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Case Report

Miniscrew-supported pole technique: Surgical-orthodontic approach for impacted or retained second molars in adolescents

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Abbreviations
M2, Second Molars
CBCT, Cone beam computed tomography
ANB, A, A-point, deepest bony point on the contour of the premaxilla below ANS
B, B-point, deepest bony point on the contour of the mandible above pogonion
ANB, angle between point A, B and point N

Summary

Background > Several treatment options have been proposed for the treatment of eruption disturbances of permanent molars. Despite being an infrequent condition, these disturbances should be solved as they can lead to important complications and play a relevant role in completing the occlusion.

Findings > The presented cases involved maxillary and mandibular included second molars (M2s) respectively. Both teeth erupted successfully after the application of the miniscrew-supported pole technique, and a functional occlusion was established.

Conclusions > This technique is a surgically assisted orthodontic procedure performed to force the eruption of impacted/retained M2s. This device uses one mesial miniscrew which allows the application of relevant force to achieve the eruption of complicated retained/impacted M2s within a short period of time.

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Introduction

Impaction or retention of second molars (M2s) is a relatively rare condition [1–5]. Although its approach can be frustrating for the orthodontist due to the difficult access in the posterior area of the mouth, it cannot be left untreated as it can lead to many problems such as over-eruption of the opposing teeth, pain, increased caries susceptibility or periodontal complications like odontomas or cysts [6,7]. The causes of these eruption alterations may be due to local factors such as the arch-length deficiency in the posterior area, abnormal angulation of the developing tooth germ, enlargement of the dental follicle or even its association to genetic disturbances [5,8].

Fortunately, the prevalence of eruption disturbances of M2s is low as it ranges between 0.06% to 2.5% [1,3], being more frequent in the mandible than in the maxilla [4,9]. The main difference between the terms impacted and retained is that in the first case, there is a physical barrier that prevents the correct eruption of the tooth, while in a retained molar there is no evident impediment along its eruption path [3,10–12].
Moreover, there are diagnostic factors that can complicate the management of these molars, such as an increased dental follicle, a closed apex, the angulation with the adjacent teeth, the severity of the degree of infraocclusion, the patient's age, the proximity to the inferior alveolar nerve canal or the maxillary or mandibular cortical bone and dilacerations of the root [12–14].

Figure 1
Patient 1: pretreatment facial and intra-oral photographs

In fact, it has been demonstrated that an early diagnosis can provide a better outcome, achieving a higher positive result in younger patients as the success in eruption is more related with the root formation than with the degree of infraocclusion [2,9,11].

Eruptive problems of mandibular M2 have been more widely studied than those in the maxillary arch, which may be due to their higher prevalence. For this reason, more techniques have been developed for the treatment of these molars, and there are several methods to upright secondarily retained mandibular M2. Many of these techniques require the tooth to have exposed cusps to place the uprighting appliance [15,16].

However, in complex cases that involve deeply included molars, surgery is the option, either with extraction, transplantation or repositioning of the tooth [4,11,13,17]. Nevertheless, the most conservative option consists in surgical uncovering with forced orthodontically-assisted eruption [13,18–20]. Currently, the use of new systems to upright impacted molars employing skeletal anchorage has been widely accepted, since a higher amount of force can be applied to the molar with simpler biomechanics minimizing dental side effects [6,7,18–22].

Therefore, the purpose of this case series is to show the application of the miniscrew-supported pole technique through two cases that present included M2s. This procedure is a surgically assisted orthodontic procedure to force the eruption of impacted or retained molars that has been previously described by Lorente et al. [23]. The first case describes the treatment of a maxillary impacted molar, and the second case a mandibular included M2.

Materials and methods

Patient 1

Diagnosis and aetiology

A 15-year-old male came to our clinic with the main complaint of the crowding of the upper central incisors. He had a slightly dolichofacial face and convexity of his facial profile. Intraoral photographs showed a Class I bilateral relationship, and it was noted that the upper right M2 had not yet erupted in the oral cavity (*figure 1*).

The initial cephalometric analysis showed a minor skeletal Class II (ANB, 1.9°) with proclination of the upper and lower incisors (Interincisal Angle, 117.1°) (*figure 2*; *table I*). Cone beam computed tomography (CBCT) was performed to detect if there was any disturbance in the upper right M2 eruption path. Scan image analysis showed agenesis of the upper right third molar and a mesially tilted molar with an angulation of 35.9 degrees (measured as the angle formed between the middle axis of the included M2 and the middle axis of the adjacent first molar) (*figure 3*). The crown of the M2 was totally impacted to the distal root of the first molar. In addition, there was a slight dilaceration

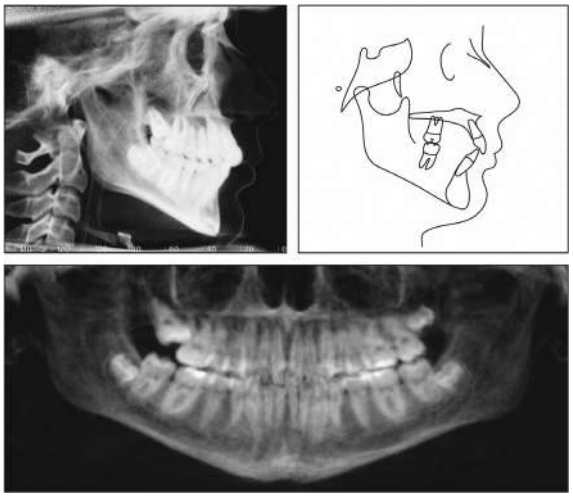

FIGURE 2

Patient 1: pretreatment panoramic radiograph, cephalogram, and tracing

TABLE I

Cephalometric analysis of patient 1.

Measurement	Norm	Pretreatment	Post-treatment
SNA (°)	82	85.3	84.3
SNB (°)	80	79.5	80.0
ANB (°)	2	5.8	4.3
Interincisal angle (°)	130	129.7	119.2
Mx1 to A-Po (mm)	3.5	5.2	6.2
Md1 to A-Po (mm)	1	1.4	2.7
Facial axis (NaBa-PtGn) (°)	90	87.7	89.9
IMPA (°)	90	98.8	103.4
Lower facial height (ANS-Me) (mm)	45	45.5	46.5
LL to E-plane (mm)	−2	−3.1	−3.6

detected in the mesial root of the impacted molar, in which the root apex was already closed. The infraocclusion degree (5.42 mm) was measured as defined by Brearley and McKibben (*figure 3*) [2,24]. In addition, some of these techniques have been successfully applied in deeply included maxillary molars [25].

All these radiographic findings in conjunction with the older age of the patient for normal eruption of the molar, and the risk of

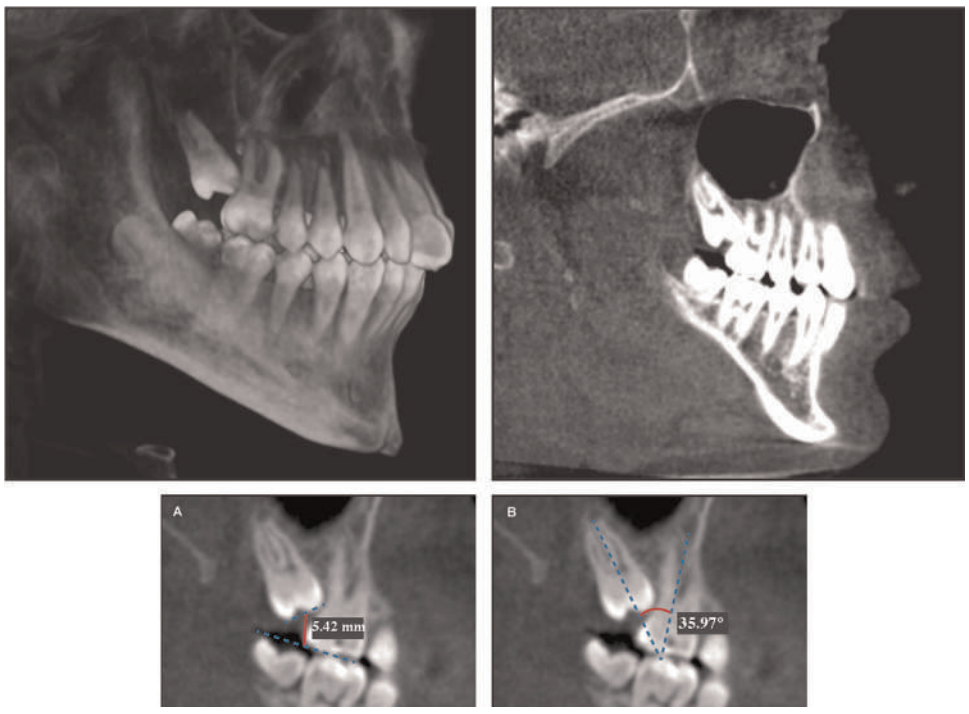

FIGURE 3
Patient 1: pretreatment CBCT images and scan measurements
A. Degree of molar infraocclusion
B. Molar angulation

root resorption of the adjacent tooth, led clinicians to conclude that the molar would not erupt properly without intervention.

Treatment objectives

The following treatment objectives were established: (1) achieve appropriate anterior overbite and overjet relationships; (2) obtain Class I canine and molar relationships; (3) force the eruption of the impacted M2; and (4) improve facial aesthetics.

Treatment alternatives

Fixed multibracket treatment was planned to correct the crowding and occlusion. Regarding the M2 situation, various alternatives were considered. The option of extraction of the impacted M2 was ruled out, as the patient had agenesis of the right third molar, so if the M2 were extracted, a prosthetic solution would have been necessary to achieve a proper occlusion. The surgical repositioning of the tooth could be another option, but less conservative, as it can put the pulpal vitality of the tooth at risk, so it was rejected. The conventional orthosurgical management with the surgical exposure of the M2, bonding of an attachment and simply the force of the archwire, seemed insufficient to the authors, as the molar presented various parameters that could point out a difficult eruption, like the older age of the patient, closed apex, or the dilacerated root. Due to these reasons, the miniscrew-supported pole technique was proposed, to enlarge the amount of force that could be applied to the molar and increase the possibilities of getting a successful eruption.

Treatment progress

The treatment plan included fixed appliances with 0.022 × 0.028 slot metal brackets (Roth prescription; Straight-Wire Synthesis; Ormco, Glendora, Calif) with an initial wire of 0.016-inch nickel titanium. In addition, a 0.021 × 0.025-inch stainless steel buccal splint with a step was placed on the three adjacent mesial teeth of the impacted molar (first molar and premolars) to pass the pole and reinforce the anchorage unit. The surgery was undertaken the same day as the bonding. Considering that the molar had a mesial angulation, the pole employed was 3 mm greater than the distance between the attachment and the miniscrew in order to generate an extrusive and clockwise rotational moment. The archwire employed to perform this "pole" was a 0.019 × 0.025-inch nickel titanium since the shape memory effect

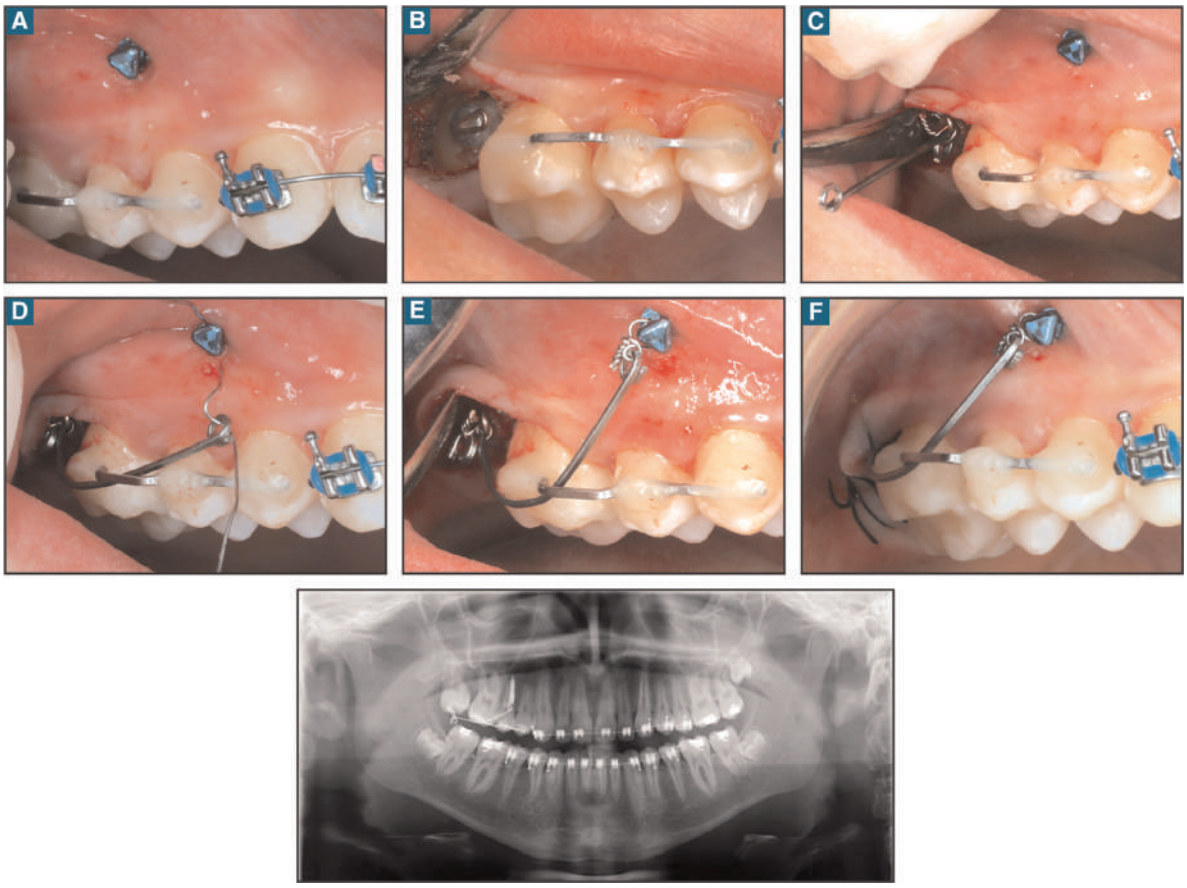

FIGURE 4

Placement procedure of the pole technique in the maxilla

A. Miniscrew inserted between premolar roots and splinting wire bonded to the adjacent teeth
B. Mucoperiosteal flap performed and attachment bonded
C. Connection of the pole to the bonded attachment
D. Insertion of the pole through the step in the splinting wire
E. Connection of the pole to the miniscrew
F. Flap replacement and closure
Control panoramic radiograph 2 months after surgery

provides a continuous extrusive force to the tooth, making the activation of the system only necessary on the day of surgery. In the maxilla, the miniscrew (Vector TAS, trademark of Ormco Corporation, Orange, CA) was inserted into the interradicular space between the first molar and second premolar at 7–9 mm from the alveolar crest and with an insertion of 30–45° to the dental axis to avoid root damage. Follow-up appointments were arranged every two weeks. One month and a half after the surgery, the molar emerged in the oral cavity. The pole technique system was then removed, and brackets and tubes were bonded to continue with the alignment (*figure 4*).

Treatment results

The duration of total active treatment was 15 months. After appliance removal, an upper Essix retainer was delivered and a lower 3-3 lingual retainer was bonded. In the intraoral photographs, a Class I bilateral occlusion can be seen with positive overbite and overjet (*figure 5*).

Post-treatment lateral cephalometric analysis showed improvement in the initial incisor proclination (interincisal angle, 121.6°) (*figure 6*, *table I*). In the final CBCT images, there were no signs of root resorption or periodontal side effects on the premolars and molars involved with the applied technique.

FIGURE 5
Patient 1: post-treatment facial and intra-oral photographs

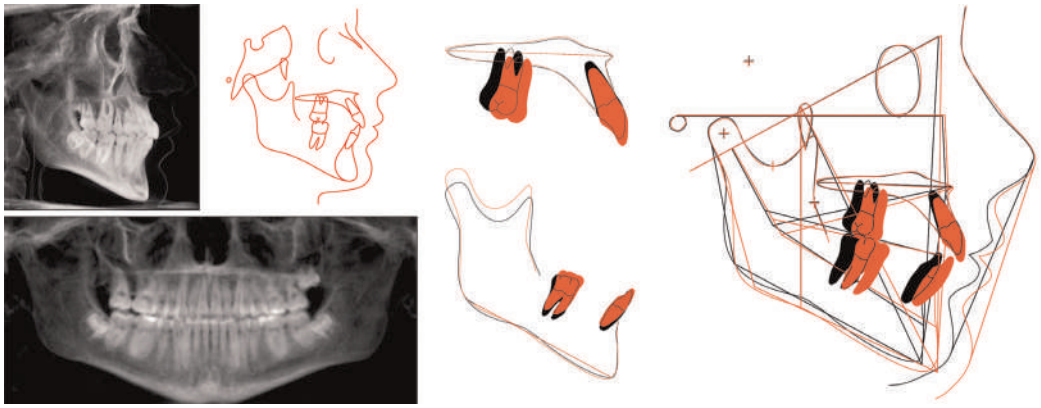

FIGURE 6
Patient 1: post-treatment panoramic radiograph, cephalogram, tracing and superimpositions

Patient 2

Diagnosis and aetiology

A 13-year-old male was attended for an initial orthodontic assessment. The patient had no relevant medical history and a complete set of orthodontic records was collected. Intraoral photographs revealed a Class II division 1 relationship on both sides at the end of mixed dentition and extrusion of the upper right M2 (*figure 7*).

Extraoral examination showed a mild brachyfacial face with lower lip eversion and convexity of the facial profile. In the tracing, a skeletal Class II was confirmed (ANB, 8.2°) and maxillary and mandibular incisors were proclined (Interincisal angle, 119°) (*figure 8*, *table II*).

In the intraoral examination, there was no evidence of eruption of the lower right M2 on palpation, and therefore, a CBCT was taken to assess the eruption of this molar. The pretreatment panoramic view showed an abnormal positioning of the lower right M2. When the CBCT images were analysed, an increased follicular cyst was revealed and a narrow relationship of the roots with the canal nerve and the cortical bone of the mandible was observed. In the coronal view, there was an evident abnormal lingual inclination of the crown. In the sagittal view, the molar was distally tilted with a negative angulation of 15.33 degrees and a severe infraocclusion of 4.17 mm (*figure 9*). Taking into account all these factors in the radiographic analysis and the fact that the antagonist molar was already extruded, it was concluded that a treatment of the included M2 was necessary as soon as possible.

Treatment objectives

The objectives of the treatment were: (1) achieve appropriate anterior overbite and overjet relationships; (2) obtain Class I

FIGURE 7

Patient 2: pretreatment facial and intra-oral photographs

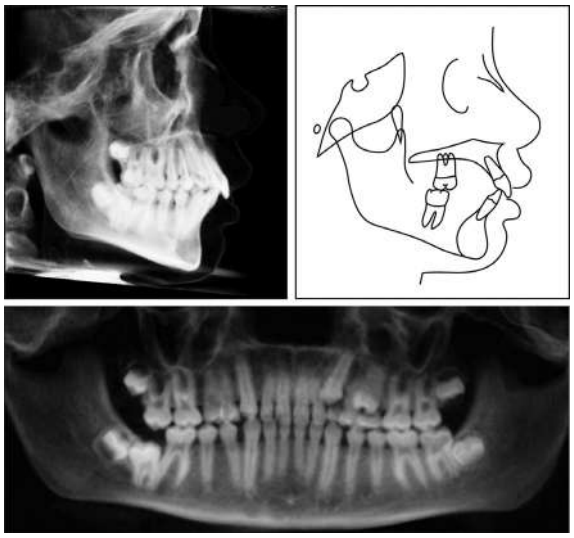

FIGURE 8

Patient 2: pretreatment panoramic radiograph, cephalogram, tracing and superimpositions

TABLE II

Cephalometric analysis of patient 2.

Measurement	Norm	Pretreatment	Post-treatment
SNA (°)	82	87.1	88.4
SNB (°)	80	78.7	81.7
ANB (°)	2	8.4	6.7
Interincisal Angle (°)	130	119.9	127.2
Mx1 to A-Po (mm)	3.5	8.6	5
Md1 to A-Po (mm)	1	3.7	0.7
Facial axis (NaBa-PtGn) (°)	90	89.1	93.4
IMPA (°)	90	108.6	105.6
Lower facial height (ANS-Me) (mm)	45	44.9	45.3
LL to E-plane (mm)	−2	3.4	−2.5

canine and molar relationships; (3) force the eruption of the ectopic M2; and (4) improve facial aesthetics.

Treatment alternatives

To achieve the occlusal targets and the proper aesthetics, fixed multibracket treatment was planned. Different alternatives to deal with the M2 ectopic eruption were suggested. Although in this case the third molar was present to erupt in the position of the second molar in case of extraction, this option was saved as a last chance in case of failure of eruption for being the most invasive. As in the previous case, the surgical repositioning of the ectopic M2 was refused because of the pulpal and periodontal risks involved. In this patient, the molar presented a distal and less pronounced angulation so in first place, conventional surgery could have been an option. However, after the examination of the CBCT findings, observing the narrow relationship between the roots and the canal nerve and the cortical bone and the enlarged dental follicle, the clinicians decided that the larger force applied on the miniscrew could increment the possibilities of a successful eruption. Also, the initial distal angulation of the tooth played an important role in the decision of applying the miniscrew-supported pole technique, as it presented an advantage over the conventional surgery, that an extrusive and clockwise rotational moment on the molar could be done at the same time.

Treatment progress

The patient was bonded with fixed appliances (Roth prescription; Straight-Wire Synthesis; Ormco, Glendora, Calif) with an initial wire of 0.016-inch nickel titanium. The same day of the bonding, the surgical procedure was performed as described in the previously mentioned case but with some differences. As the molar was distally angulated, the pole length was 3 mm shorter than the distance between the attachment and the miniscrew. In the mandible, the miniscrew was inserted into the gingiva between the first and second premolar at 90° to the cortical surface using a manual screwdriver. Monitoring of the patient was carried out every two weeks to avoid excessive extrusion of the molar because of the large amount of force produced by the device. Four months after surgery, the molar emerged in the oral cavity; the miniscrew and the pole were then removed, and a tube was bonded in the molar (*figure 10*).

Once the eruption of the molar had been achieved, the wires were gradually changed to 0.019 × 0.025-inch stainless steel. To solve the Class II molar relationship, a Forsus fatigue-resistant device (3M Unitek, Monrovia, Calif) was placed on both sides associated with a transpalatal bar for 3 months. After wearing this appliance, the patient was instructed to use Class II elastics (Masel®, 1/8-in, 6.0-oz) to establish correct intercuspation.

Treatment results

After 17 months of active treatment, the appliances were removed. A Class I dental relationship was established with normal overbite and overjet. Adequate interdigitation was achieved even in the right M2s (*figure 11*). An upper Essix retainer was delivered and a lower 3-3 lingual retainer was bonded.

Post-treatment lateral cephalometric analysis showed improvement in the initial skeletal Class II relationship (ANB, 2.4°; Wits Appraisal 2.4 mm), and the final incisor proclination was normal (interincisal angle, 127.2°) (*figure 12*, *table II*).

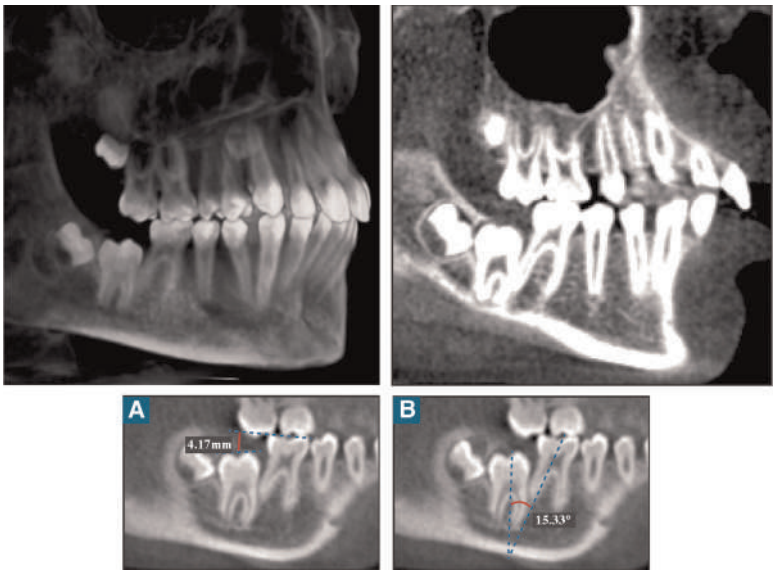

FIGURE 9

Patient 2: pretreatment CBCT images and scan measurements

A. Degree of molar infra-occlusion

B. Molar angulation

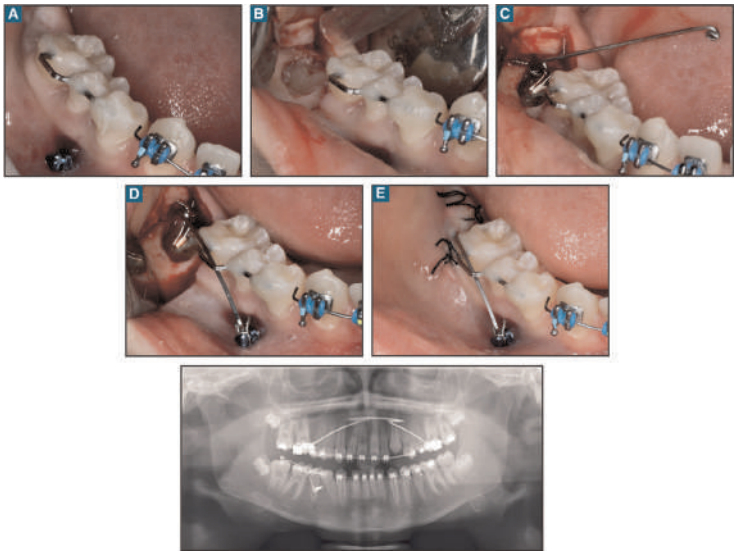

FIGURE 10

Placement procedure of the pole technique in the mandible

A. Miniscrew inserted into the gingiva between the first and second premolar at 90° to the cortical surface

B. Mucoperiosteal flap performed and exposure of the M2 to attach the button

C. Connection of the pole to the bonded attachment

D. Insertion of the pole through the step in the splinting wire and connection to the miniscrew

E. Flap replacement and closure

Control panoramic radiograph 4 months after surgery

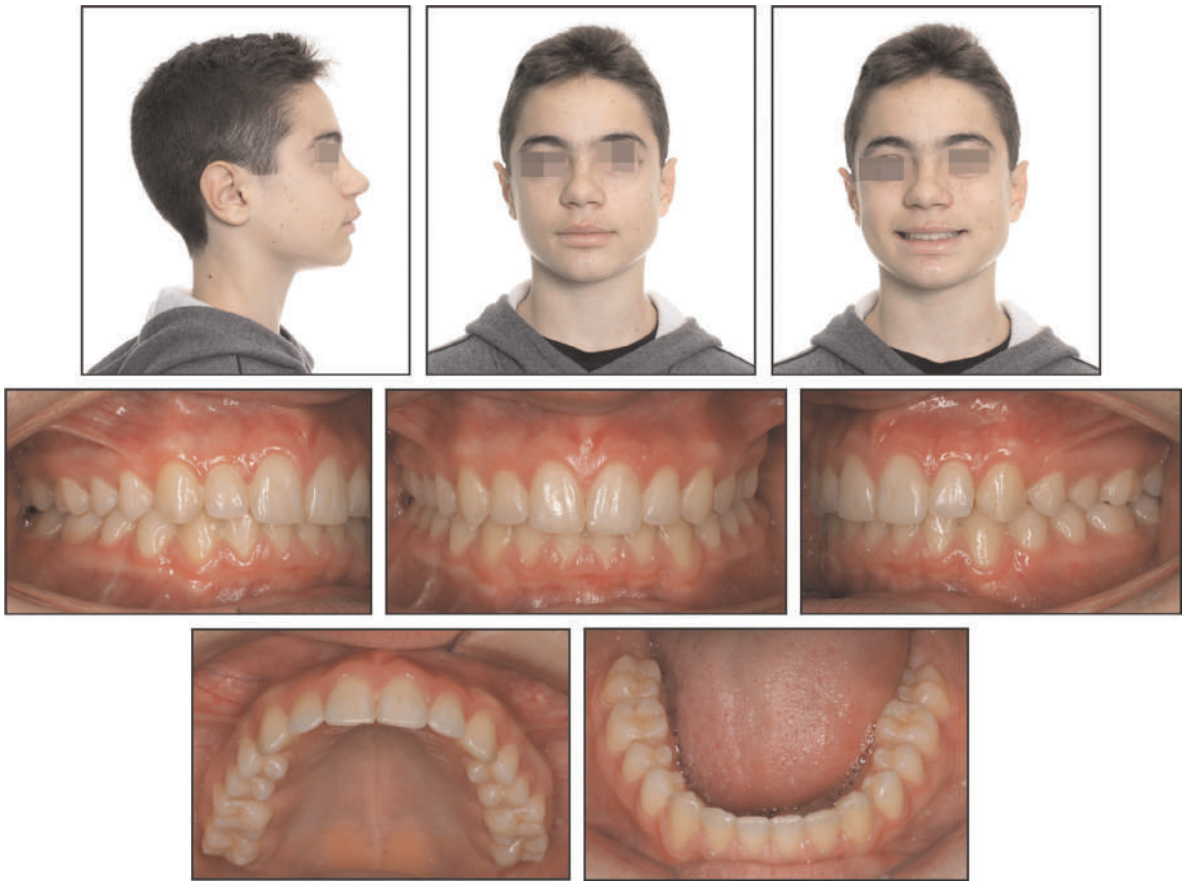

FIGURE 11

Patient 2: post-treatment facial and intra-oral photographs

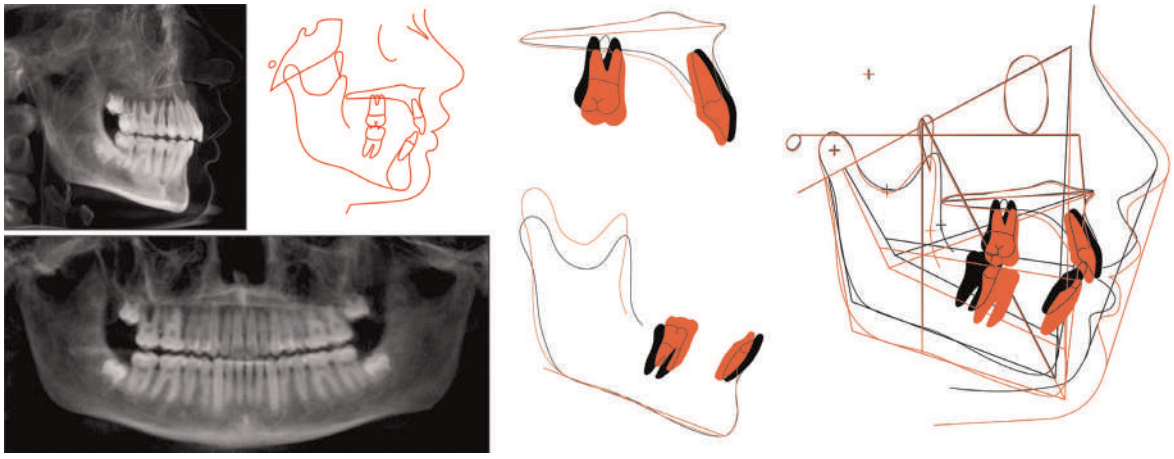

FIGURE 12

Patient 2: post-treatment panoramic radiograph, cephalogram, and tracing

In patient 2, root resorption was not detected in either the M2 or adjacent teeth.

Discussion

Several treatment alternatives for impacted or retained M2s can be chosen based on the severity of infra-occlusion, accessibility to the molar or the possible side effects of treatment [22]. There is no consensus on the best approach for M2 eruption disturbances [11]. This treatment should always be individualized and agreed with the patient, based on an accurate pretreatment analysis of all the conditions that can influence the successful eruption of the molar and also the experience of the operator [11,16]. However, it seems that there is an agreement that these molars should be treated when they are diagnosed and before the appearance of complications such as caries, follicular cystic development, extrusion of opposing tooth, periodontitis or root resorption of the adjacent tooth [13].

When an unerupted permanent molar is diagnosed, it is important to consider its angulation and infra-occlusion degree. In this case series, angulation was measured as the angle formed by the intersection of the vertical long axis of the M2 with the axis of the adjacent anterior tooth [14,26]. The degree of infra-occlusion was defined as the distance from the occlusal plane to the midpoint of the occlusal surface of the unerupted M2 [24,27,28]. Another subject of study is the time until an impacted/retained molar erupts. Most of the studies published are case reports/series with different treatment approaches, making it difficult to establish the mean duration of treatment [16], which generally ranges from 4 to 23 months [21,29]. In patient 1, the M2 erupted within 1.5 months and in patient 2, within 4 months. It was noted that the time of treatment was shorter than with conventional surgery which does not require skeletal anchorage.

Few studies [2,11,30] have analysed the success rate of impacted or primarily/secondarily retained molars after treatment. Among all the treatment options available, orthodontic treatment following a surgical procedure was only carried out in 11% to 29.8% of cases, achieving positive outcomes in 42–71% of the molars. In our two patients, with surgery involving orthodontically-assisted forced eruption based on the miniscrew-supported pole technique exerting 150–200 g of force, we achieved proper eruption of the molars with no procedure-related complications. The absence of complications was likely related to the careful analysis of the interradicular space between the first and second premolar by CBCT before miniscrew insertion [31].

After treatment, no sign of radicular root resorption of the impacted/retained molar was observed in either of our two patients.

The technique described in the present clinical article requires the placement of a mesial miniscrew and only one activation with a long lever arm that exerts considerable force the day of surgery. Compared to other techniques which use distal skeletal anchorage [6,20,21,29], this procedure has the advantage of being more comfortable for the patient reducing chair time, allowing application in the maxillary arch (not only the mandible) [25] and minimizing the need for a third molar extraction [6,20,29]. If the M2 does not emerge in the oral cavity, the third molar could replace this tooth as an alternative treatment option [30].

While impacted molars may be a very infrequent and challenging pathology, they can be treated with orthodontic techniques following surgical exposure, achieving outstanding results and good anchorage control, with successful eruption, and thus, preservation of the molar in the oral cavity in many cases. In our opinion, this should be the first option in most cases of included molars, limiting surgical extraction of the molar only to cases of orthodontic treatment failure.

Conclusions

M2 eruption failure is a dental alteration without a specific treatment protocol that should be solved due to its potential complications. The miniscrew-supported pole technique is a conservative procedure that could be considered to force the eruption of these molars. It can be applied either in the maxilla or the mandible, as shown in the descriptions of patients 1 and 2, respectively. In both cases, this technique has demonstrated to be an effective and safe procedure.

Ethics approval and consent to participate: the two patients signed an individual consent to participate.

Availability of data and materials

please contact the author for data requests.

Consent for publication: a written consent, signed by all the patients in this study, was recorded.

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Author's contributions: all authors have equal distribution in carrying out this research. All authors read and approved the final manuscript.

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