

# We are IntechOpen, the world's leading publisher of Open Access books Built by scientists, for scientists

6,900

Open access books available

186,000

International authors and editors

200M

Downloads

Our authors are among the

154

Countries delivered to

TOP 1%

most cited scientists

12.2%

Contributors from top 500 universities



WEB OF SCIENCE™

Selection of our books indexed in the Book Citation Index  
in Web of Science™ Core Collection (BKCI)

Interested in publishing with us?  
Contact [book.department@intechopen.com](mailto:book.department@intechopen.com)

Numbers displayed above are based on latest data collected.  
For more information visit [www.intechopen.com](http://www.intechopen.com)



# Orthodontic Management of Residual Spaces of Missing Molars: Decision Factors

*Hakima Aghoutan, Sanaa Alami, Amal El Aouame and Farid El Quars*

## Abstract

In the daily practice, the orthodontist may be confronted with particular clinical situations with one or more missing teeth. This can complicate the therapeutic plan and influence the choice of possible extractions imposed by treatment requirements. In case of permanent molar absence, making decision becomes even more delicate. The practitioner must use his/her critical sense and clinical common sense to make the right choice between closing and redeveloping the residual spaces. Its choice must meet the patient's expectations and correct the clinical problem without risking overtreatment, or extending duration care. Several factors guide the therapeutic decision, ranging from the patient's age to economic factors, not to mention the technical complexity, therapeutic predictability, and patient comfort, which determine proper compliance and therefore success. In this chapter, we will focus on these decision-making factors by determining the scientific evidence level in terms of success, survival, and patient-centered outcomes (quality of life and functional efficiency).

**Keywords:** missing permanent molars, first permanent molar, second permanent molar, orthodontic management, decision factors, adult, children, space closure, space reopening, multidisciplinary treatment

## 1. Introduction

Orthodontic treatment aims globally to improve dentofacial esthetic and stomatognathic system functions in harmony with the patient's wishes. To achieve these objectives, inter- and intra-arch occlusion is the guiding field of action. Therefore, any orthodontic movement must be carefully considered including in the molar area. Indeed, permanent molars are considered as significant determinants for normal tooth development and facial growth [1, 2]. They play a central role in the mastication of food, in supporting the vertical dimension of the face, and as anchorage teeth against orthodontic forces [3]. Moreover, posterior dental contacts are important to adapt and coordinate growth between the mandible and maxilla and a lack of chewing function in children will disrupt their maxillofacial growth [1, 4]. Hence, every orthodontist must ensure a well-thought-out management of missing molar spaces mostly in children.

The molar missing may be primary, due to the agenesis phenomenon, or secondary to extraction not compensated by prosthetic rehabilitation. It complicates decision-making process, since the orthodontist's first vocation is to balance dento-facial pattern with a better cost-benefit ratio, especially in young patients. What is more, molar absence is generally accompanied with other complicated dental and skeletal problems, which affect treatment planning and outcomes.

Molar agenesis may be an isolated anomaly or associated with particular syndromes. It is an uncommon clinical condition not well documented in the literature. Moreover, it has also been reported that anterior agenesis may depend more on genes while posterior missing might be sporadic [5]. Its prevalence rate has been reported to fluctuate between 0 and 0.05% in the general population for the first permanent molar (FPM) [1] and to revolve around 0.8% for the second permanent molar (SPM) [4]. This phenomenon was reported to be associated with a higher prevalence of other permanent tooth agenesis and advanced tooth agenesis [3]. Consequently, when treating patients with molar agenesis, the orthodontist should consider that observed alterations of craniofacial dimensions might occur beyond the variations associated with age and gender [6].

On the other hand, in case of acquired lack of molars, many factors can be incriminated. Carious lesions, dental hypoplasia including molar-incisor hypomineralization (MIH), and periodontal disease are the major concerns [7, 8]. Several authors have dealt with the best time to extract first permanent molar when this is unavoidable in the young patient. There is only little scientific evidence about the extraction timing in order to minimize unwanted negative effects. In a recent meta-analysis [6], authors suggested that it is when the second permanent molar is at Demirjian stage E. Otherwise, several consequences can occur and if orthodontic need arises, the treatment plan can be complicated or modified to adapt to these modifications, especially in adults.

In this section, we will address the main etiologies and dentoskeletal consequences of molar missing and focus on decision-making factors related to orthodontic management of residual space of one or several missing molars. We will discuss some clinical situations to illustrate this topic.

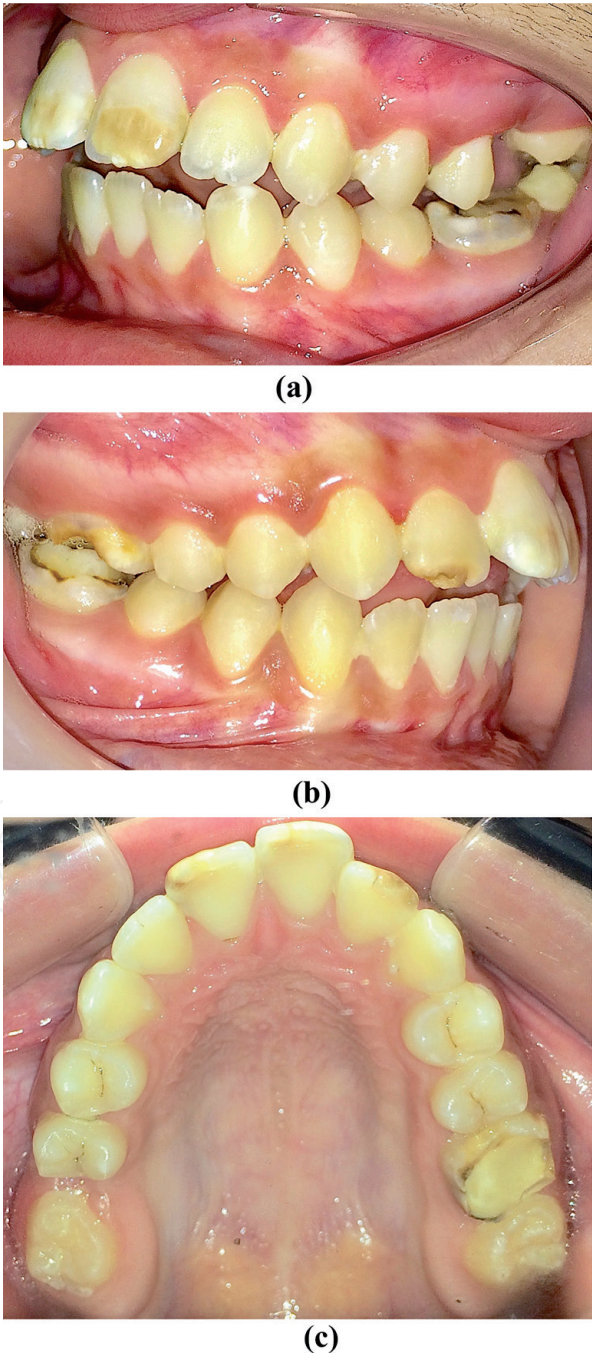
## **2. Problem statement**

The consequences of permanent molar extraction and all consequences and treatment considerations have been largely discussed in the literature for the first molar. Second molar is less commonly addressed. Currently, the majority of first permanent molars are extracted because of dental caries [9]. The eruption of the first permanent molar occurs, as its name suggests, around the age of 6 years. Its early eruption, as well as the immaturity of its histological components and its occlusal anatomy (grooves, pits, and fissures), makes it vulnerable to various microbial, periodontal, or structural pathologies, and more prone to possible premature extraction before 15 years [6, 10]. The period between the eruption of the tooth and the definitive maturation of its histological components, especially that of the enamel, is considered to be cario-susceptible.

As said above, permanent molars act as a guide for the permanent teeth since they control the establishment of dental occlusion and participate in the maxillary growth and physiology of the mandibular apparatus. Therefore, loss of permanent molars without any remedy could disturb the developing dentition, generate numerous malocclusions, and affect dental health [6]. It typically leads to occlusal disturbances by pathological migration of neighboring teeth and periodontal lesions as alveolar melting or false periodontal pocket adjacent to the tipped teeth which is induced by bone contour remodeling following the cemento-enamel junction [11] (**Figures 1–3**).

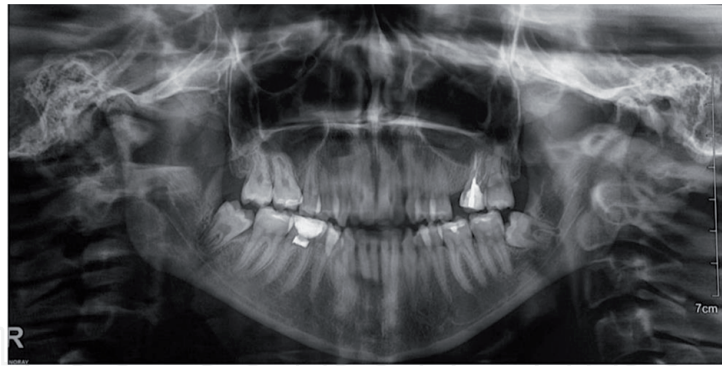
These complications are all the more serious, as the period of molar absence on the arch is extended; hence, the importance of the multidisciplinary approach with a large communication between the pediatric dentist and the orthodontist in order to establish the best care and to plan potential extraction, which is useful to correct discrepancies and prevent the development of malocclusions [10].

For managing this space problem, the orthodontist can adopt two therapeutic strategies including space reopening or space closing. The orthodontist ought to use his/her critical sense and clinical common sense to make the right choice, which must not only take into consideration dental arch length and occlusion [12] but also all the technical and biological specificities of treated case. Space can be reopened for implant insertion, autotransplantation, and prosthetic restoration; while space closing can be undertaken to correct the other associate malocclusions. Either way, his/her choice must meet the patient's expectations and correct the clinical problem

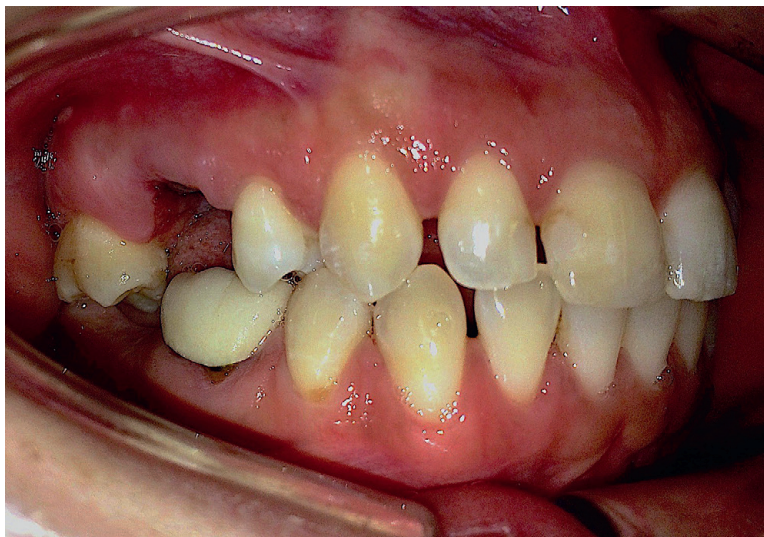


**Figure 1.**  
*Case of MIH in a 11-year-old boy, with severe molar damage and loss of 26. We can observe displacement of second left upper molar: (a and b) lateral occlusion views; (c) occlusal view of maxillary arch.*





**Figure 2.**  
*Orthopantomogram (OPG) of an adult showing the absence of 16 and 26 with version and false periodontal pocket in the mesial side of 17 and 27. We can note the low floor level of the right maxillary sinus, which may complicate orthodontic mesial movement of posterior teeth.*



**Figure 3.**  
*Case of an adult with multiple molars missing. The over eruption of 17 is due to no-compensated extraction of 47.*

without risking overtreatment, or extending duration care, especially since patients with missing molars often need a compensatory treatment in the opposite arch.

Besides, some authors [11, 13, 14] claim that space closure by molar orthodontic movement is time-consuming and more problematic mainly in the mandibular arch and in atrophic extraction sites exhibiting a reduction in vertical height and a decrease in width of the residual ridge. The orthodontist must avoid teeth tipping, damage of the gingiva and marginal bone. Hence, this decision requires confrontation with the alternative prosthetic treatment especially in old adults who usually show less bone apposition around moved molars into the narrowed space, and poor stability of the closed space, leading in some, if not several, cases to an orthodontic compromise. Nevertheless, fixed appliances can achieve excellent outcomes at different ages following permanent molars' loss particularly with the advent of temporary anchorage devices. Studies have reported that posterior spaces have been closed by protracting posterior teeth, which prevent detrimental effects without reopening of the edentulous spaces or increased pocket depth in the follow-up period [15]. In case of related orthodontic abnormalities, it is necessary to use all or part of the space given by molar extraction to correct the dysmorphism. A golden rule is to determine the anchorage value and location as well as any associated auxiliary devices.

On the other hand, before any prosthetic rehabilitation succeeding space redevelopment, the practitioner has to upright and to parallelize the adjacent teeth in order to gain sufficient space, even apically at the root level [14]. Moreover, in

these cases, wisdom teeth are often removed [16]. Consequently, the orthodontist has always to wonder which of the two options is better: (a) close residual molar space to control the wisdom tooth positioning or (b) remove the third molar and place a prosthesis on the missing molar, which is more expensive. Obviously other biomechanical considerations must be taken into account, to be explained later.

On another note, over the years of craniofacial growth, teeth and their supporting tissues are able to adapt to functional demands. Thus, continuous changes are observed after tooth missing, and the orthodontist has to choose optimal treatment for his/her patient taking into account several decision factors. In his literature review [14], Thilander has shown that both closure and space opening alternatives have their advantages as well as disadvantages, but the evidence base is weak, with currently no randomized trials reporting on the outcome of different interventions [9]. More research is needed with relevant clinical follow-up, varying craniofacial morphology, different ages, and large sample. This will be of great value for comprehension of tissue reaction to orthodontic space management and continuous changes of the dentition and its supporting tissues. From then on, treatment choice can be standardized.

### 3. Clinical features

The direct consequence of molar extraction is the creation of a 10- to 12-mm diastema. The movements of the neighboring and antagonistic teeth will cause occlusal and periodontal imbalance. It was reported that post-extraction migration occurred in the following ways: over eruption of opposing teeth, horizontal migration of neighboring teeth, space reduced by tipping, dual drift (horizontal and vertical), or complete space closure [6]. In addition to this, authors investigated contour changes of the alveolar processes of posterior extraction sites and demonstrated a reduction in width of the residual alveolar ridge of up to 50% during a 12-month healing period, of which two-thirds of the reduction occurred within the first 3 months of healing in [17]. In case of an extraction on one arch, the opposing tooth can significantly over erupt (**Figures 4 and 5**). In general terms, malocclusions are complicated by the early loss of a first permanent molar without treatment [10].

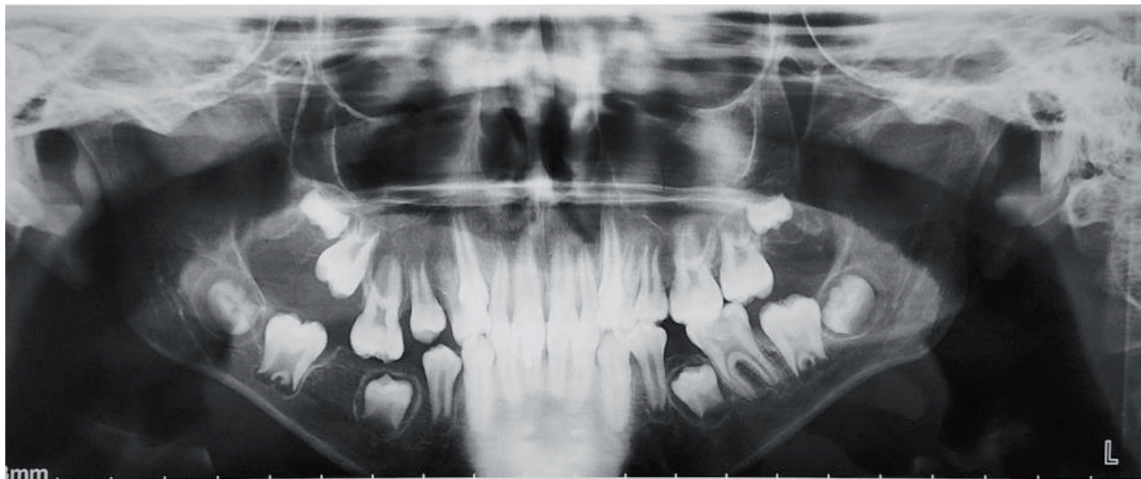
Moreover, sinus pneumatization was identified after extraction of maxillary posterior teeth. This phenomenon occurs within 4–6 months of healing duration, and is caused by atrophy associated with the replacement of dental socket by non-functional bone [18, 19]. The expansion of the sinus was larger following extraction of teeth enveloped by a superiorly curving sinus floor, extraction of several adjacent posterior teeth, and extraction of second molars in comparison with first molars [19].

A systematic review reported that the post-extraction space of first permanent molar was closed mostly by the SPM rather than by the second premolar [6]. For certain authors [20, 21], no significant relation was found between patient Angle's Classification or the timing of FPM extraction based upon SPM development stage and complete spontaneous space closure in both arches, contrary to the usual recommendations indicating that the ideal time for FPM extraction, with fewer undesirable consequences, is when the SPM is at Demirjian stage E (early bifurcation) [6, 9]. For these authors, apart from extraction timing of the FPM, the presence of the third permanent molar, mesioangulation of the SPM in relation to the FPM, and the engagement of second premolar in the bifurcation of the second primary molar are better predictors of spontaneous space closure of the FPM mainly in mandibular arch where closure space is more problematical and leads frequently to mesial tipping and distobuccal rotation of the SPM or angulation and distal movement of the second premolar. This might be due to the differences in the eruption paths of SPM in the mandible and maxilla [10].





**Figure 4.**  
*Over eruption of tooth 16 after extraction of tooth 46.*



**Figure 5.**  
*OPG of the same patient showing the consequences of extraction of tooth 46: over eruption of 16, distal displacement of 45 germ and slight mesial displacement of 47.*

The occlusal and skeletal consequences in the vertical direction after extraction of FPM were much discussed. Some authors noted counterclockwise rotation of the occlusal plane and an improvement in infraclusion [6, 13] but most studies did not notice a significant influence on the vertical dimension [6]. Also, there was no significant effect described on the maxillomandibular relationship in the anteroposterior direction.

Furthermore, it was stated that the FPM and SPM extraction accelerated significantly the development and eruption of the third molars when a posterior space is created [13, 22–24] and led to lingual tipping and retrusion of incisors mostly in lower arch [6]. However, some authors have discussed the effect of various extraction patterns on provision of space both anteriorly and posteriorly within the arch and they highlighted the fact that FPM extraction seems to have less effect on the profile than premolar extraction [13].

Finally, in the aforementioned systematic review, the authors concluded that the published studies have too many weaknesses to draw sufficient evidence. Therefore, further prospective studies are needed to investigate the consequences of FPM extraction and to confirm the ideal time of this extraction.

#### **4. Treatment choices**

In patients with missing molar, a standard treatment plan does not exist. There are essentially two orthodontic treatment approaches to manage this problem, which are space closure or reopening for prosthetic replacements, and implant or autotransplantation. Several elements guide the therapeutic decision, ranging from the patient's age to economic possibilities, not to mention the technical complexity, therapeutic predictability, and patient comfort, which determine proper compliance and therefore success.

Patients with missing molars often manifest with many underlying skeletal and dental problems and a multidisciplinary approach is recommended and depends on several factors. The amount of crowding, type of malocclusion, facial profile, age of the patient, periodontal conditions, bone volume in alveolar process, vertical or horizontal growth pattern, the number of missing teeth, and the available space should be considered in treatment plan [5]. Moreover, all the consequences that occurred after an old extraction must also be taken into account since they determine the choice of the biomechanical system.

The main advantage of the space closure resides in the fact that the whole treatment can be finished immediately after completion of orthodontics. When possible, it must be systematically preferred because better longer term outcomes can be achieved without growth-related infraocclusion, blue coloring of the gingiva, or periodontal problems as the tooth has displaced along with its supporting tissues [5]. Additionally, orthodontic space closure will reduce the financial expenses for the patient along with resolving arch crowding or anteroposterior malocclusion. Nevertheless, space closure is one of the most challenging approaches to molar extraction cases [13]. Like any treatment, this procedure presents indications and contraindications that have to be rigorously considered. For example, in hypodivergent patients, the closure of the space cannot be indicated due to the muscular and cortical anchoring, making it difficult or impossible to move the molars horizontally and to reduce the overbite [25]. Likewise, the practice of compensating and balancing the extraction of lost permanent molars along with space closing should be discussed. It aims to preserve occlusal relationships and arch symmetry within the whole dentition. A compensating extraction is the removal of a permanent molar from the opposing quadrant, while a balancing extraction signifies the extraction of a permanent molar from the opposite side of the same dental arch [9]. The long-term prognosis of the remaining permanent molars, the developmental status of the dentition including third molars as well as the underlying malocclusion were the main decision factors for or against balancing and compensating treatment [9, 13].

As regards patient age, this result is of great interest for a young adult or an adolescent by guiding the erupting teeth into a stable occlusion and can be considered a cost-effective alternative to complex restorations that require replacement over the life span [20]. Indeed, despite cessation of statural growth, vertical growth of the face permits continued teeth eruption past puberty and could adversely affect the alignment of teeth after orthodontic therapy. Facial growth in the horizontal plane is ended significantly sooner than growth in the vertical plane predominantly in patients with vertical growth patterns [26]. Accordingly, if an implant is placed before growth and eruption completion, it will become in infraocclusion, as it behaves like ankylosed teeth while the adjacent teeth continue to erupt. The magnitude of the vertical changes after age 20 seems to have little clinical importance [26].

In other words, in case of residual molar space in children, it is largely indicated to choose closure option in order to avoid all restrictions related to the periodontal



immaturity. In other cases where the extraction space is preserved in growing children, autotransplantation of the tooth is preferable to the implant option [25]. However, other parameters must be studied before deciding treatment plan.

On the other hand, in adults undergoing comprehensive orthodontic therapy, coexisting dental and periodontal problems require multidisciplinary treatment approaches to manage malocclusions often complicated by the migration of adjacent teeth into the extraction sites. Periodontal defects, multiple missing teeth, and atrophic extraction sites make it difficult to close all the extraction spaces, which require remodeling of cortical bone [11]. Also, adults show less bone apposition when moving molars into the narrowed space, poor maintenance of the closed space, and, in some cases, resorption of the second molar roots when moved in place of first molar [11]. Duration of treatment has to be considered and adapted to patient needs. For these reasons, the placement of an implant may be the treatment of choice for adults with missing molars. Be that as it may, this proposition may be in some instances valid for an adult patient whose biological and biomechanical therapeutic specificities must be kept in mind. Precise 3-D control of tooth movement during closure of extraction spaces is very important in meeting treatment goals. Second molar protraction is time-consuming and relatively difficult. Therefore, this treatment option may be justified only when the periodontal health of the protracted second molar is not compromised [24]. Protracting the molars may be advantageous for the patient by increasing alveolar ridge width that had previously been lost in the edentulous space. It should ideally be done before significant vertical bone resorption occurs [27]. In respect of orthodontic force system, bodily movement of molars can be obtained by using temporary skeletal anchorage devices and rational biomechanics [24]. Several authors have reported some useful clinical tips and tricks that surround providing this therapy [11, 13, 15, 27]: a long buccal hook, an uprighting spring, a toe-in bend in the posterior portion of the archwire with constriction, or a balancing lingual force can be used to prevent side effects such as posterior tooth tipping, mesial rotation, and buccal sweep.

Regardless of the chosen option, the fate of wisdom teeth must be assessed. The final success of the treatment depends on its satisfactory positioning [16]. So, it is important to evaluate angulation, eruption space, root developmental stage, and periodontal status of this tooth before deciding to close molar space [27]. Actually, space reopening is indicated when the wisdom tooth is absent.

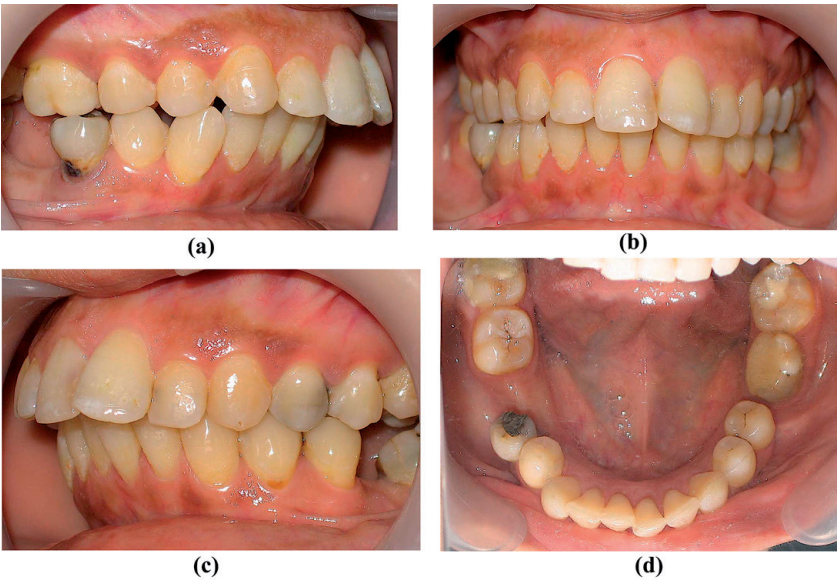
Furthermore, closure can be difficult, in the maxillary posterior area with sinus proximity, because tooth movement through the maxillary sinus is limited. The increased difficulty of moving teeth in the maxillary sinus is similar to moving a tooth in the atrophic posterior mandibular ridge. In severe cases, the pneumatization can extend completely to the alveolar bone adjacent to the gap. This not only makes it difficult to move teeth through the sinus but also to place an implant without sinus wall lifting surgery [18, 19]. Closing the space should not be chosen as the usual treatment method, as it extends the duration of the treatment without predictable results.

## **5. Clinical cases**

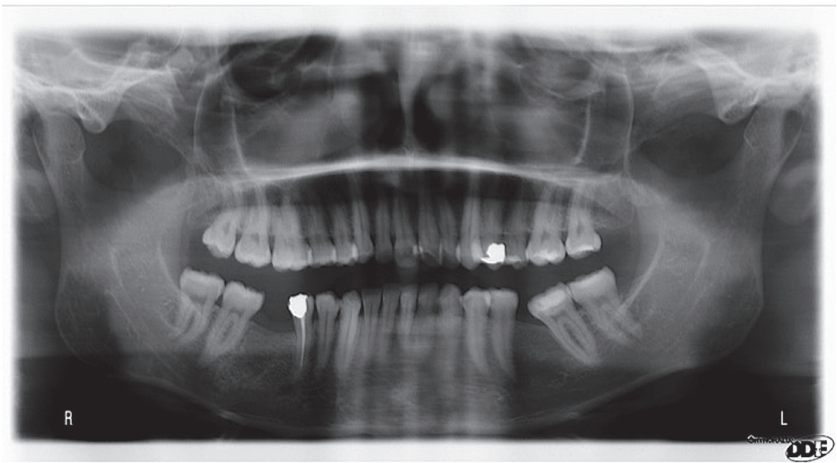
In this section, we will review some clinical cases with one or more missing molars and will justify our therapeutic choices for each situation.

### **5.1 Case presentation**

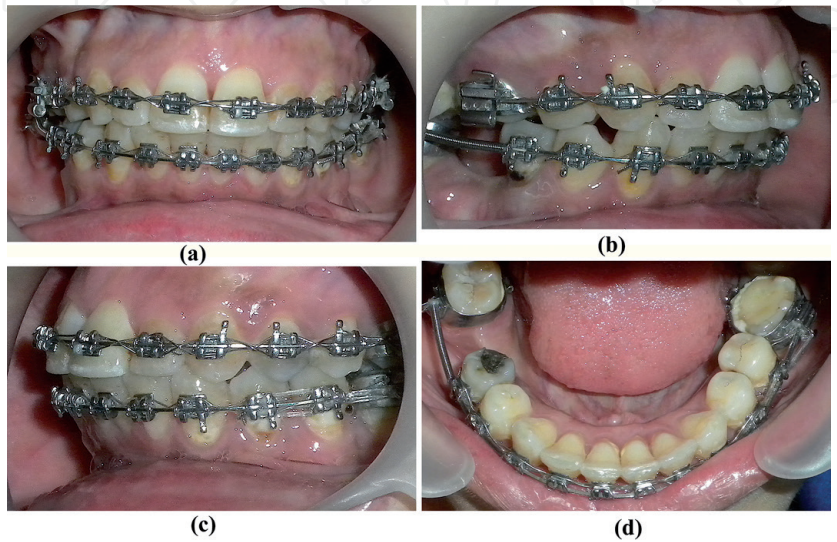
Case no. 1 (**Figures 6–9**).



**Figure 6.**  
*Pretreatment intraoral photographs of a 32-year-old woman with 36 and 46 missing. We can note mesial tipping of 37 associated to a mesiolingual rotation. The space of 36 is more closed than that of 46. (a and c) Buccal occlusion views, (b) Frontal occlusion view, (d) Occlusal view of the lower arch.*

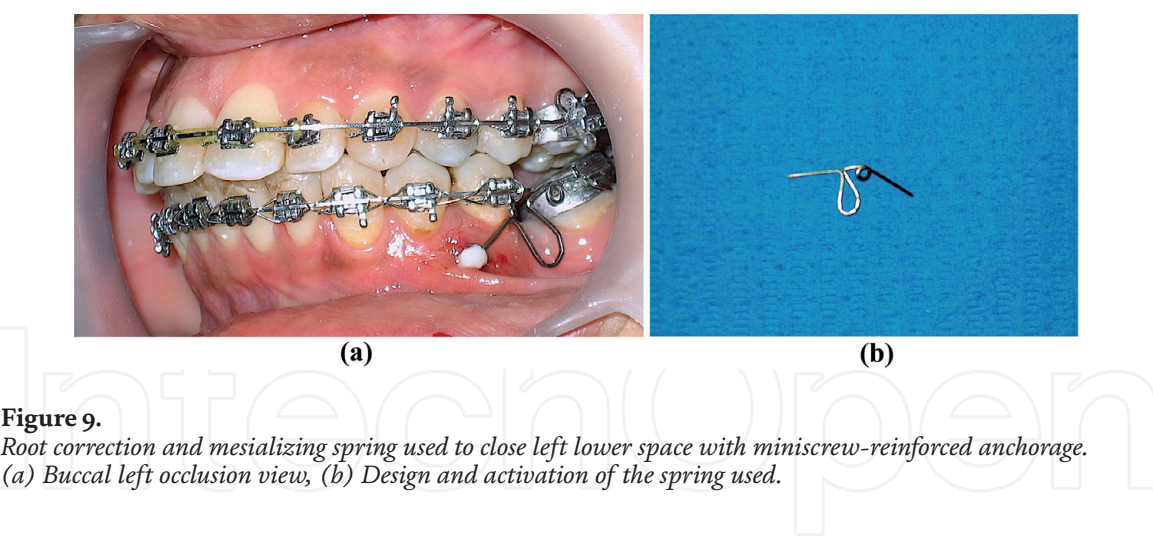


**Figure 7.**  
*Radiographic image of the mesial tipping of teeth 37 and 47, after extraction of lower FPM. Pseudo-pocket was formed adjacent to 37. Tooth 28 is absent.*

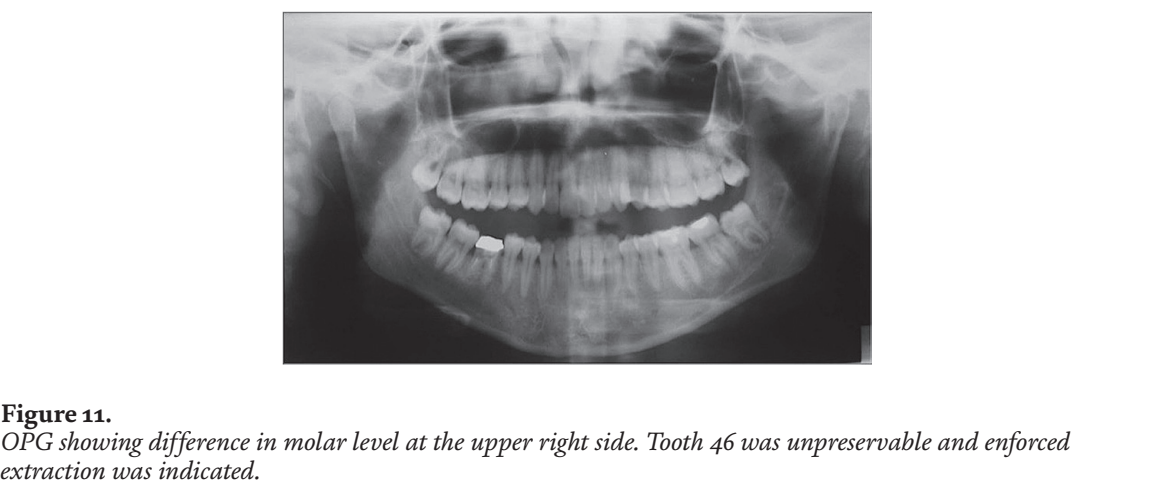
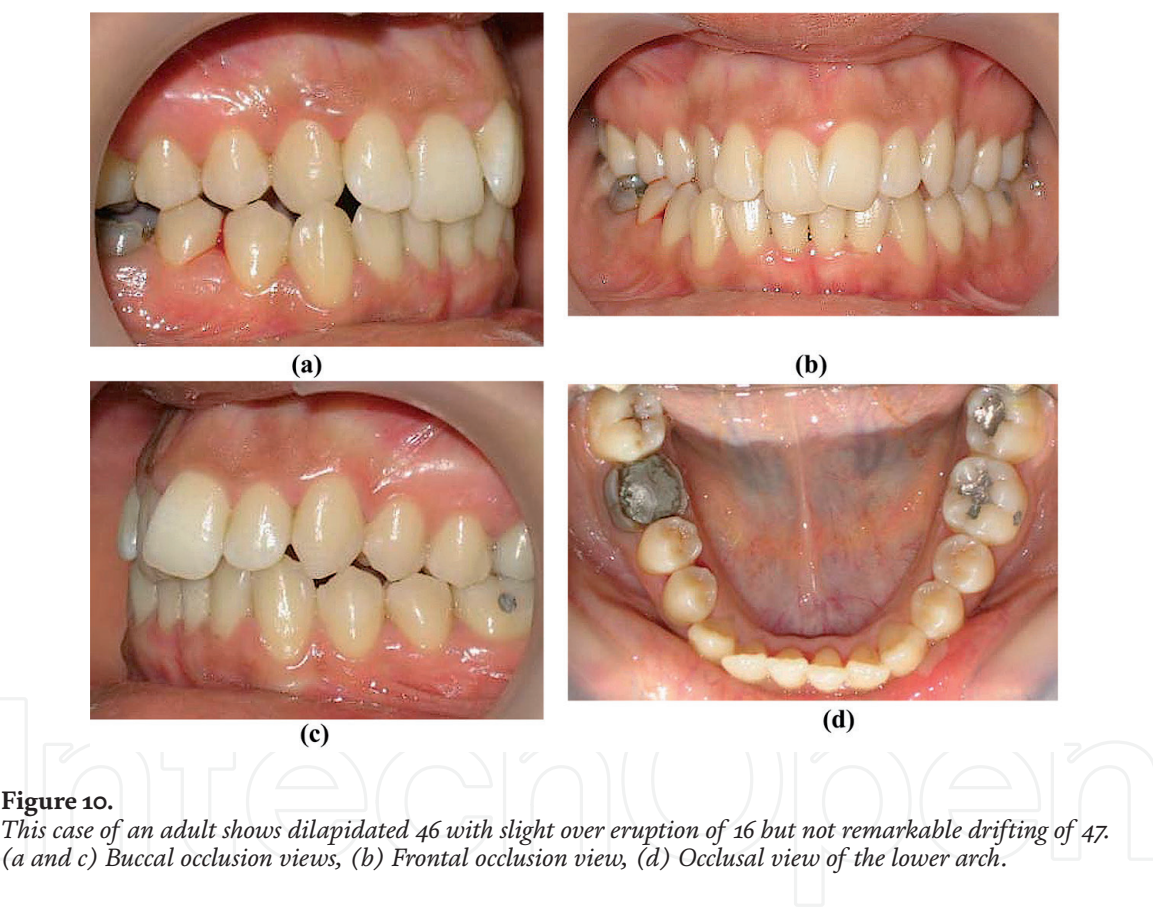


**Figure 8.**  
*Intraoral photographs of treatment progress. Extraction site of 36 was closed along with reopening of 46 space. (a) Frontal occlusion view, (b and c) Buccal occlusion views, (d) Occlusal view of the lower arch.*





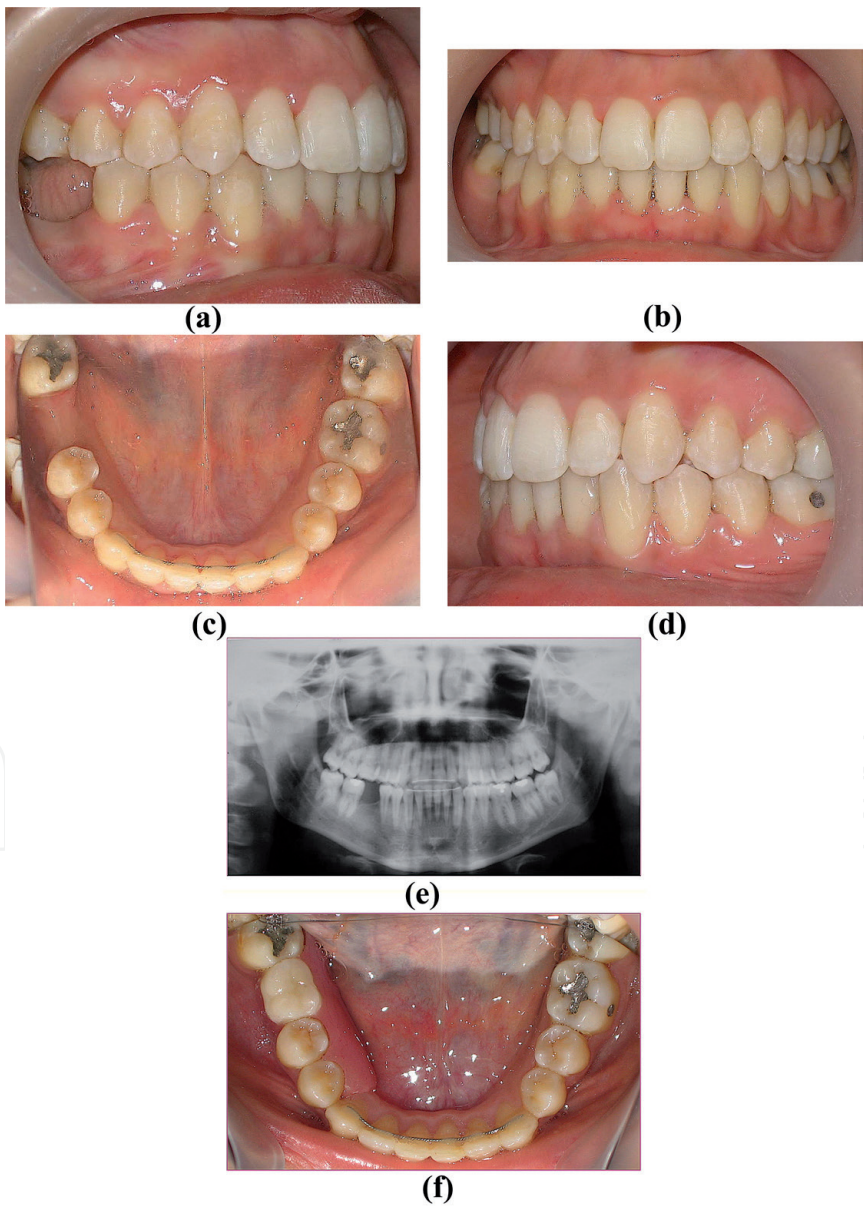
Case no. 2 (Figures 10–13).





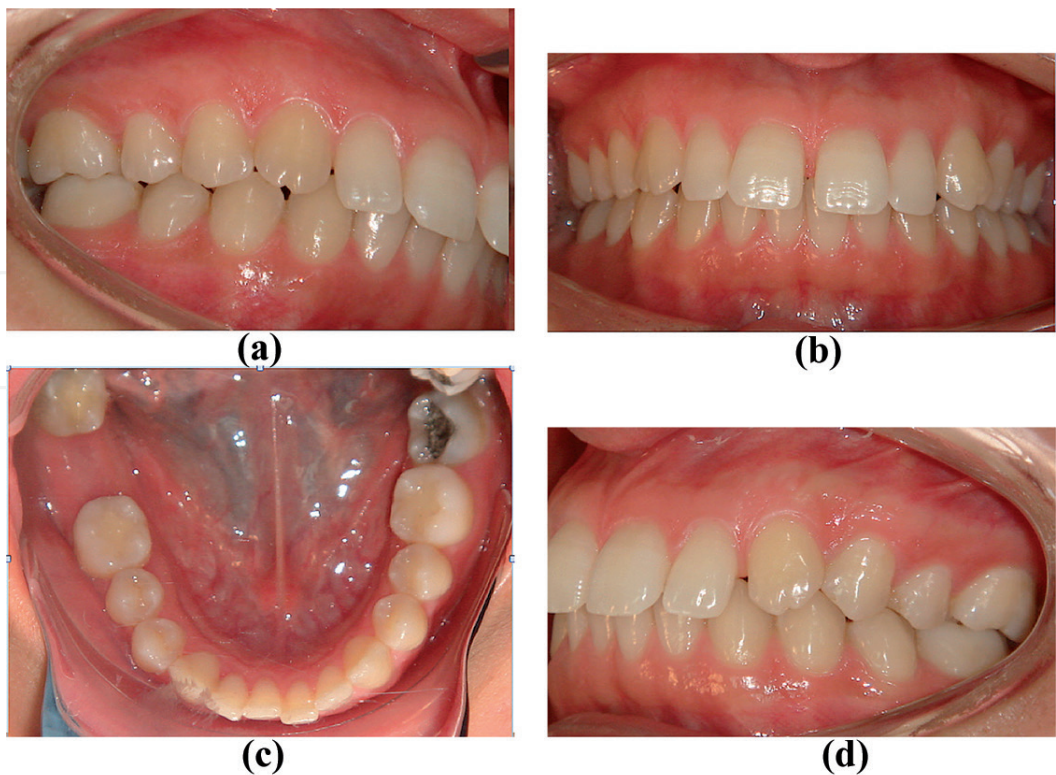


**Figure 12.**  
Orthodontic treatment was undertaken with the objective to correct the malocclusion while keeping the 46 space.

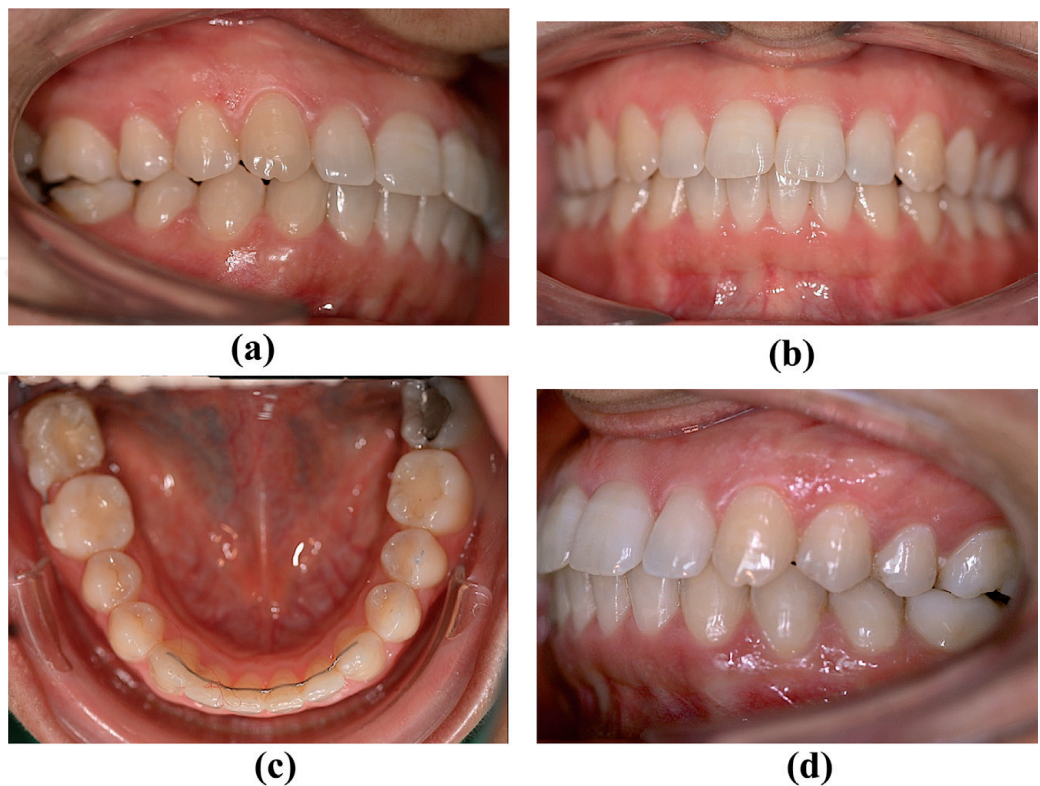


**Figure 13.**  
Posttreatment illustrations. Correction of the dentomaxillary abnormality and prosthetic restoration of missing 46. (a and d) Buccal occlusion views, (b) Frontal occlusion view, (c) Occlusal view of the lower arch, (e) OPG showing the parallelism of the root axes, (f) Occlusal view of the mandibular arch with the provisional prosthesis of 46.

Case no. 3 (Figures 14 and 15).



**Figure 14.**  
*Case of 47 extraction with large alveolar ridge and no notable migration of opposite and adjacent teeth, except for 48 that slightly drifted mesially. (a and d) Buccal occlusion views, (b) Frontal occlusion view, (c) Occlusal view of the lower arch.*



**Figure 15.**  
*Lower molar space closure was chosen. After mesializing tooth 48 in place of tooth 47, teeth 46 and 48 have been united to prevent space reopening in waiting for adaptation of periodontal ligament fibers. (a and d) Buccal occlusion views, (b) Frontal occlusion view, (c) Occlusal view of the lower arch.*



Case no. 4 (Figures 16 and 17).



**Figure 16.**  
*Case of dentoskeletal class II with absence of 16. We can observe mesial tipping and mesiopalatal rotation of 17. The width of edentulous alveolar ridge was not very narrow. (a) Frontal occlusion view, (b and c) Buccal occlusion views, (d and e) Occlusal views of the upper and lower arches.*



**Figure 17.**  
*Posttreatment intraoral photographs. Remaining space was used to correct dental class II relationship and to mesialize 17 in place of 16. In the left side, first bicuspid was extracted. Extraction of 48 was indicated to compensate upper right molars' mesializing. (a) Frontal occlusion view, (b and c) Buccal occlusion views, (d and e) Occlusal views of the upper and lower arches.*



## **5.2 Case discussion**

In all the cases presented above, the molar missing was due to dental decay. Indeed, it is the most common infectious disease worldwide [6]. According to the World Health Organization (WHO), 60–90% of school children have dental caries [6]. The molars are the most affected teeth as they evolve early.

When planning orthodontic treatment with molars missing, the patient age correlated to the amount of residual space, even apically, and the wisdom tooth condition are main decision factors described in the literature [1, 9, 16]. Patient wishes and cooperation must also be taken into account.

Case 1 concerns an adult woman who had chief complaints of upper incisors protrusion and smile asymmetry. She also wanted to resolve the residual mandibular spaces of missing 36 and 46 by the same orthodontic treatment. According to some authors [28], the ideal dimensions for the closure of the lower molars' spaces are 6 mm or less for the mesiodistal space and 7 mm for the buccolingual width. In this clinical case, the 36 space was almost closed. Furthermore, since tooth 28 was absent and tooth 18 was in functional occlusion, the treatment plan consisted of reopening the 46 space and completely closing that of 36. Also, due to mesial tipping of teeth 37, the mesializing movement was performed at the same time as the root correction using a miniscrew-supported spring. Temporary anchorage devices were indeed widely described and reported to be efficient in achieving accurate control of anchorage [15, 29] provided that the orthodontists master their biomechanics well. In case 3, as the space of lost 47 was quite large and the orthodontic abnormality not very complicated, the ideal choice was to maintain 47 space and a prosthetic rehabilitation. However, because of the absence of 18 in addition to a low economic profile of the patient, the residual space of 47 was closed at the expense of treatment duration.

In case 2 of an adult patient, all wisdom teeth have evolved and there was no need to extract to correct the anomaly. Thus, orthodontic treatment was undertaken while keeping the 46 space for a subsequent prosthetic restoration. By contrast, in case 4 that required premolars' extraction, remaining space of tooth 16 was used to mesialize 17 in place of 16 and to correct dental class II relationship with retraction of anterior teeth instead of taking out right first bicuspid.

In summary, in case of orthodontic management of molar absence, whether the residual space is closed or maintained, the control of the orthodontic movement including control of anchorage units and vertical forces as well as axial tipping and rotations is crucial to the success of the chosen therapeutic option [28].

## **6. Conclusion**

In case of missing molars, orthodontic solutions consist of either closing or opening the space. A careful case assessment must be undertaken before treatment to ensure that the benefits of treatment will outweigh any potential risk of the treatment decided upon.

Space closure remains the best choice if the suitable conditions, notably in children whose prosthetic rehabilitation is still problematic and should be postponed until the growth and eruption process is completed. In adult patients, biological and psychological characteristics must be taken into account to achieve expected outcomes.

The decision-making process depends also on other factors like concomitant malocclusions, third molar development, absence of other teeth, and patient compliance. An orthodontic treatment based on reasoned biomechanic principles will help accomplishment of initial objectives in accordance with patient expectations.

In the majority of cases, treatment is complicated by all the side effects of the uncompensated absence of molars. Management is sometimes a veritable challenge. Hence, the prevention and early multidisciplinary management are of major importance.

### **Conflict of interest**

The authors declare that they have no conflict of interest.

### **Author details**

Hakima Aghoutan\*, Sanaa Alami, Amal El Aouame and Farid El Quars  
Department of Orthodontics and Dentofacial Orthopedics, Faculty of Medical  
Dentistry, Hassan II University, Casablanca, Morocco

\*Address all correspondence to: [hakimaaghoutan.2014@gmail.com](mailto:hakimaaghoutan.2014@gmail.com)

### **IntechOpen**

© 2019 The Author(s). Licensee IntechOpen. This chapter is distributed under the terms of the Creative Commons Attribution License (<http://creativecommons.org/licenses/by/3.0>), which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited. 

## References

- [1] Gupta M, Panda S, Mutawwam FA, Kariri FMM. Diagnosis and management of a patient with congenitally missing maxillary first permanent molars: A rare case report. *Case Reports in Dentistry*. 2016;**2016**: 3-5. DOI: 10.1155/2016/5891705
- [2] American Dental Association (ADA). Tooth eruption—The permanent teeth. *Journal of the American Dental Association*. 2006;**137**:2006. DOI: 10.14219/JADA.ARCHIVE.2006.0031
- [3] Abe R, Endo T, Shimooka S. Maxillary first molar agenesis and other dental anomalies. *The Angle Orthodontist*. 2010;**80**:1002-1009. DOI: 10.2319/020210-69.1
- [4] Bondemark L, Tsiopa J. Prevalence of ectopic eruption, impaction, retention and agenesis of the permanent second molar. *The Angle Orthodontist*. 2007;**77**:773-778. DOI: 10.2319/072506-306.1
- [5] Jamilian A, Darnahal A, Nucci L, D'Apuzzo F, Perillo L. Treatment considerations for missing teeth. In: Kivanç BH, editor. *Dental Anatomy*. Rijeka: Intech; 2018. pp. 109-120. DOI: 10.5772/intechopen.69543
- [6] Saber AM, Altoukhi DH, Horaib MF, El-Housseiny AA, Alamoudi NM, Sabbagh HJ. Consequences of early extraction of compromised first permanent molar: A systematic review. *BMC Oral Health*. 2018;**18**:1-15. DOI: 10.1186/s12903-018-0516-4
- [7] Williams JK, Gowans AJ. Hypomineralised first permanent molars and the orthodontist. *European Journal of Paediatric Dentistry*. 2003;**4**:129-132
- [8] Rai A, Singh A, Menon I, Singh J, Rai V, Aswal GS. Molar incisor hypomineralization: Prevalence and risk factors among 7-9 years old school children in Muradnagar, Ghaziabad. *The Open Dentistry Journal*. 2018;**12**:714-722. DOI: 10.2174/1745017901814010714
- [9] Cobourne MT, Williams A, Harrison M. National clinical guidelines for the extraction of first permanent molars in children. *British Dental Journal*. 2014;**217**:643-648. DOI: 10.1038/sj.bdj.2014.1053
- [10] Eichenberger M, Erb J, Zwahlen M, Schätzle M. The timing of extraction of non-restorable first permanent molars: A systematic review. *European Journal of Paediatric Dentistry*. 2015;**16**: 272-278
- [11] Saga AY, Maruo IT, Maruo H, Guariza Filho O, Camargo ES, Tanaka OM. Treatment of an adult with several missing teeth and atrophic old mandibular first molar extraction sites. *American Journal of Orthodontics and Dentofacial Orthopedics*. 2011;**140**: 869-878. DOI: 10.1016/j.ajodo.2010.06.027
- [12] Yüksel S, Üçem T. The effect of tooth agenesis on dentofacial structures. *European Journal of Orthodontics*. 1997;**19**:71-78. DOI: 10.1093/ejo/19.1.71
- [13] Sandy JR, Hons BDS, Atkinson R. For four sixes. *American Journal of Orthodontics and Dentofacial Orthopedics*. 2000;**117**:418-434. DOI: 10.1177/00220345420210051101
- [14] Thilander B. Orthodontic space closure versus implant placement in subjects with missing teeth. *Journal of Oral Rehabilitation*. 2008;**35**:64-71. DOI: 10.1111/j.1365-2842.2007.01826.x
- [15] Baik UB, Chun YS, Jung MH, Sugawara J. Protraction of mandibular second and third molars into missing first molar spaces for a patient with an anterior open bite and anterior spacing. *American Journal of Orthodontics and*



- Dentofacial Orthopedics. 2012;**141**:783-795. DOI: 10.1016/j.ajodo.2010.07.031
- [16] Bassigny F. What to do in case of a dilapidated or already extracted first molar? Justification for orthodontic option. *Revue d'Odonto-Stomatologie*. 2008;**37**:135-148
- [17] Zhao L, Wei Y, Xu T, Zhang B, Hu W, Chung K-H. Changes in alveolar process dimensions following extraction of molars with advanced periodontal disease: A clinical pilot study. *Clinical Oral Implants Research*. 2019;**30**:324-335. DOI: 10.1111/clr.13418
- [18] Cavalcanti MC, Guirado TE, Sapata VM, Costa C, Pannuti CM, Jung RE, et al. Maxillary sinus floor pneumatization and alveolar ridge resorption after tooth loss: A cross-sectional study. *Brazilian Oral Research*. 2018;**32**:e64. DOI: 10.1590/1807-3107BOR-2018.vol32.0064
- [19] Oh H, Herchold K, Hannon S, Heetland K, Ashraf G, Nguyen V, et al. Orthodontic tooth movement through the maxillary sinus in an adult with multiple missing teeth. *American Journal of Orthodontics and Dentofacial Orthopedics*. 2014;**146**:493-505. DOI: <https://doi.org/10.1016/j.ajodo.2014.03.025>
- [20] Teo TKY, Ashley PF, Parekh S, Noar J. The evaluation of spontaneous space closure after the extraction of first permanent molars. *European Archives of Paediatric Dentistry*. 2013;**14**:207-212. DOI: 10.1007/s40368-013-0042-7
- [21] Teo TKY, Ashley PF, Derrick D. Lower first permanent molars: Developing better predictors of spontaneous space closure. *European Journal of Orthodontics*. 2016;**38**:90-95. DOI: 10.1093/ejo/cjv029
- [22] Sebbar M, Bourzgui F. Predictive factors of third molar eruption. *Revue de Stomatologie et de Chirurgie Maxillo-Faciale*. 2011;**112**:263-268. DOI: 10.1016/j.stomax.2011.05.003
- [23] Baik UB, Kook YA, Bayomec M, Park JU, Park JH. Vertical eruption patterns of impacted mandibular third molars after the mesialization of second molars using miniscrews. *The Angle Orthodontist*. 2016;**86**:565-570. DOI: 10.2319/061415-399.1
- [24] Baik UB, Choi HB, Kim YJ, Lee DY, Sugawara J, Nanda R. Change in alveolar bone level of mandibular second and third molars after second molar protraction into missing first molar or second premolar space. *European Journal of Orthodontics*. 2019:1-6. DOI: 10.1093/ejo/cjz001
- [25] Sayagh M, Maniere-Ezvan A, Vernet C, Muller-Bolla M. Décisions thérapeutiques en présence de premières molaires permanentes délabrées chez les sujets jeunes: Enquête descriptive. *International Orthodontics*. 2012;**10**:318-336. DOI: 10.1016/j.ortho.2012.06.001
- [26] Fudalej P, Kokich VG, Leroux B. Determining the cessation of vertical growth of the craniofacial structures to facilitate placement of single-tooth implants. *American Journal of Orthodontics and Dentofacial Orthopedics*. 2007;**131**:59-67. DOI: 10.1016/j.ajodo.2006.07.022
- [27] Baik UB, Kim MR, Yoon KH, Kook YA, Park JH. Orthodontic uprighting of a horizontally impacted third molar and protraction of mandibular second and third molars into the missing first molar space for a patient with posterior crossbites. *American Journal of Orthodontics and Dentofacial Orthopedics*. 2017;**151**:572-582. DOI: 10.1016/j.ajodo.2016.01.019
- [28] Raveli TB, Shintcovsk RL, Knop LAH, Sampaio LP, Raveli DB. Orthodontic replacement of lost permanent molar with neighbor molar:

A six-year follow-up. Case Reports  
in Dentistry. 2017;**2017**:1-9. DOI:  
10.1155/2017/4206435

[29] Raveli TB, Raveli DB, De Mathias  
Almeida KC, Pinto ADS. Molar  
uprighting: A considerable and  
safe decision to avoid prosthetic  
treatment. The Open Dentistry  
Journal. 2017;**11**:466-475. DOI:  
10.2174/1874210601711010466