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Smile Aesthetics

Abstract: The aim of this article is to outline some of the factors practitioners should take into consideration when planning optimal smile aesthetics. The components of the smile that will be discussed include the smile arc, incisor/gingival display, smile width, gingival aesthetics, tooth proportionality/symmetry, contacts/connectors/embrasures and the dental midlines.

Clinical Relevance: A systematic evaluation of the components of the smile when planning treatment will help to improve smile aesthetics and produce greater patient and dentist satisfaction.

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The demand for cosmetic dentistry has increased during the last decade. Patients often present for treatment wanting and expecting an improvement in their smile aesthetics. It is important for dentists to be able to quantify the components of a smile so that improvements can be made. With modern restorative and orthodontic techniques it is possible to create ideal smile aesthetics, assuming that the components of the smile are understood and certain principles are followed. The aim of this article is to outline the factors that are important in producing a pleasing smile. Although tooth colour is an important consideration in smile aesthetics, it will not be considered in this article.

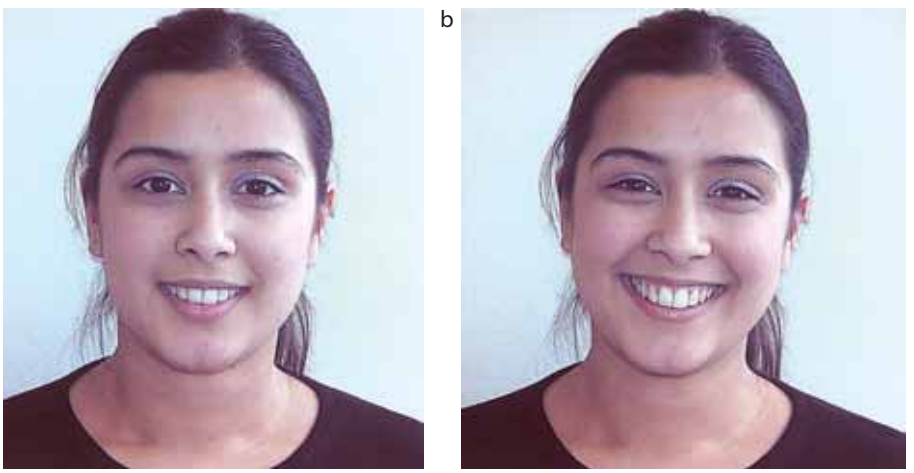

Figure 1. (a, b) A posed smile is a voluntary smile that is fairly reproducible. A spontaneous smile is an involuntary smile linked with emotion and involves greater facial expression.

Types of smile

Two types of smile have been described within the literature:

- The posed smile – this is a voluntary smile (Figure 1a), may not be linked with emotion and is fairly reproducible.
- The spontaneous smile – this is an involuntary smile (Figure 1b), is often linked with emotion and involves larger facial movements including squinting of the eyes, flaring of the nostrils and maximal elevation of the lips.

The generation of a smile

Two stages of smile formation have been described:[1]

Stage One

The levator muscles contract and raise the upper lip until resistance is met from the cheek fat present in the nasolabial folds.

Stage Two

This involves further lifting of the upper lip against the resistance of the nasolabial folds and also raising of the nasolabial folds themselves. Various muscle groups are involved in this movement including the levator labii superioris muscles, the zygomaticus major and superior fibres of the buccinator muscle. The

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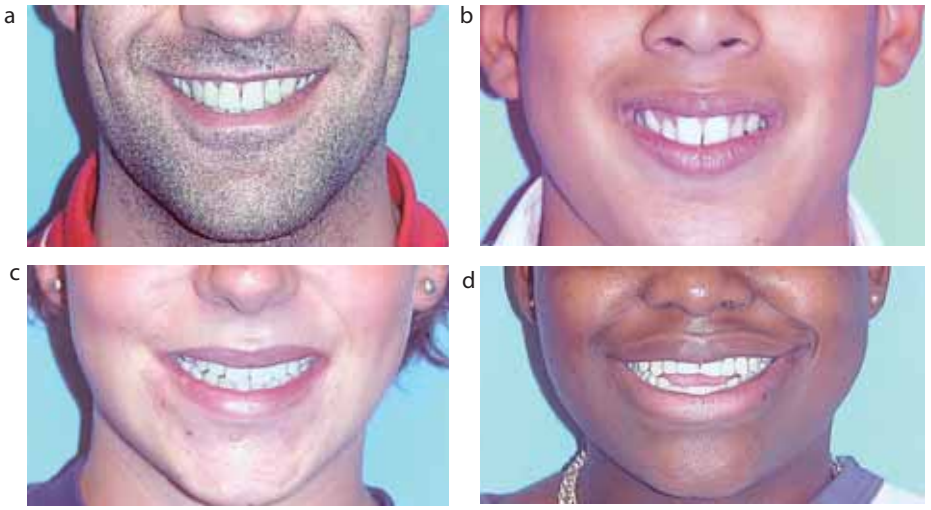

Figure 2. (a–d) In an ideal smile arc the incisal edges lie just above and follow the curvature of the lower lip. The aesthetic appearance is not as pleasing if the incisal edges lie below **(b)** or above **(c)** the curvature of the lower lip. **(d)** A flat smile arc is not as aesthetically pleasing and can be a feature of old age if there has been significant toothwear.

Figure 3. This graph illustrates the relationship between ageing and changes in upper and lower incisor exposure. Maxillary incisor exposure generally reduces with ageing, whilst mandibular incisor exposure increases with more advanced ageing.[5]

Figure 4. Excess lower incisor exposure can be associated with Class III malocclusion.

orbicularis oculi muscles may also participate in the effort to raise the lip against the nasolabial fold, which produces the characteristic squinting that accompanies a spontaneous smile.

Components of the smile

Important components of the smile that will be considered include:

- The smile arc;
- Incisor and gingival display;
- The width of the smile;
- Gingival aesthetics;
- Tooth proportionality and symmetry;
- Contacts, connectors and embrasures;
- The dental midlines.

The smile arc

The smile arc may be defined as the relationship of the curvature of the incisal edges of the maxillary incisors to the curvature of the lower lip in the posed smile.[2] Ideally, the incisal edge curvature should be parallel and just above the level of the lower lip (Figure 2a-c). A flat smile arc (Figure 2d) is considered an unattractive feature and can be a sign of ageing. It is important that the smile arc is not flattened by treatment, as has been reported in a large number of cases.[3] Important factors to consider when planning the smile arc include the vertical positioning of the incisor and canine brackets during orthodontic treatment, the method of overbite reduction (ie lower or upper incisor intrusion) or anterior restorations if restorative treatment is being undertaken.

Incisor and gingival display when smiling

The ideal amount of maxillary incisor exposure in relation to the upper lip at rest is considered to be 2–4 mm, with females showing more incisor than males on average. During spontaneous smiling the entire crown of the maxillary incisors should be displayed, in addition to 1-2 mm of gingival margin, to give a youthful appearance. A significant sexual dimorphism exists in maxillary incisor exposure during smiling, with female subjects showing 1-2 mm more tissue than males.[4] A high lip line is generally less prevalent among male subjects. With ageing and changes in muscle tone, it is normal for maxillary incisor show to decrease and mandibular incisor show to increase at rest and on smiling (Figure 3). Excess lower incisor exposure can also be a feature of Class III malocclusion (Figure 4). The causes and management of excess and deficient tooth/gingival display are summarized in Tables 1 and 2. Figure 5 shows examples of cases with various degrees of tissue show when smiling.

The width of the smile

The buccal corridor (also termed 'negative space') is the space created between the buccal surfaces of the posterior teeth and the commissures of the mouth when smiling. For ideal aesthetics, the teeth should fill the corners of the mouth to produce a full smile (Figure 2a).[10] A large buccal corridor (Figure 6) may be seen in cases where the transverse width of the dental arches is reduced or where the dental arches are retropositioned. A range of orthodontic techniques are available to increase arch width to improve archform

Aetiological factors	Treatment
Vertical maxillary excess (VME)	Children: Orthodontics to intrude incisors (eg maxillary intrusion splint) Adults: Orthognathic surgery involving maxillary impaction
Short upper lip (Normal upper lip length for males = 22±2 mm and females = 20±2 mm)[6]	Await completion of growth. Lip lengthening surgical treatment may result in small improvement
Delayed apical migration of the gingival margin	Gingivectomy
Excess muscular activity raising upper lip	Botox[7] or Surgical immobilization (Kamer technique[8])
Retroclined incisors	Orthodontic treatment

Table 1. Causes of excess gingival display and possible treatment options.

Aetiological factors	Treatment
Vertical maxillary deficiency (VMD)	Orthognathic survery involving maxillary down grafting
Long upper lip	Surgical lip lift
Incisal edge attrition (Normal upper incisor crown height males = 10.5 mm and females = 10 mm)[9]	Restorative treatment
Deficient anterior alveolar development (eg digit sucking)	Terminate habit
Proclined incisors	Orthodontic treatment

Table 2. Causes of deficient tooth display and possible treatment options.

Figure 5. (a) This patient has excess anterior and posterior gingival display on smiling due to vertical maxillary excess, whereas the patient in **(b)** has a lack of tooth display on smiling. The patient in **(c)** shows more gingivae on smiling on the right side and this is due to the presence of a maxillary occlusal cant **(d)** which can be corrected surgically.

Figure 6. The buccal corridor is enlarged and the patient would benefit aesthetically with a small degree of maxillary expansion given that there is a crossbite that requires correction.

and surgery can be used to reposition retropositioned arches. It has been suggested that extraction of premolars during orthodontic therapy leads to narrowing of the smile and a reduced fullness of the dentition, however, the evidence would suggest that extractions do not adversely affect smile aesthetics.[11]

Gingival aesthetics

For ideal gingival aesthetics, the gingival level of the maxillary lateral incisors should be slightly lower than that of the central incisors and canines and the level of the gingival margins of the maxillary central incisors, and canines should be equal (Figure 7). The interdental papilla should fill the space below the contact area of adjacent teeth. Gingival aesthetics are particularly important when the lip line is high and the gingival margins are clearly visible. Common situations where discrepancies may arise include:

- When a maxillary incisor is worn or fractured and continues to erupt;
- When canines are substituted for lateral incisors;

Figure 7. The maxillary central incisor and canine gingival margins should ideally be at a similar horizontal level and the lateral incisor gingival margin should be 1 mm below for ideal aesthetics.

Figure 8. The most apical point of the gingival margin (Zenith) is coincident with the long axis of the maxillary lateral incisor crown and distal to the long axis of the maxillary central incisor and canine crown for a natural appearance.

Figure 9. A symmetrical dental arrangement produces the most pleasing dental appearance.

- Severe crowding;
- Immaturity of the gingival margins;
- Following periodontal disease;
- Ankylosis.

The cement-enamel junction and the level of the alveolar crest determine the level of the gingival margin. It can be modified by selective intrusion or extrusion of teeth with orthodontic appliances or periodontal surgery, which may involve osseous recontouring. Orthodontic extrusion maintains the relationship between the gingival tissues and the cement-enamel junction, results in bone deposition and produces an increased width of attached gingivae. Animal studies suggest the amount of vertical gain achieved in the gingival level during extrusion will generally be approximately 80% of the distance that the tooth is extruded.[12] More data is required on the clinical effects of intrusion in humans, however, animal studies suggest that the gingivae move approximately 60% of the distance that the teeth are intruded and the gingivae also tend to bunch up, which may result in a shortening of crown height in the short term.[13] A stable occlusal contact is required to maintain an intruded tooth position successfully.

When examining the gingivae around individual teeth, the gingival shape of the mandibular incisors and maxillary lateral incisors should exhibit a half circular shape.[14] The maxillary central incisors and canines exhibit a more elliptical gingival shape with the zenith (most apical point of the gingival tissue) located distal to the longitudinal axis of the tooth (Figure 8). Periodontal surgery can be used to produce the ideal gingival shape around individual teeth.[15]

Tooth proportionality and symmetry

A symmetrical dental arrangement is an important component of an aesthetic dental appearance (Figure 9).

The maxillary lateral incisor is often peg-shaped or fails to develop. Often, patients will require orthodontic treatment to create the ideal size space for restoration. If only one lateral incisor is missing or peg-shaped, the lateral incisor that is present can be used as a guide to decide how much space should be created for the absent/abnormal tooth. However, if both teeth are missing or misshapen, the decision concerning how much space should be created is determined by aesthetic factors and the occlusion.[16] Aesthetically, the lateral incisor should be two-thirds of the width (based on the golden proportion) of a central incisor.[17] Therefore, if a central incisor is nine millimetres wide, the lateral incisor should be six millimetres wide. Occlusally, if the correct posterior intercuspation is produced, along with a normal overjet and overbite, the space for the lateral incisor may be less than ideal because of the presence of a tooth-size discrepancy. In such cases, interproximal enamel reduction may be undertaken on the distal surface of the central incisor and mesial surface of the canine in order to produce the correct amount of space. When planning such cases, it may be of benefit to prepare a Kesling (diagnostic) set up in order to help predict the final outcome and obtain informed consent. It is essential that a joint orthodontic-restorative opinion is arranged when planning such cases, and that a final restorative opinion is obtained before removing fixed appliances, to ensure that the correct amount of space is present between both the crowns and roots of teeth if implant treatment is to be considered in the future.

Another situation that may be encountered is where a central incisor is misshapen as a result of a developmental deformation or attrition. The ideal maxillary central incisor should be approximately 80% width compared with height[18] and this ratio is useful when planning the size of a build up. On average, a central incisor may be between 8.4–9.3 mm wide and between 10.4–11.2 mm in height.[14]

Embrasures, contacts and connectors

The pattern of the embrasures, contacts and connectors also influences the development of an aesthetic smile. Embrasures are the spaces between the edges of the teeth (Figure 10). Ideally, the embrasure space between the maxillary central incisors, the central incisors and lateral incisors and the lateral incisors and canines gets larger as one progresses distally. This is a useful relationship to be aware of, particularly when restoring the

Figure 10. The dotted lines outline the embrasure spaces between the anterior teeth. For ideal aesthetics the embrasures increase in size as one moves distally from the maxillary central incisors to the canines.

Figure 11. This figure shows the connector areas between the anterior maxillary teeth and their ideal length as a percentage of the central incisor crown.

Figure 12. Maxillary centreline discrepancies where the dental centreline is not coincident with the philtrum or where the centreline is canted can appear unaesthetic. In this example, the maxillary centreline is canted in relation to the true vertical and is very noticeable.

incisal edges of anterior teeth.

The connector is defined as the zone in which two adjacent teeth appear to meet (Figure 11). The ideal connector area between the central incisors is 50% of the length of the crowns, between the maxillary central incisor and lateral incisor is 40% of the length of the crown of the central incisor, and between the lateral incisor and canine is 30% of the length of the central incisor crown. The contact areas between anterior teeth are smaller than the connectors and are the points where the teeth actually meet.

The dental centrelines

Ideally, the dental centrelines should coincide with the facial midline. Although an incorrectly placed lower dental centreline is unlikely to affect smile aesthetics adversely, it is important to have coincident centrelines to produce a well intercuspated occlusion. The maxillary dental centreline should be judged in relation to the midpoint of the philtrum (Cupid's bow) as often the nose may be slightly asymmetrical, making assessment difficult. Studies have shown that maxillary dental centreline discrepancies greater than 2–4 mm are generally unacceptable, implying that a small (< 2 mm) centreline discrepancy may be largely unnoticeable.[19] What is more noticeable than a small centreline displacement is when the axial incisor angulation is incorrect (Figure 12). Angulations of greater than 6 degrees were found to be unacceptable, when judged by orthodontists, and greater than 10 degrees, when judged by lay people.[20]

Conclusions

A number of different factors, excluding tooth colour, that contribute to the aesthetics of the smile have been summarized. For smile improvement it is essential that all these aspects are examined and the use of clinical photographs can be a useful adjunct. For maximum smile benefits, it may be necessary for patients to have multidisciplinary care principally involving orthodontics and restorative dentistry.

References

1. Rubin LR, Mishriki Y, Lee G. Anatomy of the nasolabial fold: the keystone of the smiling mechanism. *Plast Reconst Surg* 1989; **83**: 1–8.
2. Sarver DM. The importance of incisor positioning in the esthetic smile: the smile arc. *Am J Orthod Dentofacial Orthop* 2001; **120**: 98–111.
3. Ackerman JL, Ackerman MB, Brensinger CM, Landis JR. A morphometric analysis of the posed smile. *Clin Orthod Res* 1998; **1**: 2–11.
4. Peck S, Peck L, Kataja M. The gingival smile line. *Angle Orthod* 1992; **62**: 91–100.
5. Sarver DM, Proffit WR, Ackerman J. Diagnosis and treatment planning in orthodontics. In: *Orthodontics: Current Principles and Techniques*. Graber TM, Vanarsdall RL, eds. St Louis: Mosby, 2000; pp. 3–115.
6. Farkas LG, Katic MJ, Hireczko TA, Deutsch C, Munro IR. Anthropometric proportions in the upper lip-lower lip-chin area of the lower face in young white adults. *Am J Orthod* 1984; **86**: 52–60.
7. Polo M. Botulinum toxin type A in the treatment of excessive gingival display. *Am J Orthod Dentofacial Orthop* 2005; **127**: 214–218.
8. Kamer FM. Smile surgery. *Laryngoscope* 1979; **89**: 1528.
9. Gillen RJ, Schwartz RS, Hilton TJ, Evans DB. An analysis of selected normative tooth proportions. *Int J Prosthod* 1994; **7**: 410–417.
10. Moore T, Southard KA, Casko JS, Qian F, Southard TE. Buccal corridor and smile aesthetics. *Am J Orthod Dentofacial Orthop* 2005; **127**: 208–213.
11. Johnson DK, Smith RJ. Smile aesthetics after orthodontic treatment with or without extraction of four first premolars. *Am J Orthod Dentofacial Orthop* 1995; **108**: 162–167.
12. Kajiyama K, Murakami T, Yokota S. Gingival reactions after experimentally induced extrusion of the upper incisors in monkeys. *Am J Orthod Dentofacial Orthop* 1993; **104**: 36–47.
13. Murakami T, Yokota S, Takahama Y. Periodontal changes after experimentally induced intrusion of the upper incisors in *Macaca fuscata* monkeys. *Am J Orthod Dentofacial Orthop* 1989; **95**: 115–126.
14. Sarver DM. Principles of cosmetic surgery in orthodontics: Part 1. Shape and proportionality of anterior teeth. *Am J Orthod Dentofacial Orthop* 2004; **126**: 749–753.
15. Sarver DM, Yanosky M. Principles of cosmetic dentistry in orthodontics: Part 2. Soft tissue laser technology and cosmetic gingival contouring. *Am J Orthod Dentofacial Orthop* 2005; **127**: 85–90.
16. Spear FM, Mathews DM, Kokich VG. Interdiciplinary management of single-tooth implants. *Semin Ortho* 1997; **3**(1): 45–72.
17. Kokich V. Anterior dental aesthetics: an orthodontic perspective III. Mediolateral relationships. *J Esthet Dent* 1993; **5**: 200–207.
18. Gurel G. *The Science and Art of Porcelain Laminate Veneers*. New Malden: Quintessence, 2003.
19. Johnston CD, Burden DJ, Stevenson MR. The influence of dental to facial midline discrepancies on dental attractiveness ratings. *Eur J Orthod* 1999; **21**: 517–522.
20. Thomas JL, Hayes C, Zawaideh S. The effect of axial midline angulation on dental aesthetics. *Angle Orthod* 2003; **73**: 359–364.