Is the Smile Line a Valid Parameter for Esthetic Evaluation? A Systematic Literature Review

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Abstract

The "smile line" is commonly used as a parameter to evaluate and categorize a person's smile. This systematic literature review assessed the existing evidence on the validity and universal applicability of this parameter. The latter was evaluated based on studies on smile perception by orthodontists, general clinicians, and laypeople.

Methods: A review of the literature published between October 1973 and January 2010 was conducted with the electronic database Pubmed and the search terms "smile," "smile line," "smile arc," and "smile design."

Results: The search yielded 309 articles, of which nine studies were included based on the selection criteria. The selected studies typically correlate the smile line with the position of the upper lip during a smile while, on average, 75 to 100% of the maxillary anterior teeth are exposed. A virtual line that connects the incisal edges of the maxillary anterior teeth commonly follows the upper border of the lower lip. Average and parallel smile lines are most common, influenced by the age and gender of a person. Orthodontists, general clinicians, and laypeople have similar preferences and rate average smile lines as most attractive.

Conclusions: The smile line is a valid tool to assess the esthetic appearance of a smile. It can be applied universally as clinicians and laypersons perceive and judge it similarly.

(Eur J Esthet Dent 2011;6:314–327)

Introduction

Improvement of smile esthetics is one of the main reasons for patients seeking dental care.[1] Smiling is one of the most important facial expressions and known as a nonverbal parameter of communication[2] expressing joy.[3] In addition, an attractive smile is described as an important tool to influence people. Surveys have verified that smiling people are trusted more than non-smiling ones.[4] Existing evidence has also revealed that facial attractiveness, in which an attractive smile plays a major role, influences voting and juror decisions, job recruitments, and other social interactions. Attractive people are considered to be of a higher social standing, more interesting, and more intelligent.[1,4] They are judged and treated more positively than unattractive persons.[5] Racial and cultural factors do not seem to have a significant influence on the evaluation of attractiveness[6] while established norms for facial and dental appearance do not differ widely.[7]

Attractive smiles not only influence other people's perceptions but also affect the psychosocial well-being of the individual as well as their behavior and character traits. A recent scientific study has shown that self-perception of an attractive smile is strongly connected to the traits of high self-esteem, low neuroticism, and dominance.[8] Moreover, attractive people tend to earn higher incomes and seem to have a more successful life outcome.[9,10] Facial attractiveness and smile attractiveness are strongly connected to each other as the oral region is the center of communication in the face. The communicators' attention is mainly directed towards the eyes and the mouth in face-to-face communications.[11]

The esthetic appearance of a smile is, among other factors, affected by the position of the lips and their curvature as well as by the relationship between the maxillary anterior teeth and the curvature of the lower lip.[12] Traditional guidelines for the maxillary anterior tooth position in complete dentures suggested that the incisal edges should run parallel to the base of the nose. A convex arc was considered to be more feminine than a flat arc.

Ackermann[13] proposed to create a staircase by raising the canine to a higher position than the lateral incisor in order to optimize the esthetic appearance of the maxillary anterior teeth. Today, the "smile line," also termed "smile arc" by Ackermann et al,[14] is defined as the relationship between the curvature of the maxillary anterior teeth and the curvature of the upper border of the lower lip.[15-17] Some authors prefer the term "smile arc" to underline the ideal form of the incisal edges of the maxillary anterior teeth creating a convex arc. In an ideal smile, the two lineaments are parallel to each other, creating a consonant smile, in contrast to a non-consonant smile with a flatter curvature of the maxillary incisal edges.[18] The smile line can also be divided into the three categories: parallel, straight, and reverse. A parallel smile line is defined by the parallelism between the two curves in contrast to a straight line of the maxillary anterior incisal edges or a reverse line in relation to the lower lip, creating a concave arc.[19]

The smile line is commonly divided into the three categories: high, average,

and low depending on the amount of tooth and gingiva exposed during smiling.[12,20] Despite little scientific evidence, many authors suggest the smile line as a parameter to assess dental esthetics and recommend following suggested guidelines when dental restorations are being fabricated in the esthetic zone.[2] These guidelines are helpful for the clinician to provide a predictable treatment outcome. It is widely unknown, however, if these esthetic guidelines are based on scientific evidence or mere speculation.

The aim of this systematic literature review was to assess the existing evidence on the validity and universal applicability of the smile line. The latter was evaluated based on studies on smile perception by orthodontists, general clinicians, and laypeople.

Materials and methods

Search strategy

An electronic database (PubMed) search was performed for articles published in the dental literature with the key words "smile," "smile line," "smile arc," "smile design." In addition, a manual search was conducted based on the reference lists in the full text articles selected from the electronic search and on textbooks pertaining to the topic.[21-26] The search was limited to English language articles published between October 1973 and January 2010.

The following criteria were defined and applied to select the articles included in this systematic review.

Inclusion criteria:

- publications in English
- studies investigating smile line/smile arc
- studies assessing the visual perception of people evaluating smile attractiveness with special regard to smile line and smile arc.

Exclusion criteria:

- patient reports
- studies comparing pre- and postoperative situation of patients with orthodontic treatment
- studies using computerized manipulation of one clinical photograph
- articles focusing on treatment recommendations
- studies comparing posed and spontaneous smiles
- studies assessing the visual perception of people evaluating smile attractiveness with special regard to factors other than smile line and smile arc
- studies based on radiographic evaluations
- studies limited to analyzing patients of only one gender.

Study selection

Titles and abstracts found through the electronic and manual search were screened for possible inclusion according to the above criteria. Full-text versions of all studies with possible relevance for this review were culled and screened again. Full-text versions were also obtained for studies that could not be clearly identified as relevant or not by title or abstract. All studies that met the inclusion criteria underwent data extraction.

Data extraction and grouping

The included studies were categorized into three groups according to the data that could be extracted. Studies investigating smile line/anterior tooth display in reference to the upper lip (high, average and low smile line) were assigned to Group I. Group II consisted of studies investigating the smile line in reference to the lower lip (parallel, flat, and reverse). Group III addressed subjective perception of the smile line by a third person (please see Figs 1–6 for examples of the different smile lines). Studies that provided data for more than one category were assigned to all corresponding groups.

For Group I and II, the following data were recorded: number and age of subject; number of each gender of subject; percentage composition of high average and low; parallel, flat, and reverse smile lines; any distinctive features between male and female subjects. In Group III, differences in smile line perception by orthodontists, general clinicians, and laypersons were recorded.

Results

The initial database search yielded 270 titles while the manual search revealed an additional 39 articles, for a total of 309. Forty-two full-text articles were selected and screened for this study's inclusion and exclusion criteria. Ultimately, nine studies were included in this review (Table 1). Excluded studies and reasons for their exclusion are presented in Table 2.

Statistical analysis of the accumulated data by means of meta-analytic methodology could not be applied, since the selected studies did not share sufficient similarities to justify a comparative analysis.[27]

Group I: Smile line in reference to upper lip

Six of the included studies investigated the smile line in reference to the upper lip and display of the maxillary anterior teeth during smiling.[12,28-32] A total of 1,526 subjects with ages ranging between 14 and 70 years were evaluated in these studies. Smile heights with a display of 75 to 100% of the maxillary anterior crowns were the most common and characterized as "average" (Table 3). Aberrations from these average values were classified as either a low (less than 75% of teeth exposed) or a high (entire teeth and gingiva displayed) smile line. Four of these studies reported that more than 50% of people have average smile lines.[12,29-31] Tijan et al and Desai et al reported that, in their studies, even two-thirds of patients had an average smile line.[29,31] One investigation did not provide exact information on the distribution of subjects in the three different categories.[28] Peck et al applied a definition and categorization of smile line in high/low/average that was different from the ones in the other studies.[32] They found average smile lines in only 35% and high smile lines in 41% of subjects. Low smile lines were observed in 24%. All studies identified low smile lines as the least common.

According to Tijan et al,[29] Maulik and Nanda,[30] and Peck et al,[32] low smile lines are more prevalent in males while high smile lines are more common in female

Fig 1 Average smile line.

Fig 2 High smile line.

Fig 3 Low smile line.

Fig 4 Parallel smile line.

Fig 5 Flat smile line.

Fig 6 Reverse smile line.

Table 1 Databases and results of the literature search.

Database PubMed	**Included studies (6)**
270 hits, 27 relevant hits	Krishnan et al, 2008[15]
	Parekh et al, 2007[33]
	Parekh et al, 2006[34]
	Desai et al, 2009[31]
	Peck and Peck, 1995[20]
	Peck et al, 1992[44]
Manual search and references	**Included studies (5)**
39 hits, 15 relevant hits	Kokich et al, 1999[35]
	Tijan et al, 1994[29]
	Dong et al, 1999[12]
	Owens et al, 2002[28]
	Maulik and Nanda, 2007[30]

Table 2 Excluded articles and reason for exclusion.

Treatment recommendations	Ker et al, 2008[63]
Ackermann et al, 1998[45]	Rodrigues et al, 2009[64]
Chalifoux, 1996[46]	**Investigation of other smile factors**
Culpepper et al, 1973[47]	Dunn et al, 1996[65]
Davis, 2007[48]	Flores-Mir et al, 2004[41]
Garber and Salama, 1996[49]	**Comparison between pre- and post-orthodontic treatment**
Gill et al, 2008[50]	
Lombardi, 1973[51]	Havens et al, 2010[66]
Mack, 1996[52]	Roden-Johnsen et al, 2005[18]
Messing, 1995[53]	Hulsey, 1970[67]
Miller, 1989[54]	**Anatomical explanations**
Morley, 1997[55]	Matthews, 1978[3]
Morley and Eubank, 2001[56]	**Cast analysis**
Moskowitz and Nayyar, 1995[57]	Wong et al, 2005[16]
Paul, 2001[58]	**Classification criteria too little**
Ritter et al, 2006[59]	Basting et al, 2006[68]
Vig and Brundo, 1978[60]	**Comparison between posed and spontaneous smiling**
Case reports	
Sarver, 2001[17]	Van der Geld et al, 2008[69]
Analysis of one subject (of each sex)	**Analysis of one gender**
Gul-e-Erum and Fida, 2008[61]	Van der Geld et al, 2008[36]
Carlsson et al, 1998[62]	

Table 3 Smile line in relation to upper lip.

					Smile line			Comparison between male and female	
Study	**Number of subjects (N)**	**Age of subjects (years)**	**Male (N)**	**Female (N)**	**High (%)**	**Average (%)**	**Low (%)**	**Male**	**Female**
Tijan et al[29]	454	20–30	207	247	10.57	68.94	20.48	Significantly more often a low smile line	Significantly more often a high smile line
Dong et al,[12] citing Yoon et al[19]	240	-	129	111	29	56	15	-	-
Maulik and Nanda[30]	230	14–35	99	131	21	57	22	Larger percentage with low smile lines	Larger percentage with high smile lines
Desai et al[31]	261	15–70	-	-	17.6	73.8	6.3 (2.3 with no dental display)	-	-
Peck et al[32]	88	15 (mean age)	42	46	41 (with special definition of high and low smile line)	35	24	Low smile line as a male lineament	High smile line as a female lineament
Owens et al[28]	253	18–41	144	109	-	-	-	Significantly less gingival display during maximum smile	Significantly more gingival display during maximum smile

Table 4 Smile line in relation to lower lip.

					Smile line			Comparison between male and female	
Study	**Number of subjects (N)**	**Age of subjects (years)**	**Male (N)**	**Female (N)**	**Parallel (%)**	**Flat (%)**	**Reverse (%)**	**Male**	**Female**
Tijan et al[29]	454	20–30	207	247	84.8	13.88	1.32	Significantly higher amount of reverse smile	-
Dong et al,[12] citing Yoon et al[19]	240	-	129	111	60	34	5	-	-
Maulik and Nanda[30]	230	14–35	99	131	40	49	10	Higher amount of flat or reverse smile	Higher amount of parallel smile
Desai et al[31]	261	15–70	-	-	48.8	31.7	3.6 (16.3 lower lip covering maxillary incisal edges)	-	-
Krishnan et al[15]	60	18–25	30	30	-	-	-	More female subjects than male subjects have parallel smile arcs	

Table 5 Smile evaluation.

	Differences between orthodontists, general clinicians, and laypeople		Remark
Study	**Yes**	**No**	
Kokich et al[35]	×		Differences regarding smile height between orthodontists and the two other groups
Parekh et al[34]		×	Laypeople rated ideal smile arcs as more attractive than the excessive smile arcs
Krishnan et al[15]		×	
Parekh et al[33]		×	

subjects. Peck et al analyzed smile lines in 42 male and 46 female subjects.[32] High smile lines occurred twice as often in females than in males. In contrast, low smile lines appeared proportionally twice as often in males than in females. Owens et al[28] confirmed these findings in a multicenter, interracial study. They found significantly greater gingival display in females than in males during maximum smiling in 4 out of 6 races.

Desai et al analyzed the smiles of 261 people and categorized them into five age groups.[31] In general, only 2.3% did not show any teeth when smiling. However, their most important finding was that the height of the smile line changes with age. No subject in the 15- to 19-year age group had a low smile line, while no subject in the 50-and-over age group revealed a high smile line. Dong et al also showed that the amount of maxillary central incisor exposure during smiling decreases with age.[12]

Group II: Smile line in reference to lower lip

Five studies investigated the smile line in its categories parallel (to the lower lip), flat, and reverse.[12,15,29-31] A total of 1,245 subjects between 14 and 70 years of age were examined. Parallel smile lines, where the upper border of the lower lip follows the incisal edges of the maxillary anterior teeth, are also called consonant smiles. These were the most common, followed by flat and reverse smile lines (Table 5).

Three out of five studies reported parallel smile lines to be the most common.[12,29,31] One study, however, did not provide sufficient information about distribution in the three different categories.[15] Maulik and Nanda reported more flat than parallel smile lines.[30] Reverse smile lines were least often, with 10% or less in all of the investigations. Flat or reverse smile lines were more prevalent

in males than in females and the incidence of parallel smile lines was higher in females than in males.[15,29,30]

Group III: Smile perception

Four of the selected studies evaluated the perception of smiles by general clinicians, orthodontists, and laypeople.[15,33-35] No significant differences concerning smile evaluation were determined between the three groups. However, orthodontists seem to be more sensitive regarding the perception of deviations (Table 5).

Kokich et al[35] reported that orthodontists rated 0 mm of gingival display during smiling (average smile line) as most attractive and 2 mm or more (high smile line) as less attractive. A gingival display during smiling was not noticeable for general clinicians and laypeople until it was 4 mm or more.

Parekh et al[34] investigated the acceptability of variations in smile line for clinicians and laypeople and did not find significant differences between them. Parallel and excessive smile arcs were more acceptable than flat ones for both groups. Laypeople rated parallel smile lines as more attractive than excessive smile lines. Both clinicians and laypeople preferred parallel smile lines and rated flat smile lines as significantly less attractive.[34]

Krishnan et al studied overall smile evaluations by clinicians and laypeople and did not find differences between the two observer groups.[15]

Discussion

This systematic literature review assessed the existing evidence on the validity of the smile line as a parameter to assess a patient's appearance. "Smile line" is one of the most common esthetic assessment tools and widely applied for the planning and execution of restorative dental treatment in the anterior dentition. It is, therefore, important to know if this generally recommended tool is based on scientific evidence or subjective interpretation.

A number of studies were identified and, based on the applied inclusion criteria, selected for this review. Despite the heterogeneity of the included studies regarding design, standardization of photographs, subjectivity of the observers and other factors, these studies identified and classified smile lines in three categories, with an "average" smile line and consonant smiles being the most common. This means that there is scientific evidence that a certain smile line/tooth arrangement is the most common, which can be applied for treatment planning purposes. These results underline the importance of the smile line when restoring a patient's intraoral situation through direct or indirect restorations, and the clinician should aim for these most common parameters.

In addition, the results of this literature review reveal that the selection of an appropriate "smile design" is dependent on the patient's age, gender, and individual expectations.[29,30,36] Younger, especially female patients may be restored with a greater amount of anterior tooth display in the form of a high smile line, and, if necessary and appropriate for the new

smile design, with a contiguous band of visible gingiva. For older, especially male patients, an average smile line with a dental display of less than 75% and no visible gingiva would be more appropriate.[36] A parallel smile line, where the incisal edges of the maxillary anterior teeth follow the outline of the upper border of the lower lip during a smile, should be the goal for any oral rehabilitation. With the knowledge of those results, clinicians should not only focus on the dental and gingival parameters, but also analyze them in regard to the patient's overall facial situation.[2] Therefore, it may be necessary to apply corrective measures including orthodontics, surgery, or restorative/prosthetic dentistry to achieve a pleasing and predictable treatment outcome when designing a new smile.[37-40]

Orthodontists, general clinicians, and laypeople seem to have similar preferences when evaluating the attractiveness of smiles. This supports the theory that the level of dental-related education has little influence on the perception and judgment of dental esthetics.[41] Some authors report differences between different observer groups.[18,42] However, many of these studies do not specifically focus on the parameter smile line and take other parameters such as buccal corridor, midline deviation, or gingival margin into consideration to evaluate overall smile esthetics.[43]

The results of this literature review confirm the validity of the smile line as an evaluation tool of dentofacial esthetics and support its universal applicability.

Conclusion

The smile line is a valid tool to assess the esthetic appearance of a smile. It can be applied universally as clinicians and laypeople perceive and judge it similarly.

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