A Novel Etiology-Based Smile Classification with Relevance to Upper Lip Position During Smiling: A Literature Review.

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Abstract

Objectives; The perfect attractive smile is considered one of the most imperative demands. Patients currently seek dental treatment to enhance esthetics rather than function. An ideal smile is composed of the integration between the lips, teeth and gingivae. **Data;** The etiology of the gummy smile is known for commonly having multifactorial causes. It can be attributed to alterations of soft and/or hard tissue as well as to the dentoalveolar morphology. The diagnostic key for an unattractive smile is the position and support of the upper lip since the lip follows what lies beneath. **Sources & study selection;** A literature search was performed using the Cochrane library and PubMed databases from 1960 to 2021, and a novel classification system for different Duchene smiles is proposed based on the upper lip position, with a clinical application for every class in case the patient is unsatisfied with this smile. **Conclusions;** In this novel etiology-based smile classification class I & II smile categories reveal maxillary teeth only during smiling, while in class III & IV smiles there is excessive gingival display upon smiling, with the upper lip supported by the alveolar ridge without maxillary bony excess, whereas class V and VI smiles demonstrate excessive gingival display upon smiling with the upper lip supported by the alveolar ridge but with maxillary bony excess. Finally, class VII smile is observed when the upper lip is supported by the alveolar ridge with vertical maxillary bony excess and with normal height of the clinical crowns. **Clinical relevance;** It is important for any clinician to perform a correct diagnosis for the smile to offer the best treatment plan for each case.

Key words: Duchenne smile, smile classification, upper lip, etiology.

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Introduction

A beautiful smile is the entrance to the world, and over the years, smile esthetics has gained its worth. Nowadays, the main goal of every esthetic dental treatment is gaining a beautiful ideal smile since it has great impact on apparent self-confidence and internal satisfaction [1]. Since smile is considered a part of facial esthetics, macro esthetics, micro esthetics and gingival esthetics, it was suggested that an entire patient analysis is essential for creating an admirable smile. Adjustments in teeth, surrounding tissues and even the smile itself may be needed after evaluating and understanding the global facial esthetics to create the ideal esthetic smile [2]. The essentials of an esthetic smile involve the harmonious integration between three primary components; lips, teeth and gingival framework [3-6]. Ideally, during smiling the upper lip should reach the gingival margins, with an upward or straight curve between the commissures and philtrum along with an upper incisal line coinciding with the border of the lower lip with minimal lateral negative space [7]. All together with an occlusal frontal plane parallel to the pupillary line. Hence, the components of a balanced smile were declared to be; upper lip length, vertical maxillary excess, the lip line, lip elevation, smile arc, upper lip curvature, smile symmetry, dental components crown height, lateral negative space, frontal occlusal plane and gingival components [8, 9].

The aim of the current review was to offer a novel etiology-based smile classification according to the upper lip position upon smiling, with a suggested treatment option.

Search strategy

A literature search was performed by two researchers (S.N. and G.N), using the Cochrane central and PubMed database from 1960 to March 2021, with the following search strategy: (“smile” OR “Duchenne smile” OR “gummy smile” OR “excessive gingival display”) AND (“classification” OR “upper lip”) AND (“‘etiology”’ OR “treatment”). The search was limited to the English language and 226 papers were retrieved.

Current Standards for Smiles Classifications

Although smile is a very frequent facial expression, but not all smiles are alike. There are two recognized forms of smiles; the posed or social smile and the Duchene, also called the enjoyment smile [10]. The posed social smile is voluntary, unstrained, not provoked by an emotion and only involves moderate muscle contraction. It can be sustained and is consistently reproducible. While the Duchene enjoyment smile is involuntary being a natural response to emotions of delightfulness and joy [4, 10]. It is unsustainable and causes full expansion of the lips as a result of maximum

muscle contraction causing gingival display [1, 11, 12].

Rubin [13] was the first to introduce smile classification according to soft-tissue determinants of the dynamic display zone. He classified the smile into three main styles; the commissure smile, the cuspid smile and the complex smile. The cuspid smile; where the teeth and gingival scaffold are seen as a result of the action of all elevators muscles of the upper lip raising it as a window shade. The complex or the full denture smile; where both the elevators of the upper lip raise it like a window shade and the depressors of the lower lip depress it like a window displaying more teeth and more gingival display. Lastly, the Mona Lisa or commissure smile; where zygomaticus major muscles, draw the outer commissures outward and upward, followed by a gradual elevation of the upper lip. Patients with Mona Lisa or commissure smiles have the tendency to display less teeth and gingival structure [1, 4, 14]. Later, Tjan et al. [15] classified the smile line into three categories according to the dentogingival visibility. The high smile; where the full length of the incisors is shown with some amount of gingival display. An average smile; with 75–100% of the upper incisors and interdental papillae are seen. The low smile line; where less than 75% of the maxillary incisors are displayed upon full smile. The authors also suggested another category including the excessive gingival exposure. Besides, they showed that the low smile line was more predominant in men (2.5:1), whereas the high smile line is more common in women (2:1).

Furthermore, Philips [16] proposed that all smiles pass through a smile cycle with four stages, starting with; Stage I where the lips are still closed, then Stage II showing resting display, followed by Stage III showing natural smile (three-quarters) and finally stage IV displaying the expanded full smile. He also claimed that there are five variations of smiles where dental and/or periodontal tissues are being displayed in the smile zone. These include; Type 1 displaying maxillary teeth only, Type 2 displaying maxillary and over 3 mm gingiva, Type 3 displaying mandibular teeth only, Type 4 displaying maxillary and mandibular teeth and finally Type 5 displaying neither maxillary nor mandibular teeth.

Furthermore, Yun et al. [17] reviewed the etiology-oriented treatment modalities for gummy smile. They stated that the etiology of gummy smile is multifactorial and depends on the soft and/or hard tissue alteration which could be attributed to skeletal, dentoalveolar morphology and neuromuscular causes. The primary etiology of the skeletal type of gummy smile is vertical maxillary excess (VME), while the dentoalveolar type of gummy smile could be due to a deep bite, gingival overgrowth and altered passive eruption, whereas the neuromuscular gummy smile could be due to

short or hyperactive upper lip. Thus, it is crucial for the clinician to reach a correct diagnosis in order to offer the optimum treatment for each case. More recently, Mercado-García et al. [18] presented a classification of gummy smile and how to treat it via hyaluronic acid alone.

The perception of excessive amount of gingival display is highly subjective, varying among genders as well as between professionals and laypeople [19-23]. Nevertheless, it is generally acceptable that ≥4 mm of gingival display is unattractive and is commonly referred to as a "gummy smile" [24]. Recently, it has been shown that laypeople perceive gingival display in a different way than orthodontists. Whereas some chose zero mm gingival exposure as the best smile, others stated that having 1 mm gingival exposure as the best smile and even some felt that less than 1 mm covering parts of the central incisors as the best smile. Therefore, it is important for the public to have a role in the decision-making process of treatment planning [25].

The individual's perception of beauty is very subjective, that's why creation of an ideal smile seem to be complex and changeable from one person to another, where one could see their smile pleasant, other could see it esthetically unpleasant [26]. To the best of the authors knowledge, the current literature lacks a precise classification for various smiles taking into consideration the etiology and clinical management of each case. Therefore, the present research proposes a novel etiology-based smile classification with relevance to the upper lip position during smiling. The classification is also clinically-oriented including a comprehensive treatment-based approach.

A Novel Smile Classification according to Upper Lip Position

The three essential components forming an ideal smile are the lips, teeth and gingiva. The key for diagnosing an unesthetic smile depends on the upper lip position, supported either with maxillary teeth and ridge or ridge only. In other words, the lip follows what lies beneath [27]. Since the upper lip position and its underlying support play a vital role in creating the final maximum smile, the authors propose a novel classification system for different Duchene smiles based on the upper lip position, with a therapeutic approach for every class in case the patient is unsatisfied with this smile.

For accurate diagnosis of gummy smile, proper understanding of tooth eruption and morphology is required. Teeth eruption consists of an active eruption stage; where the tooth emerges into the oral cavity and a passive eruption stage, which is the apical migration of the supporting structure covering the tooth crown. Failure of complete passive eruption phase occurs when the gingiva fails to apically migrate toward the CEJ leading to a short, square-looking clinical crown which is a

condition termed "altered passive eruption" [28]. In such cases, the distance between the gingival margin and cemento-enamel junction (CEJ) is greater than 1.5 mm, indicating an excessive gingival tissue covering the tooth crown [29, 30]. Nevertheless, short teeth (<9 mm) may be due to other causes than excessive gingival display, such as incisal edge wear or attrition and should be differentiated by the normal average length of the crown [31, 32]. Hence, to confirm the presence of a short clinical crown, further evaluation of the crown length-height relation must be done. The maxillary central incisor's width should be about 80% of its length, with an accepted range of variation within 65% and 85%, and 70% for the maxillary lateral incisors. The distance between the CEJ and the incisal edge is usually from 10 to 11 mm for the central incisors [29, 33].

Standardization of crown length-width ratio is not achievable, as it varies between different genders [34] and races [35]. In a recent systematic review, these mathematical formulas for proper tooth proportions failed to provide consistent results when used as a standard guide for esthetic smiles [36]. Therefore, a confirmatory method for diagnosis of altered passive eruption is required, which is the absence of what the present authors called "Tooth First Plane" **(Fig 1)**.

Regarding tooth morphology, Stein & Kuwata [37] first introduced the "Emergence profile" of a tooth. They explained that as teeth emerge from the soft tissue, they have a straight or concave contour until they meet their maximum contour situated at the junction between the cervical and middle third. This is what the present authors refer to as "The tooth first plane" **(Fig1)**. The first plane is necessary to be seen upon smiling to obtain the ideal teeth size and proportions. It can also be used as a confirmatory method for altered passive eruption. Sometimes the gingival margin might cover the tooth's first plane masking its presence, such as in cases with pseudopockets, drug-induced gingival enlargement, altered passive eruption and inconsistent gingival margin. These situations can be easily diagnosed by examining the gingiva and bone sounding using a periodontal probe [38].

Regarding the neuromuscular characteristics of the upper lip; short upper lip is diagnosed when the maxillary lip length is measured. The regular length of the upper lip for young adult females is reported to be 20-22 mm, while in young males the regular upper lip length is 22-24 mm, with an average of 21.2 mm for females and 23.4 mm for males [39-41]. Meanwhile, in the absence of dentoalveolar deformity, a change of 6 mm to 8 mm in lip length from repose to full smile is considered normal, however, lip mobility of more than 8 mm is considered hyperactive upper lip [39, 40]. Muscles responsible for upper lip elevation include the Levator Labii Superioris, Levator

Labii Superioris Alaquae Nasi, Levator Anguli Oris, Zygomaticus Major, Zygomaticus Minor, Depressor Septi Nasi and Risorius.[42] Lip anomalies are suggested when there is no cant on the occlusal plane, and a deviation is seen during smiling [17].

In order to diagnose the skeletal type of gummy smile caused by vertical maxillary excess (VME), the lower third of the face is checked to determine whether it is longer than the remaining upper two thirds. Cephalometric radiographs can be used as a supplementary aid to photographs in order to perform a proper esthetic facial analysis and to create an accurate treatment plan combining both the soft tissue and the skeletal analysis [43, 44]. Garber & Salama [45] classified VME into three degrees based on the amount of the gingival display (GD). Degree I VME has a gingival display of less than 4 mm, Degree II VME in which the GD is between 4 mm to 8 mm and Degree III VME in which the GD displays more than 8 mm gingiva [17, 46].

Based on the above-mentioned data, this novel etiology-based smile classification was developed with relevance to the upper lip position, taking into considerations all the various factors that might affect an ideal esthetic smile including presence or absence of; excessive gingival display (gummy smile), short clinical crown, tooth 1st plane and maxillary bony excess. Class I & II smile categories are identified when the upper lip reflection reveals maxillary teeth only during smiling, while in Class III & IV smiles there is excessive gingival display upon smiling with the upper lip supported by the alveolar ridge without maxillary bony excess, whereas Class V and VI smile show excessive gingival display upon smiling with the upper lip supported by the alveolar ridge but with maxillary bony excess. Finally, Class VII smile is detected when the upper lip is supported by the alveolar ridge with vertical maxillary bony excess and with normal height of the clinical crowns.

In Class I smile the upper lip is supported by the maxillary teeth only, while in Class II the upper lip is supported by the gingival margin and the underlying cervical contour of the clinical crown showing the interdental papillae. Class I and II smiles are further subdivided into two subgroups A and B according to the condition of the underlying maxillary teeth. In Subgroup A teeth are normally aligned, whereas Subgroup B includes either malaligned, fractured or missing one or more anterior teeth **(Fig 2)**.

On the other hand, Class III smile is noticed when there is excessive gingival display upon smiling, where the upper lip is supported by the alveolar ridge without any maxillary bony excess and the clinical crowns have normal height. Meanwhile, Class IV smile is observed when there is excessive gingival display upon smiling and the upper lip is supported by the alveolar ridge without any maxillary bony

excess yet with short clinical crowns. Additionally, Class IV smile is subdivided into two subgroups A and B based on the absence or presence of the tooth 1st plane **(Fig 3).** In Subgroup A, the 1st plane of the tooth is present, while in subtype B; the 1st plane of the tooth is hidden by the gingiva. In Class V smile there is excessive gingival display upon smiling with normal height of the clinical crowns yet the upper lip is supported by the alveolar ridge with maxillary bony excess. While in Class VI smile there is excessive gingival display upon smiling and the upper lip is supported by the alveolar ridge with maxillary bony excess yet teeth have short clinical crowns. Class VI smile is further subdivided into two subgroups A and B based on the absence or presence of the tooth 1st plane. In Subgroup A, the 1st plane of the tooth is present, while in subtype B; the 1st plane of the tooth is hidden by the gingiva **(Fig 4).**

Summary box:

Class	**Lip Support**	**Subclass**	**Present or hidden 1st plane of the tooth (when relevant)**	**Treatment if needed**
Class I	Upper lip is supported by the maxillary teeth	Normal		Restorations/Implants
		Malalignment		Orthodontic treatment
Class II	Upper lip is supported by the gingival margin and clinical crown cervical contour beneath it	Normal		Restorations/Implants
		Malalignment		Orthodontic treatment
Class III	Upper lip is supported by the alveolar ridge without any maxillary bony excess	Normal height of clinical crown		Botox/Lip repositioning
Class IV	Upper lip is supported by the alveolar ridge without any maxillary bony excess	Short clinical crown	Present 1st plane (Attrition)	Restorations (crowns/veneers)
			Hidden 1st plane	Esthetic Crown Lengthening
Class V	Upper lip is supported by the alveolar ridge with maxillary bony excess	Normal height of clinical crown		Removal of bony exostosis
Class VI	Upper lip is supported by the alveolar ridge with maxillary bony excess	Short clinical crown	Present 1st plane (Attrition)	Restorations (crowns/veneers) + Removal of bony exostosis

			Hidden 1st plane (Altered passive eruption)	Esthetic Crown Lengthening + Removal of bony exostosis
Class VII	Upper lip is supported by the alveolar ridge with vertical skeletal defect			Le Fort 1 orthognathic surgery

Therapeutic options based on the novel classification (Fig 5):

The novel system suggested herein is developed to help clinicians categorize smiles in a simple and reproducible manner. Furthermore, the currently proposed smile classification offers a practical decision-making guide on how and when to use validated procedures in the literature to treat different types of unesthetic smiles in specific scenarios. When assessing the key factors affecting the current classification such as position of the upper lip, gingival exposure and length of the upper incisors' clinical crowns, various levels of esthetics such as the facial, gingival and periodontal esthetics should be put into consideration. Moreover, attention should be paid to the zenith of the gingival contour, the dental axis, level of the interdental contact, balance of the gingival level, extent of labial corridors and the smile line when managing those cases [47]. To achieve the perfect patient satisfactory smile, clinical management could be categorized into two main categories; conservative treatment including restorations, orthodontic treatment, Botox injection, veneers and crowns as well as surgical treatment including; esthetic crown lengthening with or without bone removal as well as orthognathic surgery. To establish a comprehensive outline for evidence-based treatment options to manage each class, a brief overview of the possible treatment options available for each smile class is provided.

Considering Class I and Class II smiles, any unsatisfied patient with esthetic problem in the smile would be due to teeth malalignment, fractured or missing teeth. The suggested treatment plan involves implant placement and dental restorations to restore missing or broken and carious teeth, or orthodontic treatment to correct the malalignment [45]. Special attention should be made to gingival contour and gingival line upon treatment. Meanwhile, patients presenting with Class III, IV, V, VI and VII have excessive gingival display known as "Gummy smile" with either normal or short clinical crowns.

The upper lip posture is of great significance when dealing with Class III smile cases. It is considered the neuromuscular type of gummy smile, where the upper lip is supported by the

alveolar ridge without any maxillary bony excess and the clinical crowns have normal height. Hence, in such cases the manifestation of gummy smile is either due to short lip or secondary to the upper lip activity. It could be dealt with either surgically or conservatively. Surgical management involves lip repositioning with or without myotomy [48].Botox injection has been introduced as a conservative approach to manage gummy smile due to lip incompetency [49]. Recently, the use of zinc supplementation prior to Botox injections was shown to overcome its short-term effect and maintained a long-term decreased amount of gingival display [50].

As for Class IV smile, the upper lip is supported by the alveolar ridge without maxillary bony excess however, teeth have short clinical crowns. In Subtype A; where the tooth 1st plane is present, denote that the short maxillary incisors are caused by incisal edge wear or attrition. Hence, these cases could be dealt with through various restorative options such as direct or indirect restorations such as veneers or crowns to regain an ideal smile with normal teeth proportion and minimal gingival exposure [29, 33]. While in Subtype B; the 1st plane of the tooth is hidden by the gingiva due to either altered passive eruption or gingival enlargement producing short maxillary crowns. In such cases, esthetic crown lengthening with or without bone resection, is the foremost chosen surgical technique to lengthen the clinical crown. The patients' personal satisfaction is a necessity for the technique's success, since these types of procedures require time and sometimes need sutures which may result in postoperative morbidity for the patient. Gingivectomy or apically positioned flap could also be used to modify teeth length and soft tissue contour. Gingivectomy could be performed provided that, at least 2 mm remaining functional keratinized attached mucosa could be preserved otherwise; apically positioned flap should be done [30, 51].

Additionally, Class VI smile is similar to Class IV in terms of the lip support, except for having maxillary bony excess. In this condition, similar treatment options could be proposed according to the presence or absence of the 1st plane of the teeth, including restorations, crowns, veneers and esthetic crown lengthening. However, osteoplasty and osteotomy are essential to regularize and normalize bone in the anterior maxilla to correct altered passive eruption, improve esthetics and allow for better adaptation of the upper lip in the anterior region [52]. Lengthening of the clinical crown and successive osteotomy/osteoplasty have also proven established favourable results, from the patient satisfaction perspective as well as from an esthetic point of view [51, 53].

Concerning Class V, there is excessive gingival display upon smiling with normal height of the

clinical crowns yet the upper lip is supported by the alveolar ridge with maxillary bony excess. Consequently, the only treatment needed in this condition is osteoplasty to remove this maxillary excess and adapt the upper lip in a more satisfactory coronal position, thus improving esthetics [52]. Finally, in Class VII smile the upper lip is supported by the alveolar ridge with vertical maxillary bony excess and with normal height of the clinical crowns. To manage such conditions, Lefort 1 surgery is the proper treatment of choice. However, in a more conservative approach, Botox injection could be used to mask the VME. Being much less aggressive, it is thus preferred by the patients [17, 46, 54]. Further clinical trials are recommended to assess the upper lip position before and after various treatment modalities, such as; botulinum toxin A, lip repositioning, esthetic crown lengthening as well as after implant placement in the esthetic zone.

Conclusions:

An individual's perception of minor deviations from the ideal smile is usually subjective. Proper diagnosis is considered the key for appropriate treatment decisions and patient satisfaction. Therefore, smile analysis is considered a crucial part of smile diagnosis and treatment planning. Management and correction of unesthetic smiles are usually conducted through a multidisciplinary approach to achieve precise therapy and satisfying results for patients. In the currently proposed classification, most of the clinical variables affecting the position of the lip frame are analyzed and classified, with an individual treatment plan addressed to each one. It is suggested that this novel classification system might help in enhancing smile attractiveness, patient's confidence and oral functions.

Conflict of interest

The authors declare no conflict of interest concerning the authorship and/or publication of this article.

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Figure Legends:

Figure 1: The tooth first plane. **a-**the three planes of the tooth; 1st plane from the CEJ to the maximum contour, 2nd plane for the middle 1/3 of the tooth and the 3rd plane for the incisal 1/3 of the tooth. **b-**flap reflection showing the starting point of the 1st plane which is the CEJ. **c-** teeth with absence of the first plane which indicated altered passive eruption. **d-** teeth with presence of the first plane

Figure 2: a- Class I A: the upper lip is supported by the maxillary teeth only with normal alignment. **b-** Class I B: the upper lip is supported by the maxillary teeth only with missing tooth. **c-** Class II A: the upper lip is supported by the maxillary teeth only with normal alignment. **d-** Class II B: the upper lip is supported by the maxillary teeth only with missing tooth.

Figure 3: Class IV, two subgroups A & B. **a-** Short clinical crowns with present first plane (Attrition), **b-** Short clinical crowns with hidden first plane of the tooth (altered passive eruption)

Figure 4: Class III, IV, V, VI and VII. **a-** Class III: the upper lip is supported by the alveolar ridge without any maxillary bony excess and the normal height clinical crowns. **b-** Class IV, Subgroup A: the upper lip is supported by the alveolar ridge without any maxillary bony excess yet with short clinical crowns and the 1st plane of the tooth is present (attrition), **c-** Class IV, subgroup B: Same as Subgroup A but with hidden 1st plane (altered passive eruption). **d-** Class V: the upper lip is supported by the alveolar ridge with maxillary bony excess and normal height of the clinical group. **e-** Class VI, subgroup A: the upper lip is supported by the alveolar ridge with maxillary bony excess yet with short clinical crowns and the 1st plane of the tooth is present (attrition), **f-** Class VI, subgroup B: Same as Subgroup A but with hidden 1st plane (altered passive eruption). **g-** Class VII: the upper lip is supported by the alveolar ridge with vertical maxillary bony excess.

Figure 5: Therapeutic options based on the novel classification.

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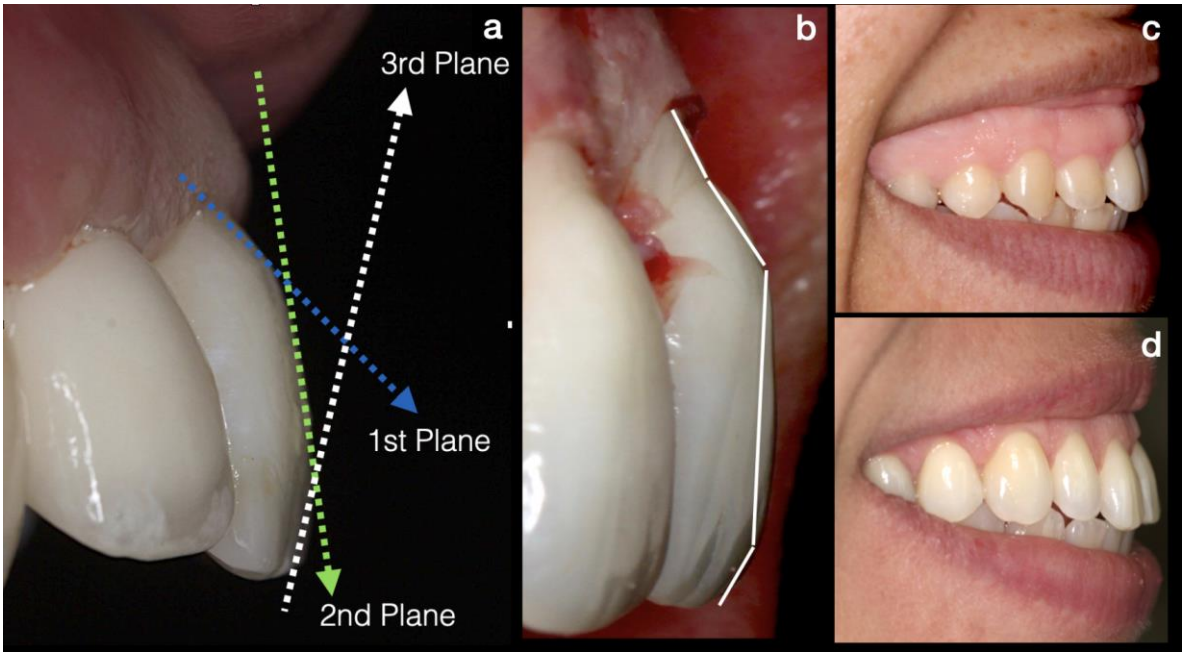

Fig 1

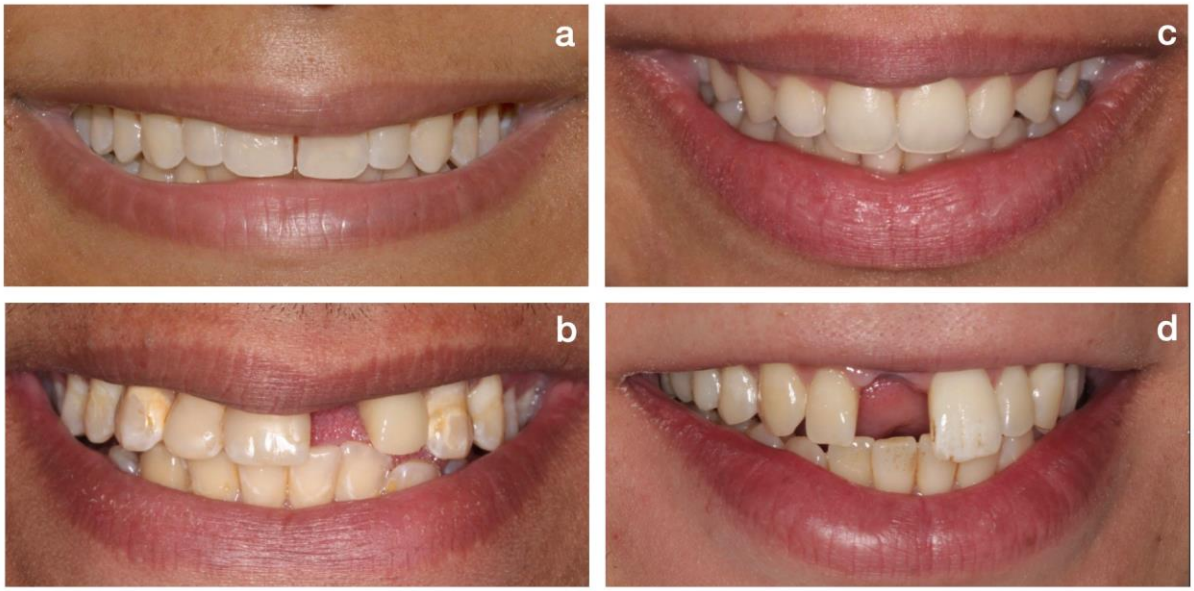

Fig 2

Fig 3

Fig 4

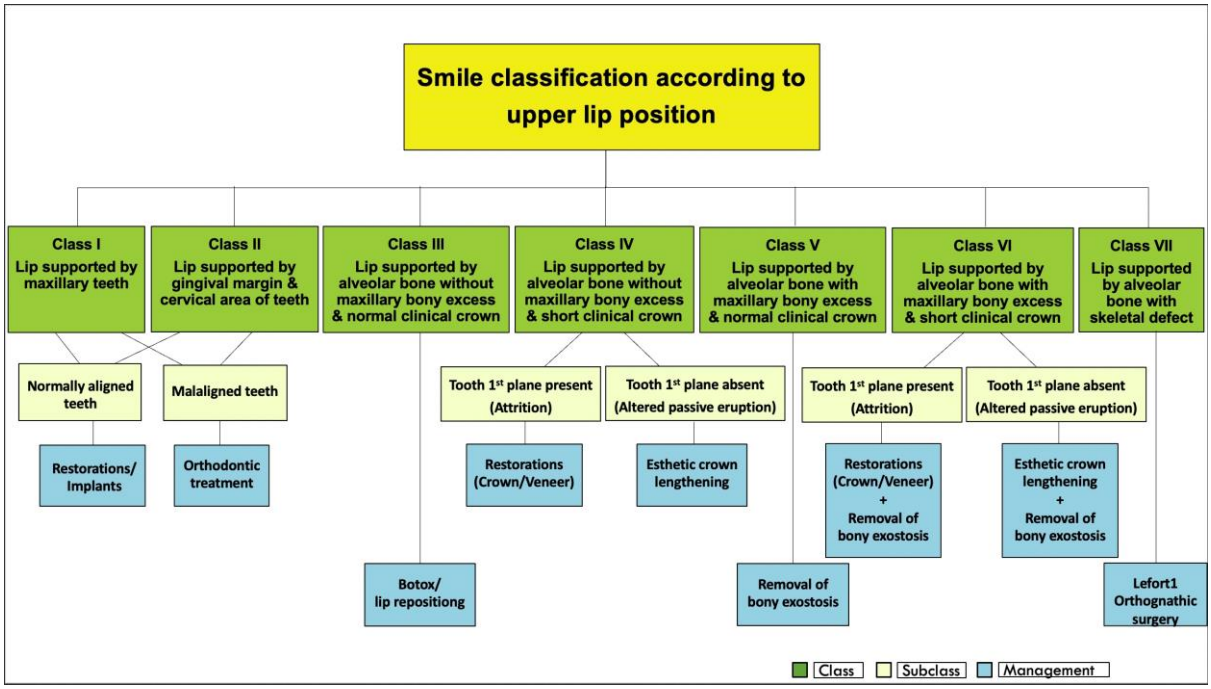
Smile classification according to upper lip position
Class I
Lip supported by maxillary teeth
Class II
Lip supported by gingival margin & cervical area of teeth
Class III
Lip supported by alveolar bone without maxillary bony excess & normal clinical crown
Class IV
Lip supported by alveolar bone without maxillary bony excess & short clinical crown
Class V
Lip supported by alveolar bone with maxillary bony excess & normal clinical crown
Class VI
Lip supported by alveolar bone with maxillary bony excess & short clinical crown
Class VII
Lip supported by alveolar bone with skeletal defect
Normally aligned teeth
Malaligned teeth
Tooth 1st plane present (Attrition)
Tooth 1st plane absent (Altered passive eruption)
Tooth 1st plane present (Attrition)
Tooth 1st plane absent (Altered passive eruption)
Restorations/ Implants
Orthodontic treatment
Restorations (Crown/Veneer)
Esthetic crown lengthening
Restorations (Crown/Veneer) + Removal of bony exostosis
Esthetic crown lengthening + Removal of bony exostosis
Botox/ lip repositiong
Removal of bony exostosis
Lefort1 Orthognathic surgery
Class
Subclass
Management

Fig 5