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Gummy Smile and Craniofacial Typologies in an Adolescent Population

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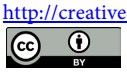

Abstract

The aim was to assess the craniofacial characteristics of patients with a gummy smile, classifying the types of gummy smile in a population of adolescents, and then estimating the impact of orthodontic treatment with premolar extractions on the persistence of this type of smile. Based on 64 complete orthodontic records, a cross-sectional study was conducted over a period of 4 months in the orthodontics department of Casablanca. The study used the analysis of various craniofacial parameters from data collected from clinical records. Estimation of the gingival smile was performed according to the four types proposed by Wu *et al.* 2010. Data analysis was carried out using Jamovi 2021 software (Version 1.8). The chi^2 test was performed to compare the data and a p-value of 0.05 was considered statistically significant. The gingival smile was present in 35.9% of the adolescent population. Girls were more likely to have a gummy smile than boys, however the statistical correlation was not significant. Facial convexity was most common in patients with a gingival smile. Resting stomion was most common in the gummy smile population. Increased overjet and overbite were most common in the gummy smile population. Skeletal class II and hyperdivergent facies were the most frequent in adolescents with a gingival smile. In conclusion, a predominance of the female gender with a sex ratio of 2:1 characterized the adolescents with a gummy smile. The majority of the cases presented a type I gingival smile defined by a continuous gingival band covering the entire smile arch, followed by type IV defined by a significant gingival exposure only in the anterior sector.

Subject Areas

Dentistry

Keywords

Smiling, Vertical Dimension, Cephalometry, Malocclusion, Orthodontics, Adolescent, Morocco

1. Introduction

The desire of beauty, youth and aesthetic compliance has become necessities, if not imperatives, created by the notion of selling the dream on social media. Furthermore, social networks are increasingly becoming the repository for patients and practitioners, as reported in the systematic review conducted by Reynders RM and Isaia. L in 2019 [1], they represent an important channel for knowledge exchange on a wide variety of patient-centered orthodontic issues.

An unattractive smile is a handicap for personal satisfaction and fulfilment as well as for professional and social success. Hence the role of practitioners and specialists in redefining the criteria and rules of beauty, of which a harmonious smile is the essential component. Having a graceful smile in harmony with the face can drastically change other people's perception of you and therefore appear more approachable and socially accepted. It is commonly accepted that the smile and particularly the teeth influence the judgement of a person's facial attractiveness, and impact on their quality of life. Thus, malocclusions in general can affect an individual's physical, social and psychological condition and quality of life. Furthermore, it has been established that a well-balanced and appealing smile is perceived as more youthful and attractive for both men and women and can significantly change the chances of being selected for a recruitment interview or even being taken on [2].

The gummy smile is a common aesthetic complaint in our patients and has been widely regarded as unattractive. The etiology of this disorder is often multifactorial; therefore, an accurate diagnosis is essential before any therapeutic effort is made. In addition, the handicap of the gingival smile can restrict the opportunities of the subjects personally and professionally. Due to its complexity, a good knowledge of the determining and influencing factors of the gingival smile allows a better management of orthodontic cases and thus the elaboration of the most adequate treatment plan to finally have optimally satisfactory results.

The gingival smile, defined by a high smile line that exposes more than 2 mm of free gingiva, is considered unattractive [3], and thus may constitute an obstacle in daily life and a major reason for consultations for orthodontic and/or aesthetic requirements. For optimal treatment, it is essential for the orthodontist to understand the characteristics of this smile, which may differ from one patient to another.

The etiology factor of the gummy smile, combined or not, may be alveolar-skeletal (related to anteroposterior or vertical anomalies), periodontal, and/or labial [4]. It is therefore important to study the possible correlations between the

gingival smile, its types and the craniofacial parameters with which it may be associated.

The main objective of this study was to explore the cephalometric, craniofacial characteristics of adolescent patients with a gummy smile by considering the types of gummy smiles in the same population. As a secondary goal, we aimed to compare the effect of orthodontic treatment with or without premolar extractions on possible changes in the type of gingival smile.

2. Materials and Methods

Cross-sectional study based on the clinical records of patients consulting the dentofacial orthopedics service within the dental consultation and treatment center of the University Hospital in Casablanca and presented by the residents during the clinical evaluation for the national specialty diploma in dentofacial orthopedics took place between July and November 2021.

Patients aged 10 to 18 years, with a complete orthodontic file: clinical examination, radiology, iconography, diagnosis and treatment plan were included in this study, also patients whose smiles appeared more than 2 mm apart while the smile was being photographed.

Excluded were all patients with previous orthodontics, orthopedics or functional treatment, patients with orthognathic surgery, patients with obvious craniofacial anomalies or asymmetries, patients with major syndromes (facial cleft, Pierre Robin...) and patients with handicaps or special needs. For each file, an information form was created on the Google Form platform citing and differentiating the variables on which the study was based. Here is the link to the form: https://forms.gle/pqQtTXwdHEXfv6Tt9.

The profile was assessed according to the Ricketts E-line classification. The labial relationship was estimated by the presence or absence of a stomion which is defined as the point at the junction of the upper and lower lips or the most inferior point of the upper lip, in case of labial inocclusion. Estimation of the gingival smile was performed according to the four types proposed by Wu *et al.* 2010 [5] and summarized in **Table 1**. This classification provides information on the types of gingival smiles by assessing the areas of the arch exposed between the neck of the teeth and the basal line of the upper lip in the large smile. The selected sample was classified according to the orthodontic treatment received, taking the extractions or not as a criterion, in order to identify the effect of premolar extractions on the persistence of the gingival smile. The cephalometric measurements used are shown in **Figure 1**.

Data analysis was performed using Jamovi 2021 software (Version 1.8) and included calculations of percentage and effective. The chi^2 test was used to compare the data and a p-value of 0.05 was considered statistically significant. The fi-index tool (https://www.fident.eu/fidentresearch/fiindextool), which aims to guarantee the quality of the reference list and limit self-citations, was used for this paper and a score of 0 was obtained for the authors according to SCOPUS® [6] [7].

Table 1. Types of gummy smile according to Wu *et al.* 2010 [5].

Classification	Description	View
Type I	Continuous line of upper gum exposed during smiling.	
Type II	The posterior edges of the gums are the only ones exposed during the smile.	
Type III	Gingival exposure is in one quadrant (right or left) without the other.	
Type IV	The gingival smile concerns the anterior arch only.	

This issue was presented and validated both in the Department of Dentofacial Orthopedics and in the Thesis Commission of the College of Departments, which has the competence of an ethics committee in our institution. The anonymous and confidential nature of the use of the data scrupulously respected the personal data of the patients and their rights to their image. All authors declare that they have no conflict of interest in contributing to the outcome of this article.

3. Results

Of the 102 files consulted and according to our selection criteria, the sample was composed of 64 orthodontic files after an exclusion of 38 files. 37 (57.8%) patients were female. And 27 (42.2%) patients were male. The age of our sample varied between 10 and 18 years at the beginning of treatment, with a mean age of 14.4 ± 2.29 years. 41 (64.1%) had no gingival smile, 23 (35.9%) had a smile line with more than 2 mm of gingiva in the vertical sense or a gummy smile. In these 23 subjects the distribution according to the type of smile was as follows: type I

in 9 patients, type II in 6 patients, type III in no patient and type IV in 8 patients (Table 2). The distribution of the sample according to profile type showed that: 20 patients (31.2%) had a flat profile.33 patients (51.6%) had a convex profile.11 patients (17.2%) had a concave profile.

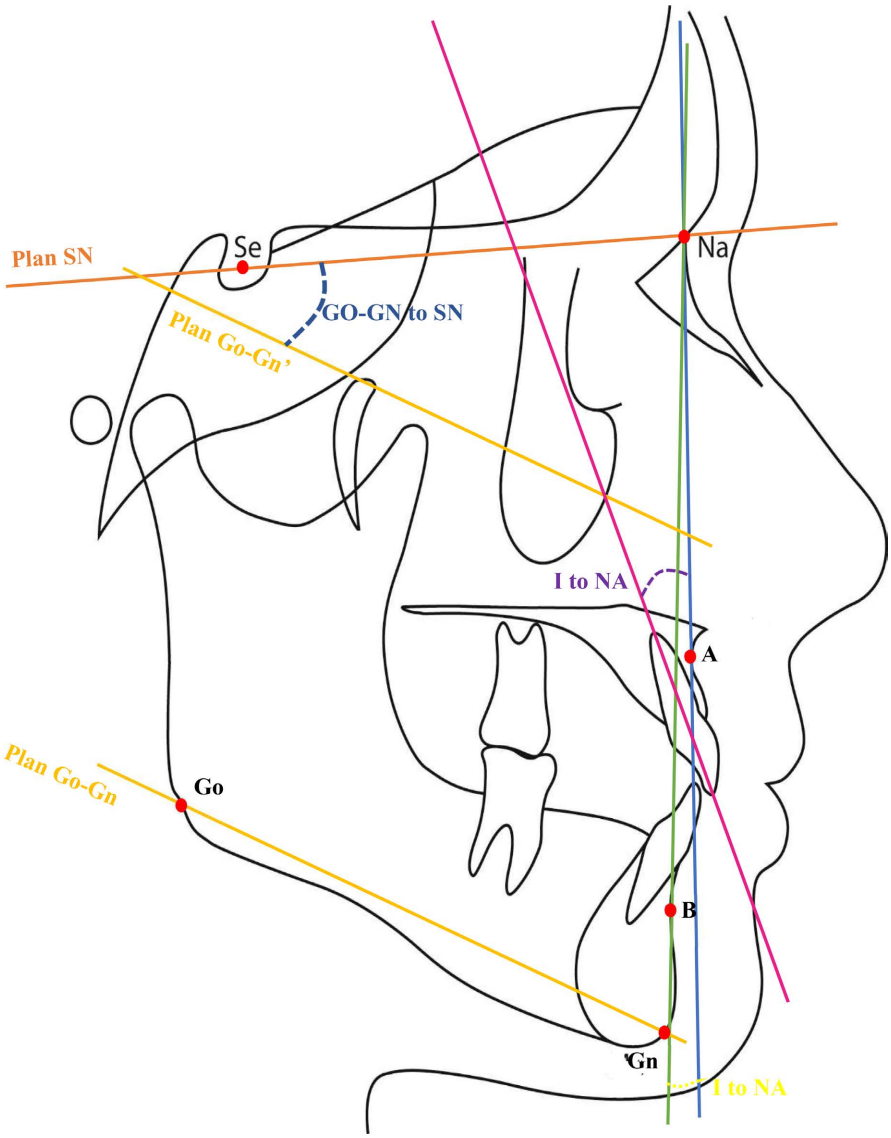

Figure 1. Cephalometric points, planes and angles used.

Table 2. Distribution according to the type of gingival smile.

Type of gingival smile	Number	Percentage
Type I	9	39.1%
Type II	6	26.1%
Type III	0	0%
Type IV	8	34.8%
Total	23	100%

Eleven subjects (17.2%) had labial incompetence with an absent stomion. 11 subjects (17.2%) had normal overjet, 24 subjects (37.5%) had increased overjet, 17 subjects (26.6%) had decreased overjet, while 12 subjects (18.8%) had negative overjet.

Regarding overbite: 20 patients (31.3%) had a normal overbite, 22 patients (34.4%) had an overbite, 6 patients (9.4%) had an underbite, 5 patients (7.8%) had an edge-to-edge overbite and 11 patients (17.2%) had a crossbite.

The distribution of the selection according to skeletal class before treatment revealed that: 12 patients (18.8%) had skeletal Class I, 36 patients (56.2%) had skeletal Class II while 16 patients (25%) had skeletal Class III.

Facial divergence showed that: 22 patients (34.4%) were normodivergent, 35 patients (54.7%) were hyperdivergent and only 7 patients (10.9%) were hypodivergent.

Cephalometric values at the beginning of treatment showed that: ANB angle had a mean of 3.11 with a standard deviation of 4.26. The Go-Gn to Sn angle had a mean of 37.7 with a standard deviation of 5.83. And the I to NA angle had a mean of 24.7 with a standard deviation of 6.93. The same cephalometric values after treatment were: ANB angle had a mean of 2.64 with a standard deviation of 2.43. The Go-Gn to Sn angle had a mean of 37.8 with a standard deviation of 5.83. And the I to NA angle had a mean of 24.1 with a standard deviation of 4.95.

The distribution of the sample according to the type of treatment received showed that: 25 subjects (39.1%) had been treated orthodontically without premolar extractions. While 39 subjects (60.9%) were treated with premolar extractions.

The patients with a gummy smile in our selection were 23 subjects before treatment and 10 subjects after treatment. These 10 subjects had a change in gummy smile type after treatment as follows: 9 patients had a type I gummy smile before treatment. After treatment, 3 subjects no longer had a gummy smile, 3 subjects still had a Type I gummy smile, 2 subjects changed to Type II and 1 subject to Type IV. 6 patients had a Type II gummy smile before treatment.

After treatment, 2 subjects no longer had a gummy smile and 4 subjects still had a Type II gummy smile. No patient had a Type III gummy smile either before or after treatment. 8 patients had a Type IV gummy smile before treatment. After treatment, none of the subjects had a gummy smile of any type (Table 3).

Table 3. The change in the type of gingival smile before and after treatment.

			Smile evolution after treatment				Total
			Type I	Type II	Type III	Type IV	
Gingival smile before treatment	Type I	9	3	2	0	1	6
	Type II	6	0	4	0	0	4
	Type III	0	0	0	0	0	0
	Type IV	8	0	0	0	0	0
	Total	23	3	6	0	1	10

Regarding, the association of the studied variables and the gingival smile: The correlation between gingival smile and gender was not significant (p = 0.369). The correlation between the gingival smile and the labial relationship was not significant (p = 0.285). The correlation between gingival smile and overjet was not significant (p = 0.189). The correlation between gingival smile and overbite was not significant (p = 0.905). The correlation between gingival smile and skeletal class was not significant (p = 0.254). The correlation between gingival smile and vertical skeletal diagnosis was not significant (p = 0.749).

Concerning the distribution of the sample according to the gingival smile before and after treatment, the correlation between the presence of a gummy smile and orthodontic treatment was significant (p = 0.001) (Table 4).

4. Discussion

The smile is a complex phenomenon that requires the involvement of several parameters to define and categorize it. In the literature, the smile is generally classified with reference to the degree of exposure of the maxillary central incisor. The gingival smile, considered a multifactorial aesthetic problem, remains a major concern for orthodontists. This smile may differ according to parameters other than craniofacial. Souccar *et al.* [8] reported that this smile decreases significantly with age, while no difference in gingival exposure was reported in relation to ethnicity.

The investigation that we carried out with the aim of understanding the gingival smile in a Moroccan adolescent population allowed the study of several factors that could characterize it. These are the following characteristics: gender, type of smile, type of profile, overjet and overbite, antero-posterior skeletal diagnosis, vertical skeletal diagnosis and type of orthodontic treatment.

In this study, the gingival smile was unequally present between females and males, with females being almost twice as affected as males (sex ratio = 2/1). Khan and Abbas [9] showed that more female subjects had gingival smile exposure than male subjects. Tjan *et al.* [10] indicated that 13.79% of females had a high smile line compared to 6.76% of males. Kapagiannidis *et al.* [11] reported that gingival exposure in relation to the premolars was more frequent in women than in men. A significant difference was reported in the study by Al-Jabrah *et al.* [12] showing that women have a tendency to expose more gingiva during

Table 4. Distribution of the sample according to the gingival smile before and after treatment.

	Before treatment	After treatment	
		Presence	Absent
Presence of the gingival smile	23	10	13
Absent of the gingival smile	41	0	41
Total	64	10	54

smiling compared to men. Miron *et al.* [13] also observed a higher prevalence of gingival exposure in women than in men with a sex ratio of 2.5. The study by Liang *et al.* [14] on Chinese youth, in contrast to our study, showed that the gummy smile was a predominantly male trait.

Our study considered the gingival smile as a whole entity and classified it according to the site of gingival overexposure during the smile following the classification made by Wu *et al.* [5] in 2010. The results of our study showed that: type I was the majority of the cases of gingival smile, followed by type IV in second place, then type II while no subject had type III. Whereas in the study of Wu *et al.* [5], describing a Chinese population, type I was predominant, followed by type II in second place, type III present with a percentage of 6% in third place and type IV in the end. In the literature, the classifications of the gingival smile are not sufficiently elaborated, but those of the smile in general are different from each other and are based on different judgment criteria. In this context, we mention for example the study of Tjan *et al.* [10] which classified the smile into three main types: A "high" smile is one that exposed the full height of the anterosuperior teeth with a continuous gingival band, also known as a gingival smile. A "medium" smile which exposes 75% - 100% of the anterosuperior teeth and only the interproximal gingiva. And a "low" smile which does not exceed 75% of the anterosuperior teeth. According to Liebart *et al.* [15], the smile lines have been analyzed according to 4 classes: Class 1 called very high line defined by more than 2 mm of marginal gingiva or apical gingiva at the amelo-cementary junction if periodontium was reduced, thus constituting the gingival smile. The class 2, called high smile line between 0 and 2 mm of marginal gingiva or apical gingiva at the amelo-cementary junction if periodontium was reduced. Class 3, called the medium smile line where only the interproximal gingiva was visible. And class 4, called the low smile line, where no gum was visible during the smile.

According to our results, the convex profile type was the most dominant (51.6%), as well as in the subgroup with a gingival smile with a percentage of 39.4%. Also, the correlation between this parameter and the gingival smile was not significant ($p = 0.440$). However, the study by Wu *et al.* [5], noted that facial convexity played an important role in determining the gingival smile. The study of Saga *et al.* [16] on the non-surgical treatment of a case of promaxillia with a gingival smile observed that the patient had a convex facial profile. According to Mahaini *et al.* [17], the type of convex profile was also an important component in defining the gingival smile.

Our results with regard to the labial ratio showed that the majority of the subjects studied had a stomion present at rest. This was also the case for the subgroup with a gingival smile. However, the correlation between these two parameters was not significant ($p = 0.285$). In contrast, in the study by Wu *et al.* [5], the resting interlabial space was much larger than the norm but it was equivocal as to whether its presence determined the gingival smile or was merely the result of several features highlighting this type of smile. Although 86% to 93% of the

subjects with a gingival smile had no stomion at rest, only 56% of the subjects with an interlabial space at rest had a gingival smile, according to Peck *et al.* [18]. This leads the author to contest the validity of this parameter in the definition of a gingival smile.

According to our study, the majority of the study population and the subgroup with a gummy smile had an increased overbite occlusion. However, the correlation between the gummy smile and these characteristics was non-significant. According to Monaco *et al.* [19], the dentoalveolar gingival smile is controlled by an excess of overjet on one side and an increased overbite on the other. Both were the parameters reflecting the excess vertical and anteroposterior growth of the maxillary alveolar process. The study by Peck *et al.* [18] also showed a significant association between the gingival smile and the preceding dental measures (overjet and overbite). Subjects with a gingival smile line had a higher overjet and overbite than control subjects. Khan and Abbas [20], also noted in their study that subjects with a gummy smile were characterized by significantly greater overjet and overbite than subjects without a gummy smile. In a study conducted to determine the relationship between occlusal-facial characteristics and gummy smiles, Barbosa *et al.* [21] found a higher mean overbite value in children with gummy smiles compared to the control group, with a significant correlation. However, for the overjet the difference was not statistically significant.

According to the results of our study, patients with a gingival smile had a skeletal class II malocclusion with a mean ANB value of 4.04˚. However, the correlation between gingival smile and skeletal class was non-significant ($p = 0.254$), even though a number of studies report the opposite. Moreover, the study conducted by Mahaini *et al.* [17] on 57 Syrian adults with the aim of understanding the craniofacial characteristics related to gingival smile. They showed that the majority of the sample presented a skeletal class II with a mean ANB value of 4.5˚, which remains higher compared to the control group. The same results were reported by Wu *et al.* [5] who stated that more than half of the sample had a class II skeletal malocclusion with a mean ANB value of 4.7˚.

In our study, the majority of patients with a gummy smile were characterized by a hyperdivergent face. The Go-Gn/SN angle in the subgroup with a gummy smile had a mean value of 38.82˚. However, the correlation between these two variables was non-significant at a value of $p = 0.749$. Our results were similar to those of Mahaini *et al.* [17] who found a tendency for the sample to have a hyperdivergent facial type. Also, Wu *et al.* [5] who reported a dominance of the long face in patients with a gingival smile. In a study of a sample of 50 women by Li *et al.* [22], to determine the relationship between smile characteristics and facial types, it was confirmed that subjects with a hyperdivergent face exposed more areas when smiling, and thus were more likely to have a gummy smile. In the study by Hosseinzadeh-Nik *et al.* [23] it was also found that skeletal overdevelopment in the vertical direction resulted in increased gingival exposure during smiling as well as other vertical parameters such as resting interlabial space

and the degree of central incisor exposure.

According to our results, the correlation between orthodontic treatment and gingival smile correction was highly significant with p = 0.001. In fact, 13 cases (9 with extractions and 4 without extractions) out of 23 subjects no longer had a gingival smile at the end of treatment. Kaku *et al.* [24] reported a remarkable reduction in gingival smile following treatment based on extraction of the premolars and intrusion of the incisors using mini-screws.

Besides the parameters analyzed in our study, other factors have been defined as determinants of the gingival smile. These include a downward lip curvature as reported by Khan *et al.* [25], a short upper lip length and/or muscular hyperfunction of the upper lip lift muscles. The upper lip is considered short when, in the static state, the distance between the subnasal point and the upper labial stomion is less than 20 mm. In the dynamic state, the presence of the gingival smile may be related to the hypermobility of the upper lip elevator muscles which causes the lip to move higher than necessary [4].

5. Conclusion

A predominance of the female gender with a sex ratio of 2:1 characterized the adolescents with a gummy smile. The majority of the cases presented a type I gingival smile followed by type IV according to the four types proposed by Wu *et al.* 2010 [5]. The dominant craniofacial characteristics of the subjects with a gingival smile in our sample were: a convex profile type, a stomion present at rest, an increased overbite/overjet, skeletal class II and hyperdivergent face. Also, the effect of orthodontic treatment plays an important role in the improvement of the gingival smile or even its suppression. This study provided a comprehensive overview of the determinants of the gingival smile and thus could serve as a guide for the proper orthodontic management of patients complaining of this type of smile. However, it would be preferable to broaden the scope of future studies and to go further by including larger samples in order to be able to stratify on the facial typology associated with the type of gingival smile for the purpose of comparison by considering the ethnic characteristics of the Moroccan population in view of its diversity.

Conflicts of Interest

The authors declare no conflicts of interest.

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