finding of retroclined upper incisors. The cephalometric norms for Malays were adapted from Mohammad *et al.* (2011) and Norman *et al.* (2020).

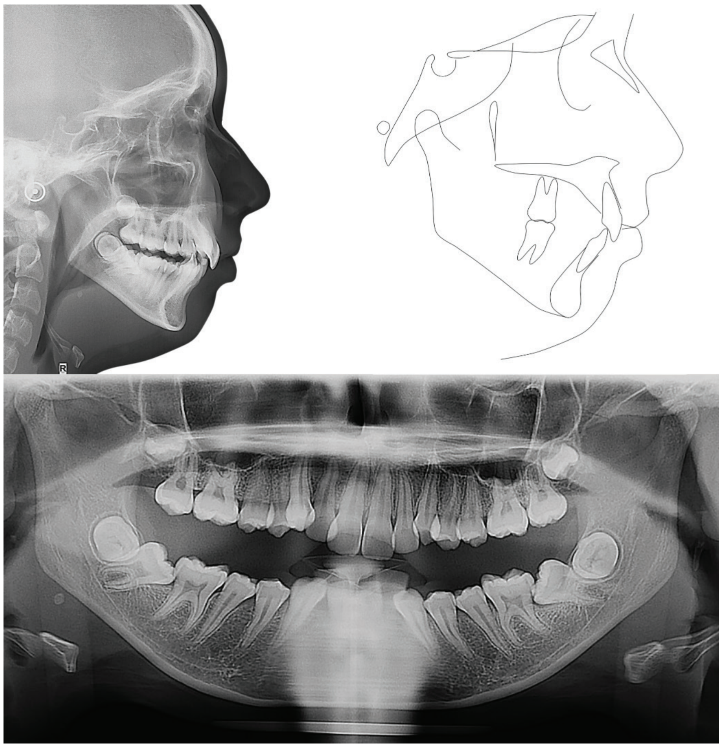

Fig. 2 Pre-treatment lateral cephalogram and dental panoramic radiograph of the patient.

Table 1 Cephalometric values based on Wits analysis and Eastman hard and soft tissue analyses for the Malay population

Cephalometric variables	Pre-treatment	Post-treatment	Norms for Malays
SKELETAL			
SNA (°)	79.1	78.8	81.1 ± 3.7
SNB (°)	73.8	74.1	79.2 ± 3.8
ANB (°)	5.3	4.8	2.5 ± 1.8
MMPA (°)	35.4	32.8	24.8 ± 6.7
LAFH (%)	55.4	53.2	55.7 ± 2.3
DENTAL			
U1-MxP (°)	96.9	117.8	108.0 ± 5.0
L1-MnP (°)	88.2	103.9	92.0 ± 5.0
Wits (mm)	1.4	2.9	−3.6 ± 2.41
IIA (°)	139.6	104.1	133.0 ± 10.0
L1-APog (mm)	3.3	5.0	−0.3 ± 2.7
SOFT TISSUE			
NLA (°)	109.9	95.5	90.3 ± 10.6
ULE (mm)	−0.8	−1.1	0.4 ± 1.05
LLE (mm)	1.1	2.5	1.4 ± 1.44

From these findings, it appears that the Class II skeletal pattern with a retrognathic mandible and a hyperdivergent skeletal structure contributes to the impaction of the MM2. The retrognathic mandible may result in a more crowded dental arch, increasing the risk of impaction (Abdelaziz *et al.*, 2024). Class II malocclusions, particularly Division 2, are frequently linked to reduced inter-canine arch dimensions and a deep bite, which inhibit the anterior development of the mandibular dentoalveolar segment (Dhakal, 2011). This lack of space can lead to mesioangular impaction of the MM2s, as the teeth struggle to find an appropriate eruption path due to the spatial constraints imposed by surrounding teeth and the skeletal relationship (Cassetta *et al.*, 2013).

TREATMENT

Treatment Objectives

The primary treatment objectives included alleviating upper and lower dental crowding through strategic space creation, followed by tooth alignment and levelling of the curve of Spee. Additionally, the treatment aimed to upright the bilaterally impacted MM2, correct the overjet and overbite, and maintain the dental midline. The intended outcome was to achieve Class I incisor, canine, and molar relationships, resulting in optimal functional occlusion with maximum intercuspation. Orthodontic retention based on standard protocols (Gill *et al.*, 2007) would be implemented to ensure the stability of the corrected teeth.

Treatment Alternatives

The patient and her mother were presented with two treatment alternatives during the treatment planning session. The risks and benefits of each treatment plan were thoroughly discussed with them. The first option was an ideal treatment plan combining orthodontic and orthognathic surgery. This plan included the extraction of the upper and lower first premolars, using fixed appliances and bilateral TADs to upright the impacted lower second molars, and a bilateral sagittal split osteotomy, followed by orthodontic retention. Although the ANB angle measures only 5.3°, mandibular advancement is necessary because, in Class II Division 2 cases, the upper and lower incisors are often either upright or retroclined, obscuring the actual skeletal discrepancy. Orthodontic decompensation in these types of cases typically involves proclining the retroclined upper incisors to normal inclination. This may result in a forward shift of the A-point on cephalometric analysis, leading to an increase in the ANB angle and a clearer expression of the underlying skeletal discrepancy. Consequently, despite her gummy smile, a Le Fort I osteotomy was not a viable option to correct the gummy smile in Class II Division 2, as the excessive gingival display may not be attributed to true vertical maxillary excess, but rather from severe overbite and excessive curve of Spee.

The alternative plan involved accepting the moderate Class II skeletal pattern and managing the malocclusion through orthodontic camouflage. This approach would involve the extraction of four permanent first premolars, followed by fixed appliances, TADs, and the eventual fitting of a fixed orthodontic retainer in the lower arch and removable retainers for both arches. A lower fixed retainer was planned as part of the retention regime, as a degree of lower incisor proclination was anticipated to improve her overjet at the end of treatment, and to address the instability of rotational corrections and the tendency for relapse in the mandibular anterior segment, especially following significant displacement.

Despite these discussions, the patient expressed reluctance to pursue orthognathic surgery and was also unwilling to utilise TADs. After extensive deliberation, a mutual consensus was reached to proceed with orthodontic camouflage treatment without TADs. This plan involves aligning her teeth using standard straight wire mechanics to upright the bilaterally impacted lower second molars. The patient was informed that this approach could potentially damage the adjacent third molars, which would necessitate their removal.

Treatment Progress

Once consent was obtained, treatment began with the upper arch. The treatment in the lower arch was deferred until the end of the upper arch alignment stage to allow sufficient room for the placement of lower anterior brackets. The patient was referred for the extraction of the upper permanent first premolars. Subsequently, the upper arch was bonded using brackets with a 0.022” × 0.028” slot size, following the McLaughlin, Bennett & Trevisi prescription (Victory Series™ 3M Unitek, Minneapolis, US). Due to a deep overbite, only the upper arch was initially bonded (Fig. 3). As the treatment progressed, the alignment of buccally erupted canines and the palatally displaced permanent lateral incisors on both the right and left sides of the upper arch was successfully achieved.

After the upper arch alignment, the permanent mandibular first premolars were extracted to alleviate crowding in the lower arch. The lower arch was bonded except for the lingually displaced lower lateral incisors after 21 weeks of the upper arch alignment. Once the lower arch alignment began, space was created to accommodate the alignment of the lower lateral incisors using nickel-titanium (NiTi) open push coils on a 0.018” stainless steel (SS) archwire. The archwire was pre-expanded to achieve a ballooning effect, facilitating the space-opening process. The alignment of both the upper and lower arches progressed accordingly (Fig. 4).

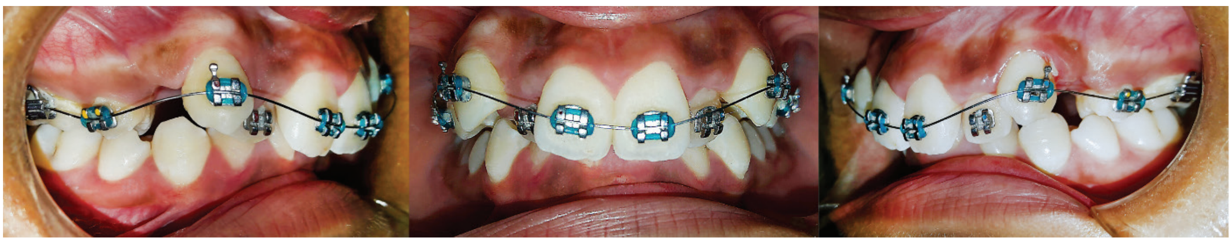

Fig. 3 The upper arch was bonded first to allow improvement in the upper incisor inclination, hence, allowing the placement of lower incisor brackets during the lower arch bonding later.

Fig. 4 The progress after 1 year and 33 weeks of treatment.

As treatment progressed and reached the crucial levelling stage, attention shifted to the impacted MM2. Once the arches had been sufficiently aligned, these impacted molars were only bonded and engaged with a 0.016” × 0.022” NiTi archwire. Bilaterally, two activated NiTi open push coils were strategically placed between the lower first and second molars. The other lower teeth were secured with elastomeric ligatures (Fig. 5a). To promote the progressive uprighting of the impacted lower second molars, the NiTi push coils were periodically replaced every four weeks, and the lower archwire was upgraded to a 0.018” × 0.025” NiTi wire (Fig. 5b). The right impacted MM2 was uprighted after 11 weeks and the left impacted MM2 were uprighted after 36 weeks of treatment (Fig. 5c).

The orthodontic treatment was continued with the placement of upper and lower 0.019” × 0.025” stainless steel archwires, followed by bilateral Class II intermaxillary elastics of 1/4” dimension and 3.5 oz of force (Ormco™, California, USA) for 25 weeks (Fig. 6). The case was completed after 33 visits throughout a course of 3 years and 8 months.

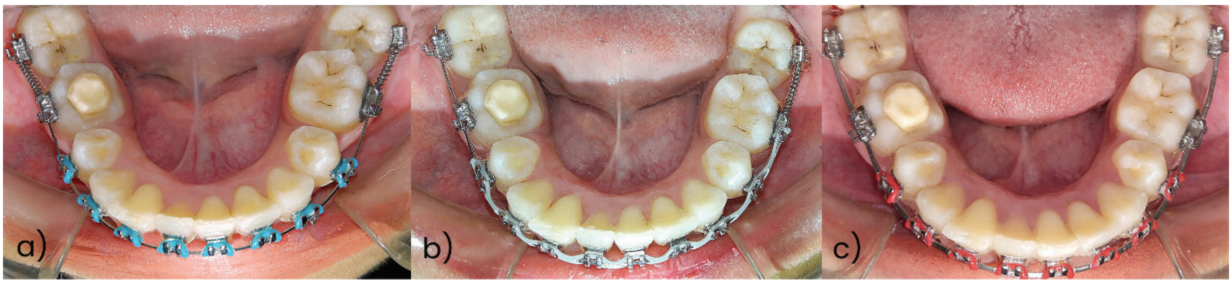

Fig. 5 (a) 94 weeks into treatment. The impacted MM2s were bonded. Lower 0.016” × 0.022” NiTi was engaged with NiTi open push coils placed between the impacted MM2 and MM1 bilaterally. (b) The right MM2 was disimpacted after 11 weeks of the uprighting process with the straight wire mechanics. (c) The left MM2 was successfully disimpacted after 36 weeks of uprighting.

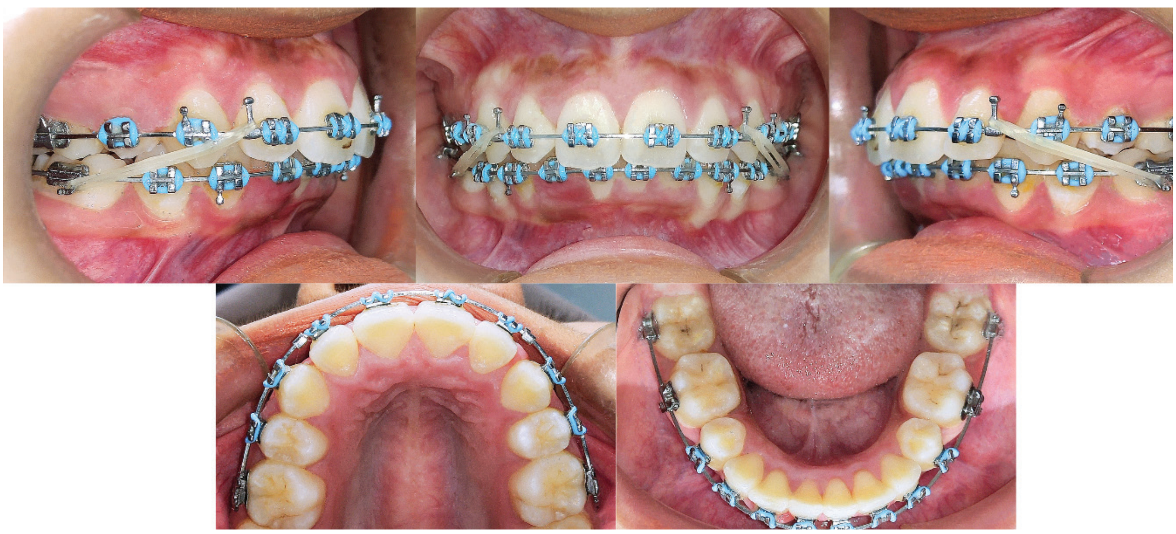

Fig. 6 Bilateral Class II intermaxillary elastics were used to close remaining space and improve overbite.

Long-term retention was advised to the patient, yet she was hesitant about having a fixed retainer in the lower arch. Therefore, retention proceeded with only the upper and lower vacuum-formed retainers. Due to the risk of relapse in the lower arch, she was advised to wear her retainers full-time for the first six months, followed by night-time wear for an additional six months, and to continue wearing them every other night. There was no consensus about when to discontinue the retainers.

Treatment Results

A favourable treatment outcome was achieved with a mutually protected occlusion evident through stable contacts in centric relation and during protrusive, retrusive, and bilateral lateral movements (Fig. 7, Fig. 8, Table 1). The facial aesthetics demonstrated well-balanced harmony. The maxillary position (SNA) remained stable, whereas the mandible advanced slightly (SNB), reducing the ANB (4.8°) and Wits values (2.9°) and improving the sagittal jaw relationship. The hyperdivergence of the face was improved to a borderline normal (MMPA 32.8°), with an improvement in the nasolabial angle (NLA 95.5°). Vertical control was achieved, as reflected by a reduction in the lower anterior facial height (LAFH 55.4%) and normalisation of the maxillary-mandibular plane angle (32.8°).

Fig. 7 Post-treatment photographs. The gummy smile has disappeared following the correction of upper incisor retroclination.

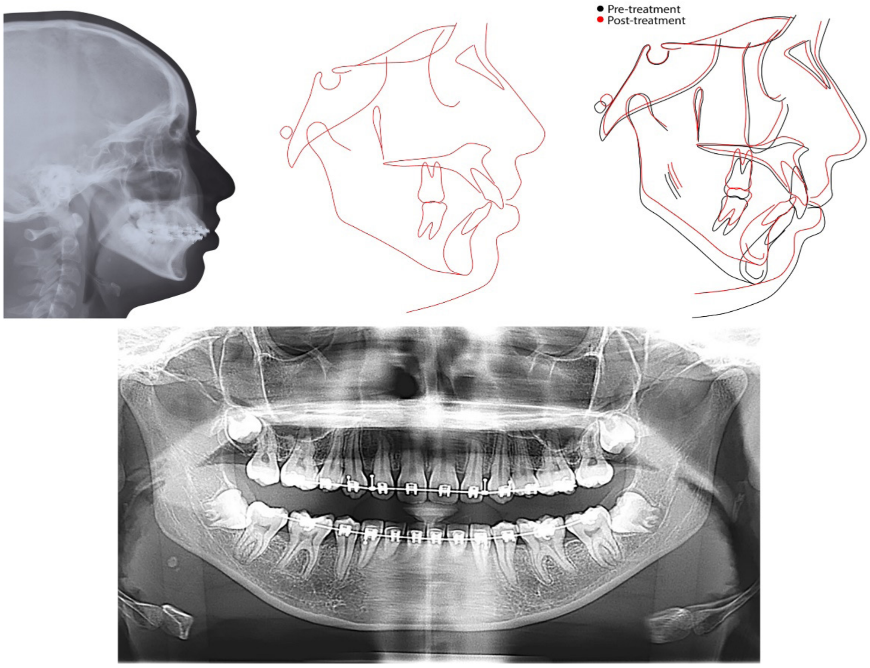

Fig. 8 Near-end of treatment radiographs. The orthopantomogram showed bilateral MM2s are now in an upright position. The cephalometric superimposition demonstrated that changes in the incisor inclination have allowed the mandible to close in a more anterior position, contributing to the observed change.

The upper incisors were proclined relative to the maxillary plane (U1–MxP 117.8°) and the lower incisors were also proclined to the mandibular plane (L1–MnP 103.9°), resulting in a reduced interincisal angle (IIA 104.1°). The lower incisor position relative to the apical base indicated lower incisor proclination within the alveolar bone (L1–APog 5 mm). A bilateral Class I molar relationship was established with stable occlusal contacts, and both overjet and overbite were corrected, with coincident upper and lower dental midlines aligned with the facial midline and chin point. Soft-tissue analysis demonstrated improved lip balance, with the upper and lower lips (ULE and LLE) lying closer to the E-line, signifying enhanced facial harmony and lip competence following treatment.

DISCUSSION

In this case, the bilaterally impacted MM2s were uprighted using a combination of NiTi open push coils and rectangular NiTi archwires, which is a complex interplay of force application, control of tooth movement, and the prevention of undesirable side effects such as root resorption and damage to adjacent teeth. The use of NiTi archwires is particularly advantageous due to their superelastic properties, which allow for the application of continuous, light forces that are essential for orthodontic tooth movement without causing root resorption (Feller *et al.*, 2016) or excessive stress to the periodontal ligament (PDL) and surrounding structures.

For the MM2 to be disimpacted and uprighted, space creation is needed before orthodontic tooth movement can occur. The space was created by the expansion of compressed NiTi open coil springs, which opened up the space by exerting a gentle, continuous pushing force on the impacted MM2s. This action distalised the impacted MM2s, allowing them to move into a more favourable position. While the open coil exerts a force that maintains space, the rectangular NiTi archwire simultaneously tips and torques the impacted MM2s. This helps control the axial rotation, ensuring the proper three-dimensional positioning of the impacted MM2s. The combination of space creation and controlled uprighting must occur concurrently through a dual-force uprighting mechanism, in which the crowns of the impacted MM2s were tipped distally and the roots were guided into a more vertical position. As a reciprocal force was also exerted on the adjacent MM1, anchorage was reinforced by consolidating the rest of the teeth with a long wire ligature. The rectangular NiTi archwire helps control any unwanted mesial tipping and rotation of the MM1 through its shape memory property.

Therefore, careful control of force levels is paramount, and the use of NiTi coils enables a more predictable and gentle approach to molar uprighting. Moreover, the NiTi coil spring and NiTi archwire combination also minimises the risk of undesirable movements, such as molar tipping and rotation, similar to TADs (Magkavali-Trikka *et al.*, 2018) and cantilever springs (Mehrotra *et al.*, 2014), but without invasive procedures and intricate wire bending. In addition to the mechanical aspects, the biological response to orthodontic forces must also be taken into account. Applying orthodontic forces induces a biological response in the PDL, which can lead to the remodelling of the bone and soft tissues surrounding the teeth.

The time taken to upright the impacted MM2 in this case was 11 weeks on the right and 36 weeks on the left, which can be translated into 4°/week and 1.8°/week, respectively. Studies of TAD-assisted uprighting generally report uprighting times of an average of around 10 months for impacted MM2 (Sbricoli *et al.*, 2022). This difference is influenced by factors including the type and degree of impaction, the presence of adjacent teeth, and the choice of orthodontic techniques employed. A systematic review and meta-analysis found mixed evidence on whether skeletal anchorage consistently shortens total treatment time compared with conventional mechanics, as some authors reported no clear reduction in overall treatment duration attributable to TADs; case selection and the severity of impaction strongly influence the timetable (Barone *et al.*, 2023).

Although surgical uprighting has been reported to have a higher success rate for mesioangularly impacted MM2 compared to vertical or distal impactions (Jacob *et al.*, 2014), no surgical correction was performed in this case. Instead, the impacted MM2 was successfully uprighted using conventional straight wire orthodontic mechanics. This highlights that, in selected cases, non-surgical approaches may serve as a viable alternative to surgical intervention.

Additionally, while the timely extraction of impacted MM2 has been advocated in certain cases to promote the spontaneous eruption of the mandibular second molars (MM3) (Barone *et al.*, 2023), the present case illustrates that this treatment approach provides a conservative management strategy where MM3 was preserved through the orthodontic uprighting of impacted MM2, thus minimising the risks associated with the surgical removal of impacted MM3. This is likely caused by the distal force from the active coils, which improved the angulation of the impacted MM3. This aligns with Sbricoli *et al.* (2022), who demonstrated the improvement in the angulation of impacted MM3 when impacted MM2 was uprighted using skeletal anchorage.

The angulation of the impacted tooth affects not only the mechanics of uprighting but also the potential for successful eruption. For instance, mesially angulated molars are often associated with limited space, which can complicate the uprighting process (Turley, 2020). Moreover, the accessibility of the impacted tooth is crucial; greater accessibility typically correlates with shorter treatment times (Takehana *et al.*, 2021). This method is effective only when adequate space is available to bond an attachment to the impacted tooth surface. In cases of complete impaction, surgical exposure is required before applying this technique (Lau *et al.*, 2013). Moreover, when the MM2 is horizontally impacted in proximity to the MM1, placement of the push coil between the two molars may become difficult. In such situations, alternative strategies, including the utilisation of miniscrews and surgical exposure with a gold chain, may be necessary. This may be implemented with or without the adjunctive use of NiTi archwires and push coils.

The proximity of the third molars can significantly affect the uprighting of MM2 through additional pressure on the MM2, thus influencing its position and the mechanics required for uprighting (Skitioui *et al.*, 2023). The choice of orthodontic techniques also plays a pivotal role in the uprighting process. Techniques such as miniscrew implants for anchorage have been shown to facilitate effective uprighting by providing stable anchorage and allowing controlled force application (Magkavali-Trikka *et al.*, 2018; Morita *et al.*, 2020). The use of elastomeric chains or springs to apply force to the impacted molar can also influence the rate of uprighting, with some studies suggesting that certain methods yield better outcomes in terms of tooth movement and alignment (Allgayer *et al.*, 2013; Venkatesh *et al.*, 2023).

The proclination of the lower incisors primarily resulted from the bilateral Class II intermaxillary elastics that were used at the end of treatment to improve the patient's overjet rather than from the mechanics for MM2 disimpaction, as observed in this case. The uprighting of the MM2 with a NiTi archwire and spring generated localised posterior forces that did not remarkably affect the inclination of the anterior teeth, as the rests of the teeth were consolidated to reinforce the anchorage during the disimpaction process. In contrast, Class II elastics exerted a mesial pull on the mandibular dentition, leading to lower incisor proclination. This timing corresponds to the period when proclination was observed, distinguishing it from potential effects of the MM2 disimpaction mechanics.

The successful uprighting of impacted MM2 using non-invasive straight wire mechanics circumvents the need for mini-screws, surgical exposure, or complex wire bending. This approach enhances patient comfort and reduces the risk of complications associated with more invasive procedures. Non-invasive straight-wire mechanics leverage biomechanical principles to achieve tooth movement by applying carefully calibrated forces through orthodontic appliances. This technique has been shown to effectively manage the alignment of impacted teeth without the need for additional anchorage devices, such as mini-screws, which often require surgical placement and can introduce risks of infection and discomfort (Chang *et al.*, 2021). Avoiding surgical exposure is particularly beneficial, as it minimises the patient's recovery time and reduces the overall treatment complexity (Yamaguchi *et al.*, 2012).

Furthermore, non-invasive methods align with contemporary orthodontic practices that emphasise patient-centred care. By eliminating the need for mini-screws, orthodontists can reduce the risk of complications such as screw failure, root damage, and inflammation of surrounding tissues, which are common concerns with mini-screw placement. Studies have indicated that mini-screw success rates can vary significantly, depending on factors such as insertion technique and bone quality, with reported failure rates ranging from 10% to 20% in certain contexts (Moeini *et al.*, 2023). In contrast, non-invasive techniques can provide a more predictable outcome without these associated risks. Additionally, applying straight wire mechanics allows for a more straightforward adjustment process, facilitating easier modifications to the treatment plan as needed. The ability to make real-time adjustments without the need for surgical intervention enhances the overall efficiency of the treatment process.

CONCLUSION

Uprighting impacted MM2 using straight wire mechanics represents a conservative, non-invasive, and cost-efficient technique that combines efficiency and patient comfort. As orthodontic technology and techniques continue to evolve, the role of straight wire mechanics in managing impacted teeth will likely expand, providing orthodontists with powerful tools to address complex dental challenges while minimising the risks associated with more invasive procedures.

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