RECOMMENDATIONS FOR THE POSITIONING AND THE ESTHETICO-FUNCTIONAL REHABILITATION OF THE RIZIFORM MAXILLARY LATERAL INCISORS

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Abstract

In this article, we aimed to elaborate a universal clinical multidisciplinary protocol in order to facilitate the management of the peg-shaped maxillary lateral incisors, via a case of two upper lateral incisors affected by microdontia. A meticulous clinical analysis, wax up and mock up are crucial to ensure optimal rehabilitation.

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DATA AVAIBILITY STATEMENT

The data that support the findings of this study are available from the corresponding author upon reasonable request.

DISCLOSURE

The authors declare no conflict of interest.

ABSTRACT

The peg-shaped maxillary lateral incisors cause functional and esthetic imbalance in the patient's mouth. Depending on the clinical situation, several therapeutic solutions can be considered. Their management can be long and complex (orthodontics, periodontal surgery, coronary restoration etc). However, no article, to our knowledge, suggests a protocol of management to simplify the rehabilitation of the lateral maxillary riziform incisors.

Objective: To elaborate a universal clinical protocol in order to facilitate the management of these lateral incisors for practitioners (orthodontists, general practitioners).

Clinical considerations: a case of two upper lateral incisors affected by microdontia restored by using an orthodontic treatment, a veneer and a direct composite resin restoration.

Conclusions: An exobuccal, endobuccal and smile clinical analysis is crucial to ensure optimal rehabilitation. In addition, wax up and mock up play a key role in the communication between practitioner and patient. They allow the validation of the therapeutic decision by the patient, the general practitioner, and the orthodontist but they also facilitate orthodontic movements.

KEY CLINICAL MESSAGE

A good inter-disciplinary communication and a meticulous clinical analysis are very important to ensure the best rehabilitation of the peg-shaped maxillary lateral incisors. Wax up and mock up play a key in the validation of the therapeutic decision.

INTRODUCTION

The smile is one of the most important components of perception and self-perception of people. It directly influences the facial expression and physical attractiveness of individuals (1). In contemporary dental practice, patient-driven esthetic diagnosis and treatment planning force clinicians to focus on the smile zone, which is directly from the patient's perspective(2). Improper anterior spacing can cause diastemas and thus it could be considered as unesthetic by lay people (3,4). It can be caused by microdontia, a genetic condition in which the teeth are abnormally small. This anomaly can be localized or generalized. One of the most common forms of localized microdontia is that which affects the maxillary lateral incisors, called a "peg lateral". A peg-shaped incisor has a marked reduction in diameter, extending from the cervical region to the incisal edge (5).

The prevalence of peg-shaped upper lateral incisors was reported to be higher than the prevalence of other morphological variations of permanent teeth. Agenesis or size or shape anomalies of maxillary lateral incisors are quite common, with a prevalence of 1,6% to 4,9% and can be either unilaterally or bilaterally on the left or right side of the jaw with a higher incidence on the left side of the incisors (6). Yet, women have 1.35 more chance of having peg-shaped maxillary permanent lateral incisors when compared to men. Simultaneous presence of both upper lateral incisors is a rare case (7).

Treatment choices for lateral peg-shaped incisors are various, however for any esthetic rehabilitation, it is necessary to follow a medical framework respecting the tissue economy and combining the biological, functional, and esthetic imperatives which are inseparable.

Treatment options for peg shaped laterals could be: no treatment, orthodontic treatment first (to align the teeth in the arch), direct composite bonding onto peg laterals, indirect composite placement, bonded crowns or veneers, or even metal crowns (8), extractions and implant placement, or a combination of treatments.

Orthodontics is the first esthetic therapy in the gradient and the most conservative. Most of the time the patient presents a maxillary default : a dento-dental disharmony resulting in an anterior Bolton index greater than 77.2% +/- 0.22 (9). An ill-considered closure of the spaces would lead to anterior buttock. In addition to the esthetic appearance of the reconstructed laterals, the lateral teeth are then overhung, and a functional anterior guide is ensured after prior placement of the canines in Angle Class I. Several therapeutic solutions can be envisaged depending on the associated anomalies: extractions, closing of spaces with the consequences associated with dento-dental disharmony, or morphological rehabilitation of these teeth to ensure the establishment of ideal inter-archal relationships.

In this case, the definitive mesio-distal diameter and final vertical positioning of these teeth must be determined at the beginning of the ODF treatment. In order to facilitate active orthodontic treatment (both for the bonding of an attachment to this tooth and for its future pre-prosthetic design), the peg-shaped lateral incisor should be provisionally reconstructed according to the described esthetic criteria (shape, mesio-distal diameter, color in relation to the adjacent teeth) prior to the placement of any appliances. This provisional restoration can be improved and readjusted during orthodontic treatment. However, the intra- and/or interarch clinical situation does not always allow it in case of maxillary anterior crowding with overlaps, dental rotation, linguo-version of the incisal block reducing the arch perimeter and consequently the spaces devoted to the lateral riziform incisor. The orthodontic treatment will, under these conditions, have to start aligning and levelling the maxillary arch, in particular, in order to meet the above-mentioned requirement.

The lack of clear best practices in the scientific literature encouraged us to establish a protocol to facilitate the therapeutic decision with the general practitioner, the orthodontist and the patient, and ultimately to guarantee the therapeutic solution best suited to the clinical situation. The patient is often referred to the general practitioner once the orthodontic treatment has been completed. This lack of coordination between disciplines represents a real loss of opportunity for patients. In this article we aim to clearly establish the different considerations to be evaluated and the steps to follow, once orthodontic treatment is started, to ensure best possible rehabilitation for the patient.

DEFINING THE TREATMENT OBJECTIVES

Before any therapeutic decision, the 3 main objectives of the bio-esthetic-functional triad must be defined between practitioners but also with the patient in order to establish an adequate treatment plan (table 1). A healthy periodontium guarantees an esthetic integration of the reconstitution (10,11) and an adapted morphology allows to restore a correct phonation etc (12).

The clinical analysis of the patient begins with the exobuccal environment of the tooth, then the endobuccal environment to finally lead to the analysis of the tooth concerned.

The exobuccal analysis will not be dealt with in its entirety in this article, although it is important in bio-esthetic-functional dental rehabilitation. It is therefore necessary for the practitioner to evaluate 1) the dimension of the 3 levels of the face (including the vertical esthetic and occlusal dimensions), 2) the maxillary labial protrusion as well as the naso-labial angle, 3) the orientation of the horizontal lines of the face, and 4) the position of the chin.

In parallel, the practitioner evaluates the 5) phonation and 6) the 3 smiles (without the appearance of teeth, social and spontaneous) of the patient (13,14).

STUDY AND ANALYSIS OF THE CLINICAL SITUATION

A) Exo-oral environment: the smile

The smile represents a real importance in everyone's social interactions. It influences physical, social and intellectual attraction (15), hence the efforts of practitioners to ensure a harmonious smile. Several variables must be evaluated in a smile before reconstructing a maxillary anterior tooth (Table 2). The study of the smile can be carried out either dynamically (video) or statically (photography) (16).

B) Analysis of the endobuccal environment of the tooth (image 1)

a) Periodontium

As we said previously, the periodontium has all its importance in esthetics (17) but also in the bio-functional integration of the reconstitution (10,11). According to the state of periodontal health, the therapeutic decision can vary. In addition, for esthetic reasons (18), the position of the gingival edges of the maxillary anterior teeth can be brought to be modified by gingival or osteo-gingival plasties (19,20).

Adjacent teeth

Teeth color: Determining the color of the lateral incisors can be complex due to the high saturation of the adjacent canine teeth and the generally less saturated central one. Some teeth may have peculiarities such as white stains from fluorosis or brown stains from a molar incisor hypomineralization (MIH) (21). It should be noted whether the patient wishes these particularities to be reproduced on the future reconstitution or removed in advance.

Tooth size : The literature is not unanimous on this subject. The golden ratio (width/height) of 62% does not seem to be the most esthetic ratio (22) for lay people. Indeed, patients seem to prefer maxillary lateral incisors with a ratio of 67% or 72% (23,24). According to German et al. 2016, the mesio-distal diameter of a maxillary lateral incisor is 2mm less wide than that of the maxillary central incisor (25).

Positions of the teeth : A smile is considered esthetic if the maxillary central incisal edge is at the same level as the maxillary canine edge (26) and if the maxillary lateral incisal edge is between 0.5 and 1.5 mm more coronal than the central one (6,8,27).

c) Occlusion (static and dynamic)

The evaluation of the anterior guidance as well as the occlusal contacts in terms of dynamics and statics is necessary in order to select the type of restoration and thus ensure its durability (28).

C) Position of the tooth in the mouth

Once the analysis of the exo- and endo oral environment is completed, we begin the analysis of the tooth in the mouth: evaluating 1) its position in the transverse, vertical and antero-posterior direction. This crucial step tells us if the position of the lateral incisor is correctly positioned for a future bio-esthetic-functional reconstitution; 2) the characteristics of the tooth: depending on the amount of remaining dental tissue (quantity of enamel, dentine exposure, quality of pulpal vitality) and its color, the therapeutic decision may vary (making a crown instead of a veneer, prior lightening may be necessary etc).

Once this global analysis is done, a virtual project can be elaborated in order to make a wax up of the future rehabilitation.

DIGITAL SMILE DESIGN (DSD) AND WAX UP : DETERMINING THE LATERAL IN-CISORS DIMENSIONS (image 2)

This step must be done during the orthodontic phase, at the stage of the last finishes. Using the DSD, we can determine the ideal dimensions of the future restoration (height and width), its morphology and gingival margin. The DSD also allows us to determine if modifications to other anterior teeth are necessary.

When the DSD is validated by the practitioner and the patient, it will be communicated to the orthodontist in order to guide him/her in the position of the anterior teeth. In order to facilitate the movement of the riziform tooth, the DSD can be transformed into a wax up and then mock up if the situation permits (29,30). In our clinical case the DSD was not performed because it would not provided us with any additional information.

Determining the positioning of the tooth concerned

This step plays a key role in our protocol. Determining the ideal position of the tooth and its placement will allow us to preserve the dental tissue to the maximum extent possible and guarantee optimal durability of the restoration.

The goal is to provide sufficient space for a veneer or direct composite resin restoration. In order to avoid parasitic movements on the other teeth, the rehabilitation of the riziform tooth with the mock up facilitates this positioning step.

Transversal direction

Sufficient space must be maintained for the restoration (0.5 mm for veneers and 1.5 to 2 mm for the direct technique) (27). The mesial (M) and distal (D) spaces must be evenly distributed to better mimic the tooth tissue (same amount of Enamel/Dentin in M and D). To achieve this, the tooth must be positioned in the middle of its space. In cases of dental disharmony with persistent anterior space, we recommend either a diastema distal to the lateral (studies show that this is the least unsightly location in a smile) (3,31) or a diastema distal to the canine. In general, diastema is considered unsightly by the general population (26).

Vertical direction

Within the framework of a rehabilitation with a facet, a palatal covering can be performed (32,33). Depending on the patient's occlusion, an anterior overlap of -2 to 0 mm may then be indicated in order to avoid excessive preparation of the incisal edge of the riziform tooth. In addition, the taller the tooth, the lower the width/height ratio will be and the more esthetic the tooth will be (23,24,34). This notion is to be taken into account if the space of the riziform tooth is too large and therefore requires an increase in its M-D diameter. According to the situation, to avoid any periodontal surgery, we recommend to take advantage of the orthodontic treatment in order to harmoniously position the gingival edges (35).

Antero-posterior direction

Since an additional thickness will be added to the vestibular of the riziform tooth, we recommend placing the tooth in question in the palatal area and thus avoiding an alignment of the incisal edge with the other teeth in order to limit dental preparations.

The fact of absolutely wanting to close the space between the teeth can lead to a tooth that is too square (especially in the case of dento-dental disharmony) (34). If the M-D space is too large, either the diameter of the adjacent teeth can be increased or the incisivo-canine block can be receded. If these solutions prove to be unattractive or dysfunctional, a 1 mm canine advance (thus having a light canine class II) to close more of the D-space of the riziform tooth, without disturbing the anterior guidance can be done.

MOCK UP (image 3)

Temporary removal of the concerned tooth bracket and mock up

In order to validate the position of the tooth as well as the prosthetic project, a mock up should be put in place. The bracket is first removed from the concerned tooth, followed by the placement of a silicone tray in the mouth.

Validation of the mock up

The mock up must be validated by the general practitioner, the orthodontist and the patient.

Re-bonding the bracket on the mockup of the concerned tooth and orthodontic finishes

Then, an attachment on the mock up resin is put in place in order to achieve the orthodontic finishes. At this stage, the temporary restoration can be modified as needed to facilitate orthodontic movements.

REMOVAL OF THE ORTHODONTIC APPLIANCE AND CONTENTION

If the coronary reconstruction appointment with the general practitioner does not take place on the day of the removal of the orthodontic appliance, then we recommend the installation of a transformed thermoformed resin tray in order to avoid parasitic movements.

RECONSTRUCTION OF THE CONCERNED TOOTH (images 4-6)

Depending on the results of the clinical situation analysis, the reconstruction of the riziform tooth can then begin. The mock up previously placed can either be used as a reduction guide (if the practitioner and the patient opt for a veneer) (36), or the mock up can be used to make a palatal key for the direct composite resin restoration. Figure 1 summarizes the various steps of our protocol implemented in our clinical case.

DISCUSSION

The interest of a multidisciplinary care is to limit the dental biological cost: the riziform tooth has a reduced dental support, the orthodontic treatment and the analysis of the situation beforehand make it possible to limit to the maximum the dental preparations, but also to limit the periodontal biological cost, since the orthodontic treatment can in certain cases avoid an useless periodontal surgery (35). We are however aware that the realization of an impression on a multi-attach appliance makes the reading of the plaster models difficult. Moreover, it is important to note that the notion of "beautiful smile" remains a subjective notion depending on each individual. A study has shown that the appreciation of a smile varies according to the age of the evaluator. Older people are less fussy about black triangles than younger people, as is the uncovering of teeth by the lips when smiling (18). Some studies show an inter-sex difference on the judgment of a smile, women seem more critical than men (37) while other studies show that there are no inter-sex differences, especially concerning the appreciation of the mesio-distal diameter of the maxillary lateral incisors (38). In addition, overall, orthodontists seem more critical (39) towards a smile than a general practitioner. And people in the general population seem less critical than a general practitioner (24,40). However, in another study, the notion of "smile arc" seems to be evaluated identically between orthodontists, general practitioners and the general population (41). For this, from an esthetic point of view, it is important to focus more on the patient's appreciation than on our own personal appreciation as a practitioner, and to take into account the differences in inter-individual appreciation (sex, age, origin, etc) and especially to clearly define the objectives of the protocol. The most conservative approach to correcting tooth shape is direct resin composite bonding because it can be achieved without removal of tooth structure. Recent esthetic composite resin materials have similar physical and mechanical properties to that of the natural tooth and possess an appearance like natural dentin and enamel. They offer an expanded range of shades and varying opacities designed specifically for layering technique whereas early brands of composite resins offered only "body" shades and appeared dull and dense. Treatment is usually completed in one appointment. In addition, direct resin composite bonding treatment is less expensive compared with ceramic veneers. In this case, we decided to set up a veneer on the left lateral because of its shape and the high inter-proximal space to fill, and to establish a direct resin composite on the right lateral because of the low inter-proximal space. If a veneer was set up, it would have led to unnecessary deterioration of the enamel.

Adhesive ceramic veneers constitute a minimally invasive therapeutic approach and are able to replace defective natural enamel with a more or less dandruff ceramic facet. This conservative technique, is very suitable to treat many clinical situations while preserving the vitality of the teeth. However the diagnosis and the indication have to be well defined, and the protocol has to be strictly followed.

DSD and mock up play a crucial role in our protocol. Not only do they facilitate the orthodontic finishing process (determination of the position of the tooth concerned, provision of a better bonding surface for the bracket), but they also guarantee an optimal final result and help with the preparation of the tooth (36). In our clinical situation, the M-D diameter of the laterals was within the norm compared to the MD diameters of the centrals, therefore the DSD provided little additional information. It is of particular interest in the case of severe dental dysmorphoses that result in excessively high MD diameters of the laterals, which inevitably lead to diastemas.

Furthermore, no study has dealt with the unsightly appearance of a diastema between a canine and maxillary first premolar in comparison with a diastema between a lateral incisor and maxillary canine. Despite the efforts made to limit diastema, in some situations diastema is unfortunately unavoidable, which can make the patient's smile look unsightly (26). Several indices have been developed to determine the ideal mesio-distal diameters of the 6 maxillary anterior teeth, such as the Mavroskousfis index, which states that the sum of the mesio-distal diameters of the 6 maxillary anterior teeth is equal to the inter-alar distance + 7mm. The Lee index states that the mesio-distal diameter of the maxillary central incisor is equal to one quarter of the inter-canal mesio-distal diameters is 44.6mm. If we applied the Mavroskousfis index, this would result in an overly palatal position of the maxillary sector and consequently a sub-nasal profile in retro-position. The Lee index was not applicable in our clinical case because the diameter of the central incisor was 8.2mm and the quarter of the inter-alar distance is 11.2mm. For these reasons, we therefore applied the rule of German et

al. cited above.

CONCLUSION

The prevalence of riziform maxillary laterals is relatively high in the general population, however no clear multidisciplinary protocol has been defined so far. Our idea was to merge general dentistry with orthodontics in order to really bring a multidisciplinary management of riziform teeth in order to guarantee an optimal final result for the patient.

AUTHORS CONTRIBUTION

NO: involved in the study conception and design, material preparation, prosthodontic treatment of patient, and wrote most of the manuscript; SF: involved in orthodontic treatment of patient; BV: involved in criticizing the content of the manuscript; JB: contributed in writing a part of the manuscript and did the final review.

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| Biological objectives | -respecting the remaining dental structures by being as conservative as possible (42) -preservation of the biological space after rehabilitation (11) |
|------------------------|--|
| Functionnal objectives | -restauring a functionnal anterior guide -ensuring food incision -ensuring an intelligible phonation (12,43) |
| Esthetical objectives | -harmonious integration of the restauration in the patient's smile -respecting the color and position, of the peg-shaped teeth and their periodontium. |

52. Tjan AH, Miller GD, The JG. Some esthetic factors in a smile. J Prosthet Dent. janv 1984;51(1):24-8. TABLES 1 and 2

 $Table \ 1: \ The \ bio-esthetic-functional \ triad$

| Buccal corridor | -an intermediate buccal corridor is considered as most esthetica narrow buccal corridor is considered as more esthetic than a wide buccal corridor (higher than 16% (13,44,45). |
|---|---|
| Maxillary central incisors width/height ratio and assymetry | -the esthetic ratio width/height of the central maxillary incisor varies between 75 and 85% (26). -a smile is considered as unesthetic if the central incisons have accurately incised advant (4). |
| Midline and tooth angulation | -a midline deviation greater than 2mm is considered as unesthetic (46) -an angulation greater than 3.5° is notable to lavpeople (47) |
| Gingival exposure | -according to various studies, a smile is considered as unesthetic if the gingival margin exposure exceeds 2 to 3 mm (30.48) |
| Gingival margin | -gingival margin difference between the central incisors and the maxillary canines varies between 0 and 1mm(49)lateral incisors have a gingival margin of 0 5mm balaw the central incisor (50) |
| Smile arc | -depends on the vertical positioning of the maxillary incisorsa smile is considered as esthetic if the incisal edges of the maxillary incisors are below the cuspid tip of the capinos (41.51) |
| Lips and teeth positionning | -voluminous lips are considered as most esthetic (26) -maxillary incisal edges must touch the lower vermilion of the lip (52). |
| Tooth color and anatomical shape | (see text above) |
| Anterosuperior teeth ratio | (see text above) |
| Diastema | (see text above) |

Table 2 Smile characteristics

FIGURE 1



Figure 1 Interdisciplinary coordination for restoring lateral peg-shaped upper lateral incisors IMAGES 1 to 6



Image 1 Initial case : The MD diameters of the the right lateral incisor, right central incisor, the left central incisor and the left lateral incisor are respectively: is 6.0mm, 8.2mm, 8.2mm, 4.5mm. The MD width of the right lateral incisor is 6.7mm and of the left lateral incisor 6.5mm.



Image 2 Wax Up showing that there is no diastemas between the anterior maxillary teeth.



Image 3 Mock Up validate by the patient, the orthodontist and the general practitioner



 ${\it Image~4~Conservative~tooth~preparation~for~ceramic~veneer}$



Image 5 Direct composite resin restoration



Image 6 Final result : direct composite resin restoration (right lateral incisor) and ceramic veneer (left lateral incisor)

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Tableaux 1 et 2 .docx available at https://authorea.com/users/420271/articles/526633-recommendations-for-the-positioning-and-the-esthetico-functional-rehabilitation-of-the-riziform-maxillary-lateral-incisors