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Chapter

Prosthetic Management of Tooth Malposition

Yosra Gassara, Rim Kallala, Emna Boudabous, Ines Azouzi and Zohra Nouira

Abstract

Tooth malposition can negatively affect the appearance of a person's smile. In these cases, it is essential to conduct a comprehensive clinical and radiological examination to determine the type and extent of the tooth malposition before selecting the appropriate treatment option. Orthodontic treatment is generally used to correct mild to severe malocclusions. In cases where the tooth malposition is associated with other dental issues such as tooth discoloration, ceramic restorations may be a suitable alternative.

Keywords: dental veneers, dental crowns, dental bridges, tooth malposition, malocclusion

1. Introduction

Tooth malposition may impair the esthetic smile. In these cases, it is essential to conduct a comprehensive clinical and radiological examination to determine the type and extent of the tooth malposition before selecting the appropriate treatment option.

After cephalometric analysis, orthodontic treatment, with or without orthognathic surgery is considered to be the conventional approach for correcting mild to severe malocclusions. The orthodontic treatment has several disadvantages. First, according to Fink DF, the duration of an orthodontic treatment is from 19.4 to 27.9 months [1]. This long period does not encourage patients for the surgical- orthodontic correction. Second, relapse after orthodontic treatment is frequent, it has been attributed to tongue posture, treatment parameters, growth pattern, and surgical fragment instability. In addition to that, linked to orthodontic intervention, numerous local effects with manifestation on dento-maxillary structures are described, as enamel demineralization and discoloration, root resorption, and gingivitis [2].

All of these factors lead patients to find another treatment modality and have inspired clinicians to opt for ceramic prosthesis to correct malocclusion. This restorative approach is commonly referred to as "Instant Orthodontics" or "Two appointment orthodontics" [2, 3].

Prosthetic management of tooth malposition involves the use of dental prostheses, such as dental bridges, crowns, and veneers, to correct the appearance and function of misaligned teeth. The treatment approach will depend on the severity and cause of the tooth malposition.

For mild to moderate cases of tooth malposition, dental veneers can be used to improve the appearance of the affected teeth. Veneers are thin, custom-made shells that are placed over the front surface of the teeth to conceal any cosmetic imperfections, such as tooth discoloration, cracks, or minor misalignments.

For more severe cases, dental crowns or bridges may be necessary. Dental crowns are used to cover damaged or discolored teeth, while dental bridges can replace missing teeth. The prostheses can be designed to correct the alignment of the teeth, which can improve the overall appearance and function of the patient's mouth [3].

Orthodontic treatment may also be necessary to correct severe tooth malposition, and the use of dental prostheses may be combined with orthodontic treatment to achieve optimal results.

The practitioner should evaluate the position of teeth and gum, discuss the various available treatment, and recommend to the patient the best option to achieve an esthetic outcome [4].

This chapter aims to describe different types of teeth malposition: Misalignments, open bite, crossbite, and deep bite. We include a discussion of preparation and possible prosthetic solutions for the correction of mispositioned anterior teeth.

2. Ethical concerns regarding restorative correction of mispositioned teeth

The correction of mispositioned teeth using fixed prosthesis presents significant clinical as well as ethical quandaries. According to the American Dental Association Principles of Ethics and Code of Professional Conduct, the clinician should respect some principles when treating misaligned teeth restoratively.

Five fundamental principles form the foundation of the American Dental Association Code: patient autonomy, non-maleficence, beneficence, justice, and veracity.

Respecting these principles, the dentist should choose the more conservative method following the “therapeutic gradient” (**Figure 1**) and exhibit the pros and cons of every possible treatment approach.

The decision to restore an anterior tooth with crown or veneer depends on some criteria. These criteria should be considered when evaluating a patient for esthetic rehabilitation: thorough medical and dental histories, clinical photographs, study casts, periapical and panoramic radiographs, the diagnostic wax-up/mock-up, as well as, the use of a planning technique like the digital smile design (DSD).

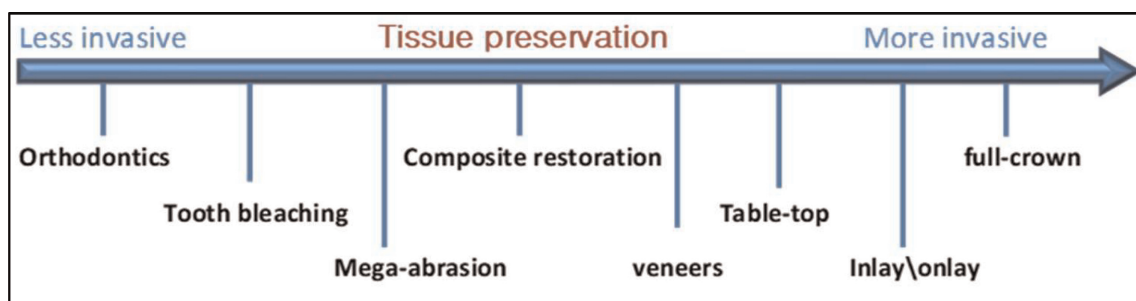


Figure 1.
Therapeutic gradient for tooth malposition.

3. Clinical examination

A comprehensive evaluation of the patient before initiation of any esthetic rehabilitation is important to establish a treatment plan. For the long-term success of any treatment, a detailed analysis of the patient involving medical/dental history and clinical examination includes assessment of oral soft tissues and dental hard tissues [5]:

- Pernicious habits
- Hereditary syndromes which feature hypoparathyroidism
- Dietary habits
- Present and future restorative and oral care
- Previous dental visits and treatments, past dental problems, previous conditions, and patient responses to procedures

After the entire medical and dental history is complete, extraoral examination is performed involving:

- Facial contours
- Facial symmetry
- Lip position at rest and smile
- Midline axis
- Temporomandibular joint
- Muscle tension
- Mastication

After that, a detailed clinical evaluation of all determinants of the mouth such as periodontal condition, dental hard tissues, oral soft tissue, occlusion, and esthetic analysis is done.

Anterior restoration must be esthetically pleasing for patients, functional, and biocompatible with the soft tissue.

Following points should be evaluated in esthetic rehabilitation [6–9]:

- Gingival levels
- Gingival embrasure
- Gingival recession
- Periodontal pockets

- Plaque and calculus
- Mobility of a tooth
- Tooth-tooth relationship
- Tooth-gingival relationship
- Caries lesions
- Defective restorations
- Tooth defects such as erosion, abrasion, and attrition.
- Overjet
- Overbite
- Amount and localization of the diastema
- Maxillary and mandibular relationship
- The midline
- Smile line
- Shape, size, and color of teeth
- Relationship of teeth with the lips and face of the patients on the esthetic reconstruction area.

4. Esthetic planning project

4.1 Wax mock-up

Prosthetic treatment aims to use a minimally invasive approach to improve the appearance of the smile.

The wax-up\ mock-up binomial is a guide for restorative dentists and for laboratory technicians to get the best esthetic, phonetic, and functional outcome with preservation of maximum dental tissue [10].

The diagnostic cast should be waxed referring to the important elements for an esthetic smile design: tooth dimension, axial inclination, gingival level, teeth alignment, tooth-tooth relationship, embrasures and gingival architecture [11].

In addition to that, a color-coded wax-up (**Figure 2**) can be used for easy identification of zones that need reduction and areas that require addition of materials. This color code facilitates the quantification of removed dental tissue or of the thickness of ceramic to be added. If they are minimal, porcelain laminate veneers must be the first option when planning for an indirect restoration for the esthetic sector. According to Jacopo Castelnovo, [12] to enhance and standardize the predictability of such

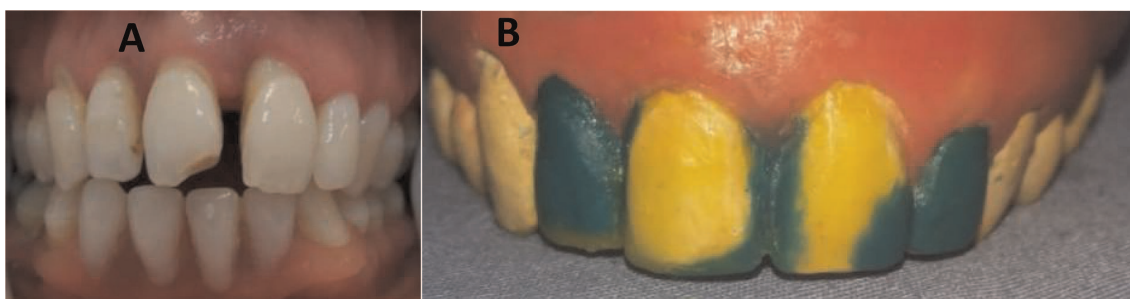


Figure 2.
Color-coded wax-up.

restorations, a minimum 50% of tooth preparation should be in enamel. Therefore, before starting the preparation, the practitioner can make the right decision with a color-coded wax-up.

A: Initial case, B: The yellow wax corresponds to areas which necessitate dental tissue removal, green areas correspond to the additional thickness needed in this situation: interface between silicone matrix and wax showing the amount of removal.

The wax-up should be tried in the patient's mouth with a resin mock-up in order to validate the prosthetic project.

4.2 Esthetic virtual planning project

To achieve esthetic and functional harmony, the prosthesis should be similar to the mock-up. The adaptation of the prosthesis, shape, size, and color of the new elements in relation with the soft tissue and the whole face are very important in the decision-making.

A large number of errors can occur at the various stages of the traditional prosthetic treatment. Each stage requires a transfer of two-dimensional and three-dimensional (3D) data between operators [13].

Thus, contemporary digital technologies may provide advantageous features to help in this diagnostic treatment step, assisting clinician in visualizing and measuring dentogingival discrepancies, as well as allowing patients to previsualize the therapy planning.

DSD is based on a clear extraoral and intraoral photographic protocol, which is necessary for the esthetic analysis of some specific elements [14]:

- Facial analysis.
- Dentofacial analysis.
- Dentolabial analysis (incisal edge position, smile line, buccal corridor).
- Dentogingival analysis.
- Dental analysis (inter- and intra-tooth relationships).

All data are arranged in a slideshow by means of general presentation software (Keynote for Apple users; PowerPoint for PC users) or dedicated software (e.g. Digital Smile System, DSS) that allow a digital previsualization of the final smile.

In addition to that, DSD may aid to making decision between restoring anterior teeth with porcelain veneers or all-ceramic crowns. In situations of tooth malposition, DSD helps us to quantify the amount of the modifications needed on every single tooth to obtain an anterior sector in harmony with the patient's dentition. [14]

This approach allows to measure the residual enamel tissue after tooth preparation, if an important quantity is eliminated and the dentin is exposed, bonding will be compromised and porcelain veneers will not be indicated.

Today with the evolution of software and digital dentistry, the esthetic virtual planning project is essential before starting any prosthetic treatment.

This project is made by using patient photographs and basic image processing software to carry out the analysis and propose ideal and appropriate esthetic designs in the form of a virtual wax-up with precise shapes and measurements that can be transcribed into a physical wax-up.

Thanks to the validated virtual planning, a model of the future project will then be produced in order to materialize the final treatment before any irreversible gesture. It will be a key communication tool between the patient and the various treatment stakeholders.

Some software like Exocad smile creator make it possible to create a virtual wax-up using the optical impression of the dental arches with more possibilities of individualization to finally obtain a 3D design of the virtual project. This virtual wax-up can help the practitioner to choose the appropriate prosthetic decision by evaluating the amount of dental tissue to be removed. If this quantity is minimal, the malposition can be corrected by veneers. If the preparation will be important, the indication of full coverage crowns will be necessary.

5. Misalignments \ crowding or dental malposition

Malocclusions are often caused by multiple misaligned teeth due to rotation, labial and lingual tipping [15–17]. The evaluation of the level of malocclusion is mainly subjective and so it may be assessed as minor, mild, moderate, or severe [2]. Many classifications of teeth crowding have been reported in the literature such as the malalignment Index of Van Kirk and Pennel (1959) which presents three scores: 0, 1, and 2 depending on the grading of the tooth displacement and rotation [15].

Score 0: Ideal alignment: absence of any apparent deviation from the ideal arch line (**Figure 3**).

Score 1: Minor malalignment that includes two types:

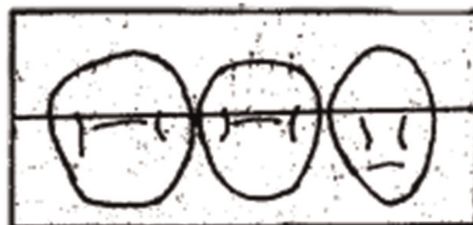


Figure 3.
Ideal alignment.

- Minor malalignment due to rotation: the angle between the line projected through the contact areas of misaligned tooth and the ideal alignment is less than 45° (**Figure 4**).
- Minor malalignment due to displacement: both contact areas of misaligned tooth are moved less than 1.5 mm in the same direction from their ideal position (**Figure 5**).

Score 2: Major malalignment that includes two types:

- Major malalignment due to rotation: the angle between the line projected through the contact areas of misaligned tooth and the ideal alignment is 45° or larger (**Figure 6**).
- Major malalignment due to displacement: both contact areas of misaligned tooth are moved by 1.5 mm or more from their ideal position (**Figure 7**).

Distinguishing between minor and major misalignments can be made using wax casts. So, the correct alignment of the incisal margins will be waxed up, and the ideal placement of the anterior teeth will be identified [16]. Due to the length of treatment

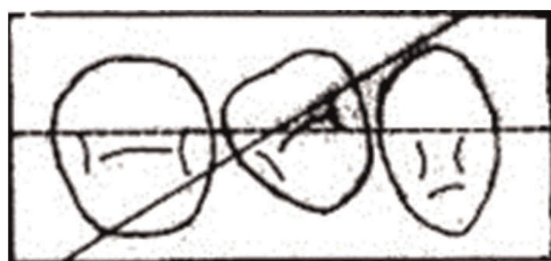


Figure 4.
Rotation: Less than 45 degrees.

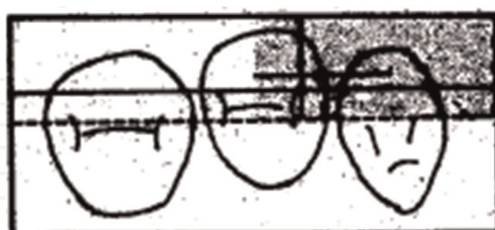


Figure 5.
Displacement: Less than 1.5 millimeters.



Figure 6.
Rotation: More than 45 degrees.



Figure 7.
Displacement: More than 1.5 millimeters.



Figure 8.
Minor malalignment.

duration and the high perceived costs of transparent aligners and orthodontic therapy, using porcelain veneers to correct minor misalignment issues (**Figure 8**) can be an optimal choice.

Additionally, if the incisors are positioned lingually to the arch, it may only be necessary to slightly reduce their incisal edges in order to create a new point of contact for the porcelain veneers to correct crowding incisors. So, no-preparation porcelain veneers are more readily accepted by patients, particularly those having dental phobia or objecting to have their tooth structure removed [18].

When opting for porcelain veneers, removed tooth structure's amount will be diminished. Preservation of the enamel tissue is crucial when reconstructing teeth with porcelain veneers for a number of reasons including the elastic modulus of the enamel, which is stiffer than that of feldspathic ceramic and prevents ceramic fracture by absorbing stress. Additionally, the shear bond strength has become more significant and bonding predictability and success have enhanced when there was more present enamel [12].

Consequently, restoring an esthetic smile with ceramic crowns in cases of severe misalignment may result in the creation of teeth with pleasing inherent proportions to one another as well as a pleasant tooth arrangement that is in harmony with the patient's gingiva, lips, and face [19].

Full crowns are more appropriate when crowding of the teeth is accompanied by other anomalies such dental anomalies of structure, form, or color (**Figure 9**).

6. Open bite

In order to ensure long-term stability, a rigorous diagnosis is necessary for anterior open bite (AOB) which is a vertical malocclusion of the anterior teeth occurring when the posterior teeth are in occlusion. Some authors claim that the term

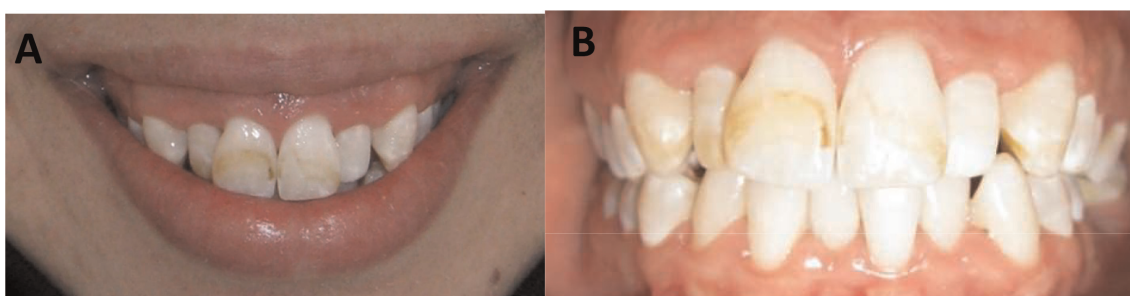


Figure 9.
Teeth crowding associated with fluorosis. A: Patient's smile, B: Front view.

“open bite” can refer to incisal end-to-end contact as well as situations where there is no incisive contact. The anterior open bite is influenced by a number of factors, including variations in dental eruption or alveolar growth, inordinate neuromuscular growth, and aberrant neuromuscular function because of tongue dysfunction or oral habits [20].

Treatment for this malocclusion is challenging and demands long-term retention. Among the two types of open bite (skeletal and dental open bite), only the open bite of dental origin can be restored by prosthetic rehabilitation [21, 22].

In cases with open bite occlusion, feldspathic veneers may be assumed as a conservative therapy to offer a satisfactory smile. Given the cohesive strength of feldspathic ceramic, Mc Lean has suggested limiting the amount of unsupported ceramic to 2.0 mm to minimize cohesive ceramic fracture. According to Castelnuovo et al., when utilizing a leucite reinforced ceramic like IPS-Empress, the amount of unsupported incisal ceramic can be increased by up to 4.0 mm [19]. The diagnostic wax-up is used to determine how much ceramic should be added to fix an open bite. Some parameters should be taken into consideration, including tooth size, axial inclination, gingival level, tooth-tooth relationships, embrasures, and gingival architecture [20].

If the amount of unsupported incisal ceramic is less than or equal to 4.0 mm, ceramic veneers may be recommended. Instead, zirconia-based crowns may be used when there is more than 4.0 mm of unsupported incisal ceramic because of their superior esthetics and high stress resistance [11].

However, in some cases of severe open bite, complete restoration of the open bite would result in longer incisors than the tooth length recorded by G.V. Black [23]. In order to lessen the dark space between the maxillary and mandibular anterior teeth and enhance esthetics, a partial correction of the open bite will be planned.

7. Crossbite

Anterior crossbite is characterized by an abnormal labiolingual relationship between one or more maxillary and mandibular incisors affecting function and esthetics. In some clinical situations, a fixed prosthesis may be used in place of orthodontic repositioning [24, 25].

Porcelain veneers are contraindicated for the restoration of cross-bited teeth as they can be fractured and debonded due to the excessive stress [26]. A more aggressive approach to tooth preparation and full coverage crowns are required to address this malocclusion.



Figure 10.
Anterior crossbite.

Changes in the proprioception of the teeth and lips must be taken into account when treating an anterior crossbite (**Figure 10**). Enough alveolar bone is necessary to support the new tooth position in an anterior crossbite. Since the strains are reversed, the alveolar bone and periodontal ligament will realign to the new stresses [27].

8. Deep bite

Deep bite is one of the most challenging malocclusions to treat successfully. According to Bishara, a deep bite is a malocclusion in which the maxillary incisors excessively overlap the mandibular incisor crowns vertically when the teeth are in centric occlusion [28]. Lack of inter-occlusal space, soft tissue trauma, and tooth wear are among the complications that are caused by the deep overbite. As a result, restorative management may be necessary and could involve extending the occlusal vertical dimension with fixed restorations. To create prostheses with the appropriate functional and occlusal context, careful assessment and treatment planning are, therefore, imperative.

Study models should be articulated on a semi-adjustable articulator in order to plan treatment. Models' articulation makes it easier to evaluate occlusal interactions and can aid in figuring out how much more OVD is required to provide the conceivable treatment. Dentate patients tolerate well OVD changes. The limitations of this approach have been identified by a number of authors, who demonstrated that most therapies may be delivered with increments of between 1 and 3 mm. The diagnostic wax-up with elevated OVD can aid in treatment planning. To safeguard weaker teeth, the occlusal morphology of anterior restorations must be carefully studied, and the proper wax-up guidance should be produced [20].

9. The choices of prosthetic restorations types

9.1 Dental veneers

Dental Veneers present the most conservative prosthetic solution dealing with minor tooth malposition. Once the preparation is performed in the enamel tissue, this therapeutic option should be preferred by the clinician.

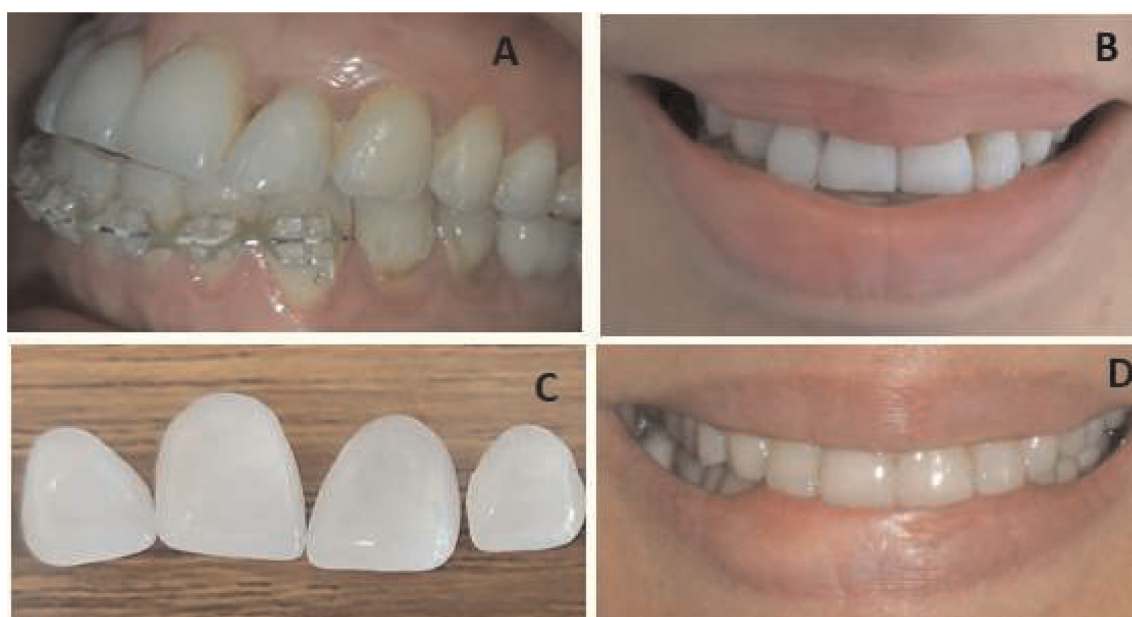


Figure 11.
Clinical situation treated by dental veneers; a: Initial situation showing the anterior gap; B: Initial smile; C: Lithium disilicate ceramic veneers fabricated using chairside CAD/CAM; D: Final outcome with a corrected open bite.

The present clinical situation (**Figure 11**) is about a young patient who has already benefited from orthodontic treatment for 4 years. She is not satisfied with the result. She consulted for the correction of a persistent slight gap.

Once the needed preparation was not necessary, four lithium disilicate ceramic veneers were indicated to establish a correct open bite while optimizing the teeth shape and color.

9.2 Full coverage crowns

In some situation where the Dental Veneers cannot be indicated to correct the tooth malposition, full coverage crowns seem to be the most suitable solution.

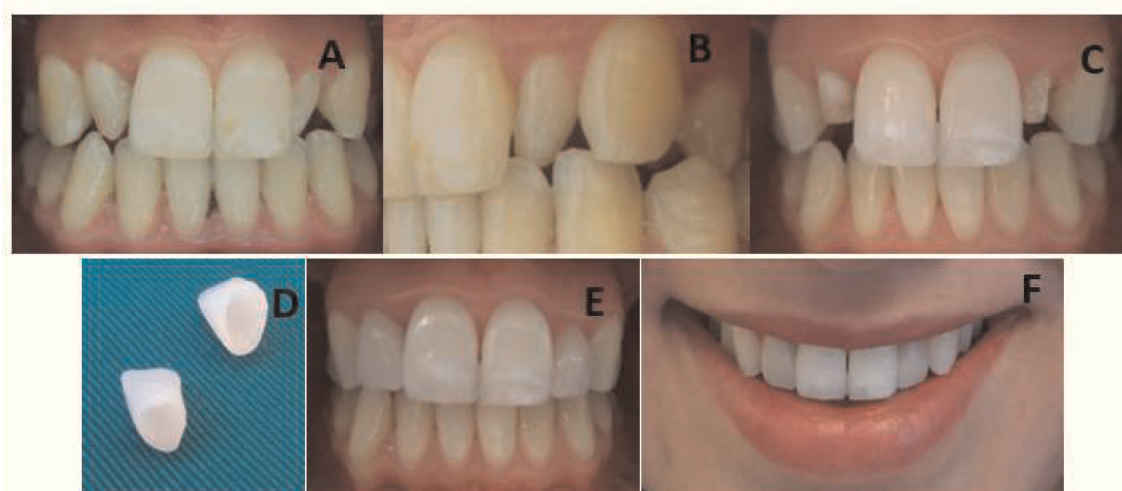


Figure 12.
Clinical situation treated by full coverage crowns; a: Initial situation showing peg-shaped lateral incisors; B: Lateral incisors were in palatal position; C: Prepared teeth; D: Ceramic crowns; E: Final result; F: Final smile.

Clinical situation			Crown	Veneer	Orthodontic treatment
Tooth malposition	Crowding teeth	Score 1	×	×	×
		Score 2	×		×
	Open bite	Minor open bite		×	×
		Severe open bite	×		×
	Crossbite		×		×
	Deep bite		×	×	×

Table 1.
Management of tooth malposition.

The present clinical situation is about a young female patient who asked to regain her smile, judged unsightly, because of peg-shaped maxillary lateral incisors (**Figure 12**). These teeth were, also, in palatal position. After a deep clinical examination, it was decided to perform two IPS e.max CAD crowns.

9.3 What is the suitable prosthetic solution for tooth malposition?

Variable prosthetic solutions are available to manage the tooth malposition.

On the one hand, veneers are the most conservative solution mainly indicated for intact teeth with very slight malposition in order to preserve the enamel tissue necessary for the bonding. Therefore, with the advances in dental ceramics and adhesive systems, porcelain veneers are considered as a much more conservative treatment in terms of preparation, they give satisfactory and lasting esthetic results and they have shown a very important survival rate [14, 29]. Edelhoff and Sorensen measured, with a gravimetric analysis, the amount of tooth structure removed during different preparation designs for many types of prostheses. They showed that tooth preparation for porcelain laminate veneers required approximately one-quarter to one-half the amount of tooth reduction of conventional full coverage crowns [30].

On the other hand, full coverage restorations could be, in some situations, a suitable solution for the management of tooth malposition, as they offer the best solutions in terms of esthetic result, durability, and biocompatibility [29]. But, this type of restoration involves the sacrifice of significant quantities of mineralized dental tissue and cannot be undertaken before the maturation of the periodontal tissues.

Many factors have to be taken into consideration: A deep medical and dental histories, clinical photographs, study casts, periapical and panorama radiographs, the diagnostic wax-up/mock-up, as well as, the use of a planning technique like the digital smile design (DSD).

Table 1 summarizes different solutions managing tooth malposition taking into consideration the open bite, crossbite and deep bite (**Table 1**).

10. Conclusion

The anterior tooth malposition is a frequent chief complaint. The orthodontic treatment is considered as the ideal treatment for those situations. Nevertheless, prosthetic management could be indicated such as dental veneers and full coverage

crowns. The most suitable prosthetic solution has to be well raised taking into consideration variable factors to ensure both patient satisfaction and the longevity of this restoration.

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Conflict of interest

The authors declare no conflicts of interest.

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