

Appraisal of Different Parameters of Smile Esthetics for Facial Attractiveness - A Systematic Review

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Abstract

Objective: The objective of this systematic review was to appraise the various parameters of different parameters involved in smile esthetics for facial attractiveness and to determine the most important parameters of an esthetic smile that affect the facial attractiveness.

Methods: The data for this systematic review was collected from search engines like PubMed, Cochrane Library and Google Scholar. From these search engines all data was screened until December 2020. All the studies analyzing the various parameters of an esthetically pleasing smile were screened and filtered according to the inclusion and exclusion criteria. Two researchers screened and analyzed the data from the mentioned search engines.

Results: After screening the data from the search engines and filtering them according to inclusion and exclusion criteria, a total of 16 articles were included in this systematic review. These included observational photographic studies, video-graphic studies, cross sectional studies and review articles.

Conclusions: Parameters like smile arc, buccal corridor spaces, Morley's ratio, smile symmetry, smile index/modified smile index, gingival display, incisal edge position, arch form, dental and facial midlines and golden proportions were the ones most commonly assessed.

Keywords— Smile Analysis, Orthodontic Smile Correction,

I. INTRODUCTION

“A smile is a curve that sets everything straight” as quoted by Phyllis Diller, is indeed the true meaning of a smile. The thesaurus definition of smile is “a facial expression characterized by upward curving of the corners of the mouth is often used to indicate pleasure, amusement, and orderliness.”¹ Smile is a crucial part of the facial esthetics. There is a strong correlation between an individual's physical appearance and his or her social attractiveness that is well documented in the literature. It has also been documented that smiling individuals tend to be trusted more than non-smiling

individuals by strangers². Hence, the correction of the smile and facial appearance are the most common reasons for patients seeking orthodontic treatment.³ Research has shown that at least 70% of the population is affected by some or the other form of occlusal misalignment, which also affects the smile of an individual.⁴

Orthodontic diagnosis and treatment planning comprises of detailed analysis of an individual's smile on clinical examination and a part of photographic analysis. The analysis of the smile starts with its classification. Smile can be classified as Social/Posed smile or Enjoyment/Spontaneous smile.^{5, 6} Leonard

Rubin⁷ conducted a study on 100 random individuals both males and females and found that there are three basic patterns of smile- Commissural/Mona Lisa Type, Cuspid Type and Complex Type.

Commissural or Mona Lisa type of smile is the most common type of smile (67% of the population). It is characterized by the corners of the mouth being pulled upwards and outwards and the upper lip contracted by the action of all the elevator muscles displaying the crowns of maxillary anterior teeth as well as the gingival scaffold. Cuspid type of smile is the second most common type of smile (31% of the population) and is characterized by the corners of the mouth being pulled upwards and outwards by the action of levator labii superioris muscles exposing the maxillary canine teeth, with the corners of the mouth at a lower level than the upper lip curvature in the region of the canines. Lastly, the complex type of smile is the least common type (2% of the population) which is characterized by contraction of levators of upper lip and corner of the mouth simultaneously with contraction of the depressors of the lower lip exposing both maxillary and mandibular anterior teeth on smile.

The classification of smile can be done clinically on the patient while routine conversation or on the photographs. Apart from classification, other parameters that are analyzed in a smile include smile arc, buccal corridor space, Morley's ratio, smile index and modified smile index, Golden or divine proportions, incisal edge position, crown inclinations, occlusal cant, dental arch forms and dental and facial midlines.

Smile arc or smile line is the curvature of the incisal edges that coincide with that of the lower lip⁸. The buccal corridor spaces are the lateral negative spaces that are seen between the commissures of the mouth and the posterior most visible teeth in the smile¹. Morley's ratio is the degree of visibility of the maxillary anterior teeth during smile⁸. The smile index and modified smile index are the width to

height relationship of a smile on the photograph⁸.

The present systematic review aims to determine that which amongst the many parameters of smile analysis hold the key to design an esthetically pleasing smile during orthodontic diagnosis and treatment planning.

II. OBJECTIVES

The aim of this systematic review is to appraise the different parameters involved in smile esthetics for facial attractiveness and to determine the most important parameters of an esthetic smile that affect the facial attractiveness on basis of scientific evidences from the existing literature on all the peer-reviewed orthodontic journals according to the Cochrane collaboration principles. With this systematic review, we have attempted to answer these questions:

1. What parameters of smile are analyzed during orthodontic diagnosis and treatment planning?
2. Which are the parameters of a smile that most influence the attractiveness of the face?

III. MATERIAL AND METHODS

Protocol and search strategy

This systematic review was performed according to the guidelines of the Cochrane Handbook for Systematic Reviews of interventions⁹. For this systematic review, all the studies that have analyzed the various parameters of an esthetic smile in attractive faces were screened through literature survey conducted on search engines like PubMed, Google Scholar and Cochrane Library. The survey covered the period from January 2015 to December 2020 using the Medical Subject Heading (MeSH) terms like "Smile esthetics" which was crossed with "Attractive faces" and "Smile analysis" which was crossed with "Parameters" and "Parameters, Orthodontic diagnosis" (Table 1).

Table 1: Search Strategy

Search Strategy Results	
MeSH* Terms	Search Strategy Results
Smile esthetics	1200
Smile esthetics, Attractive faces	770
Smile analysis, Parameters	400

*Medical Search Headings

Eligibility criteria

❖ Inclusion Criteria

- Studies that have analyzed the various parameters of smile in diagnosis and treatment planning.
- Randomized and non-randomized controlled trials, prospective, retrospective observational studies and reviews.
- Photographic and video graphic studies on smile analysis in orthodontic diagnosis and treatment planning.
- Studies with adequate sample size analysis.
- Studies with detailed statistical analysis have been selected.
- Studies published in English language.

❖ Exclusion Criteria

- Case reports.
- Studies using the profile view photographs for smile analysis.
- Descriptive studies.
- Studies regarding smile conducted on models and casts.
- Studies conducted on surgically corrected smiles.

Information sources and study selection

Detailed search from relevant electronic databases was conducted by two reviewers and the studies dated from January 2015 to December 2020 were searched. PubMed,

Cochrane Library and Google Scholar were the search engines from where the articles were searched. The data for this systematic review was collected based on a customized template for data extraction because the selected articles for this systematic review did not necessarily fit into the standard templates for data selection (like PICO). The following are the parameters on the basis of which studies for this systematic review were selected: Sample size, year of study, type of study, language of the study, and the quality of statistical analysis.

The selection of the studies for this systematic review was done by two reviewers. Firstly the articles were selected by screening the titles and abstracts and filtering them according to the inclusion and exclusion criteria. Then detailed screening of thus selected articles was done by going through the full text of each article. This screening procedure was based on the PRISMA guidelines for systematic reviews.

Quality of the evidence

All the data selection for this systematic review was independently conducted by two researchers, and their results were compared to identify the discrepancies. Both the researchers referred to the abstracts of all the studies to be selected. For those studies in which the abstracts did not provide adequate information, the whole articles were completely analyzed. Any inter-examiner conflicts were resolved by discussing the article to reach a consensus regarding the inclusion criteria. After thorough screening, finally 16 articles were selected. The articles selected for this systematic review are all non-clinical studies hence they did not fit into any standard tool for assessment of the methodological soundness. Therefore, the assessment of risk of bias for the studies selected in this systematic review was based on the criteria for methodological scoring given by Witt and Flores-Mir¹⁰ (Table 2).

Table 2: *Criteria for Methodological scoring of selected articles*

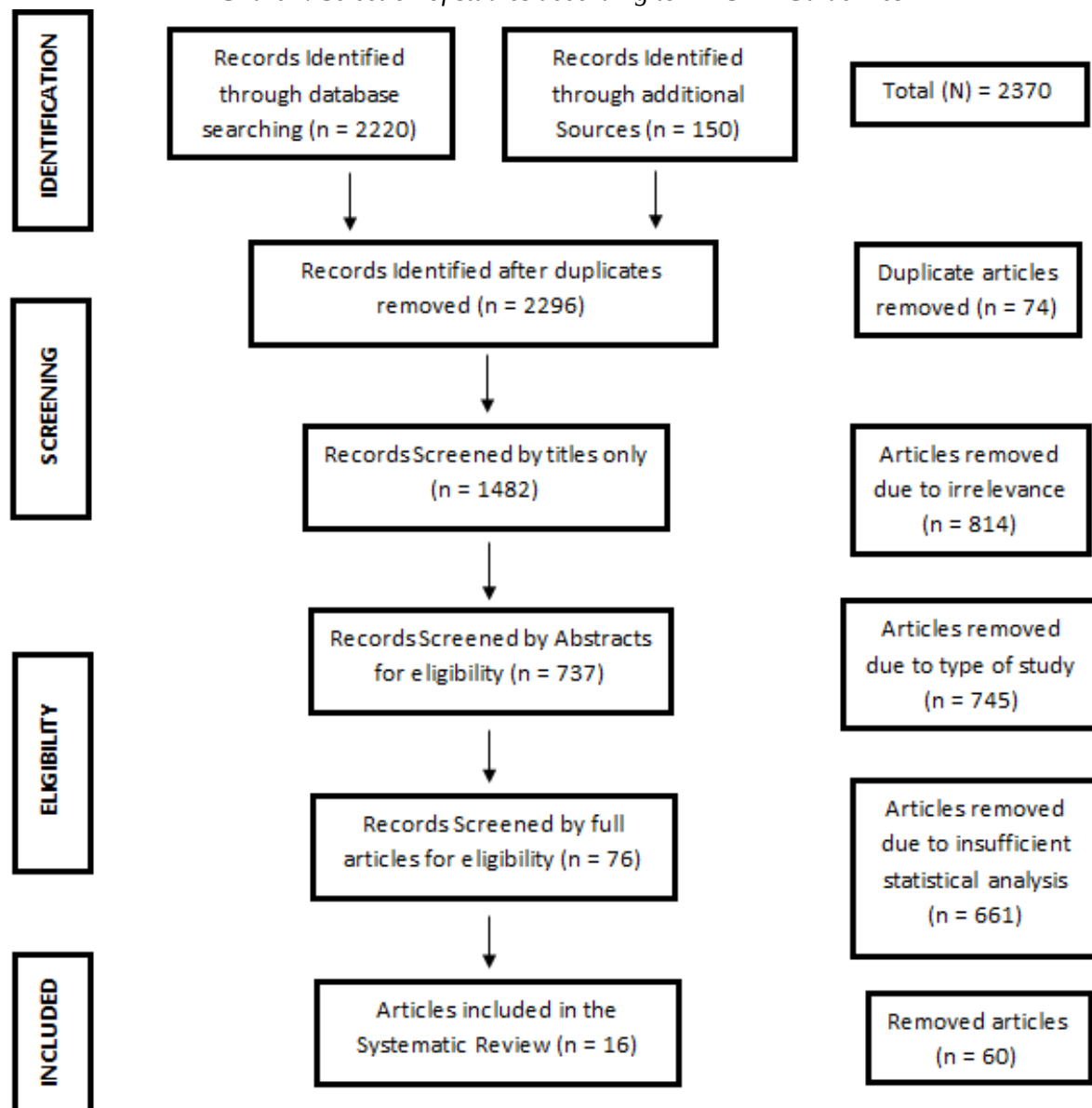
Criterion	Score
Number of participants involved in the evaluation • <10 • 10-29 • 30-99 • ≥100	1/4 2/4 3/4 4/4
Participant source • Not mentioned • Patients or patients' parents from a dental office • People recruited from a public place (mall or neighborhood)	1/3 2/3 3/3
Presentation type • Patient's full-face photograph • Patient's perioral photograph • Patient's intraoral photograph • Intraoral photograph unchanged except for altered teeth • Perioral photograph unchanged except for altered teeth • Full-face photograph unchanged except for altered teeth	1/6 2/6 3/6 4/6 5/6 6/6
Viewing Protocol • Viewing procedure not described • Participant viewed more than one photograph at a time; participant manipulated a digital photograph to find an acceptable value • Participant viewed one photograph at a time; multiple viewings of each photograph allowed • Participant viewed one photograph at a time; no re-reviewing allowed	1/4 2/4 3/4 4/4
Intra-examiner reliability • No test of reliability mentioned • Reliability tested (evaluation repeated or photograph viewings repeated in series)	1/2 2/2
Scoring techniques • Rank ordering of available photographs • "Acceptable" versus "unacceptable" • VAS-like scale or other numerical scoring method	1/3 2/3 3/3

Based on this scoring system, the sixteen articles selected for this systematic review were scored accordingly (Table 3).

Table 3: Quality assessment of the studies

Authors and year of publication	No. of participants involved as judges	Participant source	Presentation Type	Viewing Protocol	Scoring Technique	Intra-examiner Reliability	Total Score
Burcak Kaya, Ruzin Uyar (May 2013) ¹¹	4	3	2	3	3	2	17
Vinod Krishnan, Sunish T. Daniel, Don Lazar, and Abin Asok (April 2008) ¹	3	2	4	2	3	1	15
Christopher Maulik and Ravindra Nanda (November 2005) ¹²	4	3	5	4	3	2	21
Theodore Moore, Karin A. Southard, John S. Casko, Fang Qian, and Thomas E. Southard (November 2003) ¹³	4	3	3	4	3	2	19
Dustin Roden-Johnson, Ronald Gallerano, and Jeryl English (February 2004) ¹⁴	3	3	3	3	3	2	17
Jang-Ching Chou, Aaron Nelson, Diksha Katwal, Eiad N. Elathamna, Marcelo T. Durski (September 2016) ¹⁵	3	2	5	3	3	2	18
Hideki Ioi, Shunsuke Nakata and Amy L. Counts (April 2010) ¹⁶	3	2	6	2	3	1	17
Adam J. Martin , Peter H. Buschang , Jimmy C. Boley , Reginald W. Taylor and Thomas W. McKinney (October 2007) ¹⁷	4	1	2	3	3	2	15

Diana Cunha Nascimento, Êmeli Rodrigues dos Santos, Andre Wilson Lima Machado, Marcos Alan Vieira Bittencourt (August 2012) ¹⁸	4	3	3	1	3	2	16
Chan A. Chang, Henry W. Fields, Jr, Frank Michael Beck, Nathan C. Springer, Allen R. Firestone (October 2011) ¹⁹	3	3	3	3	3	2	17
Serene A. Badran , Mariam Mustafa (July 2013) ²⁰	4	2	4	2	2	2	16
Sapna Singla, Gurvanit Lehl (August 2014) ²¹	3	2	5	4	3	1	18
Suchita Madhukar Tarvade (Daokar), Gauri Agrawal (March 2015) ²²	3	2	5	4	3	2	19
Daltro Enéas Ritter Luiz Gonzaga Gandini Jr Ary dos Santos Pinto Dirceu Barnabé Ravelli Arno Locks (February 2006) ²³	3	2	5	4	3	1	18
Shradha Wahi, Shruti Mittal, Preetinder Singh, Parul Dasson, Priyesha Nohria (January 2017) ²⁴	2	3	6	3	3	1	18
Neha Grover, DN Kapoor, Santosh Verma and Preeti Bharadwaj (December 2015) ²⁵	4	2	4	1	3	2	16

Chart 1: Selection of studies according to PRISMA Guidelines

IV. RESULTS

The search strategy for this systematic review resulted in 2370 articles. After screening these articles through the inclusion and exclusion criteria, finally 16 articles were selected for the systematic review as summarized in Chart 1. The main reasons for the exclusion of the other articles were case reports, descriptive studies, lack of adequate statistical analysis and studies conducted on surgically corrected individuals. These 16 articles included ten Observational photographic studies, one observational video-graphic study, two Cross sectional studies and three Review articles. The study characteristics of the selected studies have been summarized in

Table 4. The following are the parameters that have been extensively evaluated in the analysis of smile.

Smile Arc: From the review it was found that nine^{1, 11, 12, 19-24} out of sixteen studies have put emphasis on the smile arc. Smile arc of the flat type and consonant type are more esthetically acceptable than non-consonant types of smile arcs. Orthodontists and other dental professionals (Prosthodontists, Endodontists, etc.) should formulate treatment plans that end in maintaining a curvature in the smile line or smile arc that follows the curvature of the lower lip (Consonant type). From the studies it was also clear that minor variations in the smile arcs

are known to affect the perception of esthetically pleasing smiles amongst laypersons, dental professionals or orthodontists.

Buccal Corridor Space: In this systematic review it was seen that thirteen^{1, 12-14, 17-25} out of sixteen studies have taken into consideration the role of negative spaces or buccal corridor spaces in the perception of esthetically pleasing smiles. However, the influence of buccal corridor spaces in the perception of smile esthetics is controversial. In this systematic review, out of the thirteen studies that have evaluated buccal corridor space and its importance in the perception of esthetic smiles, there were four studies^{1, 14, 19, 24} which showed that buccal corridor space has minimal role in the perception of esthetically pleasing smiles amongst laypersons, general dentists, dental professionals or orthodontists. But the other nine studies^{12, 13, 17, 18, 20-23, 25} have shown otherwise.

Morley's Ratio: Two^{24, 25} out of sixteen studies in this systematic review have taken into consideration Morley's ratio in the perception of esthetically pleasing smiles. An esthetically attractive smile is the one in which 80% to 100% of the maxillary anterior teeth are visible. Morley's ratio is different in males and females. It is more for males as compared to females.

Smile symmetry: Smile symmetry is an important parameter in the visual perception of an esthetically pleasing smile. Three²¹⁻²³ studies have taken into account this parameter. In an esthetically pleasant smile, the smile should be perpendicular to the facial midline. Symmetric smiles contribute to an esthetically attractive smile.

Smile Index and Modified Smile Index: Smile index is correlated with the growth pattern of an individual. The smile index is a parameter that is analyzed in the smile analysis during the diagnosis and treatment planning. Two^{1, 25} studies in this systematic review have

considered smile index and modified smile index.

Gingival Display: The maxillary gingival display affects the perception of smile significantly. Three^{11, 16, 19} studies have mentioned about gingival display in the perception of esthetically pleasing smiles. All studies showed that minimal degree of maxillary gingival display is esthetically pleasing in a smile.

Incisal Edge Position: The edges of the maxillary anterior teeth play an important role in the smile esthetics. The positions of incisal edges correspond to the smile arc. The incisal edges should follow the contour of the lower lip in good attractive smiles. Three^{15, 21, 22} studies have considered incisal edge positions to play a role in the perception of esthetic smiles.

Arch Form: The arch form corresponds with the buccal corridors as it directly influences the width of the buccal corridor spaces. Wider or broad arch forms tend to reduce the buccal corridor spaces and in such smiles, all the posterior teeth are visible. This is considered to be less esthetically attractive. Two^{14, 21} studies have mentioned of the role of arch forms in the perception of esthetically pleasing smiles.

Dental Midlines: Shifted dental midlines tend to be noticed easily during smile. It is important in an esthetically attractive smile that the maxillary midline coincides with the mandibular midline. However this might not be necessary in smiles in which mandibular dentition is not visible. The maxillary dental midline should more importantly coincide with the facial midline in attractive smiles. One²³ study has covered the role of dental midlines in the perception of esthetic smiles.

Golden Proportions: The Golden proportion, also called Divine proportion could be important in the smile perception and smile designing. The degree of show of the teeth in a smile is determined by the Golden proportion.

In esthetically attractive smiles, the lateral incisors are 0.618 times the mesio-distal width of the central incisors. Similarly, the canines are 0.618 times the width of the lateral incisors. One²² study included in this systematic review has mentioned the importance of Golden proportions in esthetically pleasing smiles.

Apart from these mentioned parameters, there are many other parameters that are not as significant in the determination of esthetically pleasing smiles. These parameters include crown inclinations, the smile pattern and cant of the occlusal plane. These parameters are checked for indirectly when analyzing the other parameters.

Table 4- Study characteristics and various parameters assessed

Sr. No.	Place and Year of study	Type of Study	Panel of Evaluators / Judges	Parameters Assessed	Observations
1	Turkey ¹¹ , 2013	Observational Photographic	210 (70 each of Orthodontists, General dentists and Laypersons)	Smile arc, Buccal Corridor	Flat smile arc and 11% buccal corridor are acceptable.
2	India ¹ , 2008	Observational Photographic	20 (10 each of Dental professionals and Laypersons)	Smile arc, Gingival display	Smile arc and Gingival display are important in perceptions of an esthetic smile
3	USA ¹² , 2007	Observational Video-graphic	2 Authors	Smile arc, Buccal corridor and Modified smile index	Consonant smile arcs are acceptable; Buccal corridors have minimal impact on smile esthetics; Modified smile index has little effect on perception of an esthetic smile.
4	USA ¹³ , 2005	Observational Photographic	30 adult laypersons	Buccal corridor	Minimal buccal corridor spaces in males and females are preferred esthetic.
5	USA ¹⁴ , 2005	Observational Photographic	60 (20 each of Orthodontists, General dentists and Laypersons)	Buccal corridor and Arch form	Buccal corridor does not influence the smile esthetics.
6	USA ¹⁵ , 2016	Observational Photographic	50 laypersons from four different age groups	Smile index and Incisal Edge position	Both, smile index and incisal edge position influence the attractiveness of the smile

7	Japan ¹⁶ , 2010	Observational Photographic	31 Orthodontists and 55 Dental students	Gingival display	No significant influence of gingival display on the smile attractiveness for between both the groups
8	USA ¹⁷ , 2007	Observational Photographic	82 Orthodontists and 94 laypersons	Buccal corridor	Smaller values of buccal corridor spaces are acceptable in an esthetic smile.
9	Brazil ¹⁸ , 2012	Observational Photographic	60 (20 each of orthodontists and laypersons)	Buccal corridor	Medium widths of buccal corridor spaces are acceptable in attractive smiles
10	USA ¹⁹ , 2011	Observational Photographic	100 laypersons	Buccal corridor, Smile arc and Gingival display, incisal-edge discrepancy, cant, overbite, central-incisor gingival margin discrepancy, and maxillary midline to face, and maxillary midline to mandibular midline	Buccal corridor does not have a significant influence; smile arc and gingival display both influence the perception of attractive smiles greatly. Occlusal cant does not influence the attractiveness of the smile.
11	Jordan ²⁰ , 2013	Observational Photographic	104 laypersons and 52 orthodontists	Buccal corridor and Smile arc	Minor variation in the smile arc influences the attractiveness of a smile; however the buccal corridor space doesn't influence it that much.

12	India ²¹ , 2014	Review	NA	Midline, Smile arc, Buccal corridor, Symmetry, Gingival parameters, and Dental parameters	All the mentioned parameters have to be checked during the detailed diagnosis and treatment planning.
13	India ²² , 2015	Review	NA	Smile arc, Buccal corridor, Gingival margin, axial inclination of teeth, tooth proportions and alignment of smile	All the parameters are important and influence the smile esthetics.
14	Brazil ²³ , 2006	Review	NA	Smile line, midlines, gingival exposure, buccal corridor, incisal frames, symmetry and golden proportions, tooth inclinations	The orthodontist must know the esthetic principles that govern facial and dental harmony, achieving optimal tooth positioning within the soft tissue and skeletal characteristics of each patient.
15	India ²⁴ , 2017	Cross sectional Observational Photographic	20 (10 each of Dental professionals and Laypersons	Smile arc, buccal corridor, Morley's ratio	Consonant smile arc and 75-100% Morley's ratio seem to affect the smile esthetics. Buccal corridors seem to have a lesser effect on the smile esthetics.
16	India ²⁵ , 2015	Cross sectional Observational Video-graphic	4 Authors	Upper incisor exposure, Interlabial gap, smile width, buccal corridor	Sexual dimorphism is distinctly seen in the smile parameters. Buccal corridor has positive correlation with smile esthetics.

V. DISCUSSION

The perception of an esthetic smile is highly subjective and it differs from individual to individual. The perception of smile is also different amongst laypersons and dental professionals and orthodontics. Dental professionals seem to scrutinize the smiles more closely and specifically as compared to the laypersons. Correction of smile is one of the most common reasons for individuals to seek orthodontic treatment³. We as orthodontists have to consider smile correction simultaneously along with the correction of the existing malocclusion.

In this systematic review, there were 2370 articles that were reviewed. After filtering them through the inclusion and exclusion criteria for this systematic review, there were sixteen that were selected in the end. There were many parameters that were evaluated in these articles. It was clear from this systematic review that the following parameters are essential to be evaluated during the orthodontic diagnosis and treatment planning: Smile arc, buccal corridor space, Morley's ratio, smile symmetry, smile index & modified smile index, incisal edge position, arch form, dental midlines and Golden proportions.

Smile arc or smile line is the curvature of the incisal edges that coincide with the curvature of the lower lip⁸. When it does, it is said to be a consonant smile arc. Consonant smiles are considered to be esthetically pleasing. The buccal corridor spaces are the lateral negative spaces that are seen between the commissures of the mouth and the posterior most visible teeth in the smile¹. The buccal corridor space is the ratio of inter-canine width to the inter-commissural width¹⁷. The presence of buccal corridor spaces is believed to be controversial in orthodontics. But minimal value of buccal corridor spaces in the smile is considered to be esthetically acceptable. Morley's ratio is the degree of visibility of the maxillary anterior teeth during smile⁸. The degree of visibility of the maxillary anterior teeth should be 75-100%. The smile index is the ratio of inter-commissural width to the inter-vermillion

distance¹⁵. The modified smile index is the ratio percentage of inter-vermillion distance at the midline to the inter-commissural width^{1, 8}. Incisal edge position and arch form correspond to the smile arc and buccal corridor space respectively. The dental midlines coinciding with each other and more importantly the maxillary dental midline should coincide with the facial midline.

Many other parameters like crown inclinations, the smile pattern and cant of the occlusal plane need not be directly assessed because they are indirectly assessed along with the other parameters.

VI. CONCLUSION

With this systematic review it was found that during smile analysis in orthodontic diagnosis and treatment planning the important parameters assessed are smile arc, buccal corridor spaces, Morley's ratio, smile symmetry, smile index/modified smile index, gingival display, incisal edge position, arch form, dental and facial midlines and golden proportions. Hence it can be concluded that these are the parameters that influence the smile significantly and hence the overall facial attractiveness. The smile of an individual is the ornamental factor which enhances the face value. Amongst various analyses available to assess the face value, smile analysis in orthodontic diagnosis and treatment planning is of prime importance. Addressing the smile is an imperative key to patient satisfaction. Hence orthodontic diagnosis must include detailed smile analysis to enhance esthetic harmony.

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