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Smile: A key factor in orthodontic treatment

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Abstract
Orthodontics plays a pivotal role in enhancing facial aesthetics, with the smile being one of the most significant features influenced by dental alignment. This article provides a comprehensive review of the smile, focusing on its classification, analysis, and the techniques used to preserve its natural aesthetics during orthodontic treatment.

Keywords: Smile, smile arc protection (SAP), components, smile index, SAMRA

Introduction
The pursuit of enhanced dentofacial aesthetics remains a significant focus in contemporary society. This articles covers smile as a whole and various bracket positioning to protect the smile arc. The smile, which may be observed on both the upper and lower lip, is composed of the teeth and the gingival scaffold. Some examples of soft tissue parameters include the thickness of the lip, the breadth of the intercommissure, the smile index (width/height), and the architecture of the gingiva [1].

Dentofacial esthetics
The following three phases should be used to conduct a methodical assessment of the appearance of the face and teeth:
1. The dimensions of the face in all three spatial planes (macro-esthetics)
2. The relationship between the face and the teeth (mini-esthetics).
3. The position of the teeth relative to each other (micro-esthetics)

Smile Classification
There are two main kinds of smiles (Fig. 1)
1. **Social/Posed Smile:** The social smile, commonly used as a greeting, is a voluntary and unstrained facial expression that remains static.
2. **Enjoyment/Spontaneous Smile:** Taking pleasure in smiling is an automatic response to joyful emotions like laughing or extreme pleasure. It causes the lips to swell to their maximum size, exposing more of the gums and teeth in the front [3, 4].

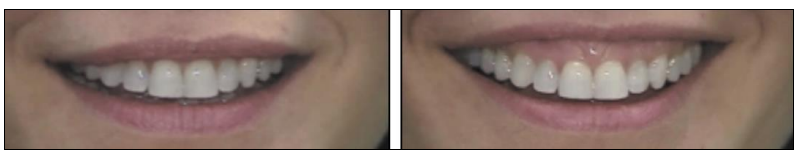

Fig 1: Gingival display in A.posed smile B. unposed smile

Smile style is an important soft-tissue factor in defining the dynamic display zone. There are three primary styles: the Mona Lisa smile, cuspid smile, the complex smile.
1. **The Mona Lisa Smile:** When one smiles, the zygomaticus major muscles pull the corners of the mouth forward and outward, and then the upper lip is lifted slightly.

Patients with a Mona Lisa smile typically display less gingiva and fewer teeth compared to those with a complex smile.

2. **The Cuspid (or Commissure) Smile:** In this smile, all the upper lip elevators engage, raising the lip like a window shade to expose both the teeth and the gingival tissue.
3. **The Complex (or Full-Denture) Smile:** In this technique, you lift your upper lip like a window shade and lower lip like a window pane by using the upper lip elevators and lower lip depressors at the same time [1, 5].

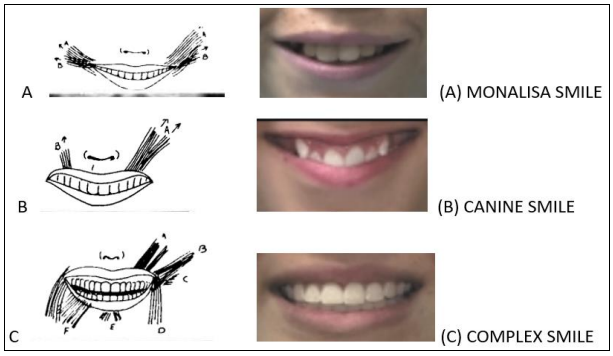

Fig 2: Types of smile style

Smile analysis

Smile analysis can be conducted using two methods:

1. Static Records
2. Dynamic Records

Static records gather images, radiographs, and primary casts. Various face expressions may be captured by digital cameras, such as:

- Frontal at rest
- Frontal smile
- Oblique facial smile (to evaluate the occlusal plane, palatal cant, overjet, etc.)
- Close-up oblique smile (for assessing crown height and gingival architecture)
- Profile smile.

Dynamic records involve capturing the smile and speech in motion, typically using digital videography. With digital video technology, we can capture up to 30 frames per second in both straight ahead and slanted perspectives. In order to evaluate the repeatability and dependability of posed grin images, Ackerman *et al*. created SmileMesh, a software [1, 6].

Smile index

Ackerman *et al*. defined the Smile index as the ratio of the inter-labial gap to the inter-commissural width when smiling. When the aesthetic smile index is between 5.0 to 7.5, it is considered to be within the normal and acceptable range [8, 9]. (Fig. 3).

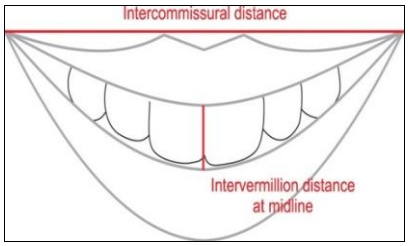

Fig 3: Smile Index

Smile mesh

The concept of Smile Mesh was first introduced by Hulsey [9], and later computerized by Ackerman *et al*. [3]. The mesh is created using a posed smile photograph, where an adjustable grid is superimposed. Three horizontal and four vertical lines make up this grid, and you may drag and drop them over the picture to reposition it. The Smile Mesh is designed to measure 11 key attributes of a smile (Fig. 4).

	Horizontal lines (H)		Vertical lines (V)
1	The tangent to the most inferior point on the upper lip, which is also known as the smile line	1	Distal to the canine on the left and right side
2	A line that is perpendicular to the upper right centre and tangent to the most incisal point;	2	Commissures of lips
3	A line drawn along the lower lip's superior edge that is perpendicular to the deepest midline point		

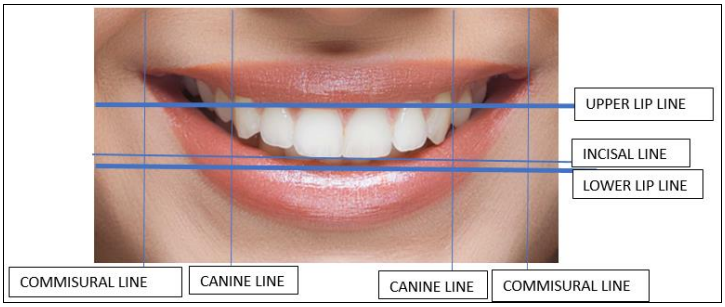

Fig 4: Horizontal and vertical lines for smile mesh

11. Attributes

1. Maxillary incisor exposure
2. Upper lip drape (amount of gingival show)
3. Lower lip to maxillary incisors
4. Inter labial gap
5. Inter canine width
6. Smile width
7. Buccal corridor left
8. Buccal corridor right
9. Buccal corridor ratio (inter canine width/smile width)
10. Smile index (smile width / inter labial gap)
11. Smile arc

Components and commandments of smile

8 Components of Smile: (Fig 5)

Roy sabri [10] has given eight components for a balanced smile that includes.

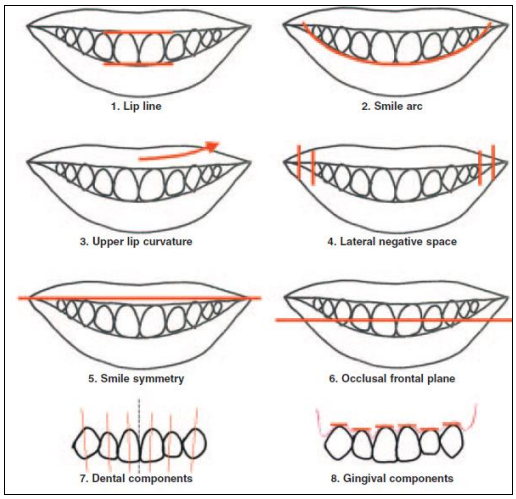

Fig 5: Eight components of balanced smile

10. Commandments of Smile

Andre Wilson Machado [11] has outlined ten key principles for achieving an ideal smile. These principles are as follows: Andre Wilson Machado [11].

1. **Smile arc**
2. **Symmetry and Proportion of Maxillary Central Incisors:** Maintaining the appropriate ratio and symmetry is essential.
3. **Proportions of the Anterior Teeth:** The ratio among the anterosuperior teeth should be harmonious.
4. **Space in the Antero superior Region:** Well-defined, tight contacts in the anterior teeth. Midline diastema and spacing is not considered esthetic.
5. **Gingival Contour:** The design and health of the gingiva play a significant role.
6. **Gingival Exposure Levels:** The extent of gingival visibility should be well-balanced.
7. **Buccal Corridor**
8. **Midline Alignment and Tooth Angulation:** The alignment of the midline and the angle of the teeth contribute to the overall appearance.
9. **Tooth Details:** Factors such as tooth color and anatomical shape are important for a natural look.
10. **Lip Volume:** The volume and positioning of the lips enhance the overall smile aesthetics.

Lip line [10]: The lip line indicates the degree of vertical tooth visibility when a person smiles. Specifically, the height of the upper lip relative to the maxillary central incisors. It is influenced by six key factors:

- Length of the upper lip
- Elevation of the lips
- Height of the maxilla in the vertical dimension
- Height of the dental crown
- Vertical dimension of the teeth

Female lip lines are 1.5 mm higher on average than male lip lines. A gingival display of 1-2 mm at maximum smile is considered normal for females.

Morley's Ratio [12] refers to the percentage of incisal exposure in a posed smile relative to the clinical crown height. A normal bite is defined as having seventy-five to one hundred percent of the upper incisors visible below a hypothetical line formed between the commissures.

The smile arc: [10, 11]

When you smile, your lower lip will follow a hypothetical arc that runs along the borders of your upper teeth. This curve is called the Smile Arc. The types of smile arc include:

- **Consonant**
- **Non-Consonant:** Flat/Reverse (Fig. 6)

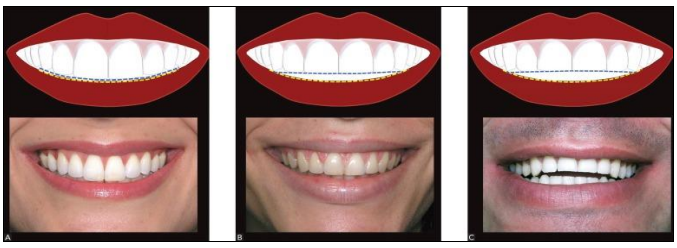

Fig 6: Smile arc - a consonant b.flat c. Reverse

Smile arc is affected by the following factors

- Excessive Intrusion of Upper Incisors
- Placement of Orthodontic Brackets
- Tilt or Angle of the Occlusal Plane
- Wear and Shortening of Central Incisors Due to Attrition
- Oral Habits, Including Thumb Sucking
- Enhanced Vertical Growth in the Posterior Region
- Muscular Structure of the Lower Lip
- Inclination of the Upper Incisors

Upper Lip Curvature [10] is evaluated from the centre of the lips to the corners of the mouth while smiling. (Fig. 7). The classifications of upper lip curvature include:

- Upward
- Straight
- Downward

Fig 7: Upper lip curvature - A Upward B. Straight C. Downward

The Buccal Corridor Space, also the lateral negative space that shows up when you smile, between the teeth and the corners of the mouth, is called transverse dental projection.
When a person smiles, the mouth's width can expand by up to 30%, meaning that significant transverse lip extension might result in a broader buccal corridor.
Johnson and Smith [13] proposed a method for evaluating the proportion of negative space during a smile. This method involves measuring the width of the maxillary dental arch as shown in a smile photograph and calculating its proportion relative to the distance between the lip commissures. This provides an assessment of how much of the space between the lip corners is occupied by the dental arch.
Aesthetic standards for this measurement are outlined in Table 1.

Table 1: Aesthetic Variables for Maximum and Minimum Acceptability in Relation to Facial Attractiveness and Gender

	Smile variable	Gender	Maximum	Minimum
1	Buccal corridor (percentage of dark space of inter commissure distance)	M	24	15
		F	14	10
2	Gingival display (mm of tooth coverage)	M	0.5	1
		F	0.5	0.5
3	Upper Midline to Face (Shift)	M	2.3	0
		F	2	0

Typically assessed by comparing the commissural line to a vertical plane, which shows how the corners of the mouth are aligned. (Connecting the corners of the mouth) and the pupillary line (connecting the centers of the pupils). Asymmetry may be indicated by discrepancies in this alignment.
Myofunctional exercises are sometimes prescribed as a remedy smile asymmetry and balance. Facial muscle strengthening and coordination helps to achieve an harmonious smile.

Dental Components involved in smile aesthetics include

1. Midlines
2. Angulations
3. Space connectors / Interproximal contacts
4. Golden proportion
5. Width/height ratio of the maxillary central incisors
6. Position of the incisal edges of the anterior teeth

Midlines: Research suggests that midline deviations of 3-4 mm or less are not noticeable to laypeople [14].

Angulations: Minimum of 2 mm change in the angulation of the anterior teeth in are considered unesthetic by laypeople [14].

Space Connectors / Interproximal Contacts: In a frontal grin shot, the connector space is the area where the front teeth seem to contact. The optimal spacing between the front teeth of the upper jaw, as dictated by the 50-40-30 rule, is:

- The recommended connector space between central incisors is 50% of their whole vertical length.
- Recommended spacing between lateral incisors and central incisors is 40% of their total crown length.
- The ideal distance between the canines and the lateral incisors is 30% [15] (Fig. 8).

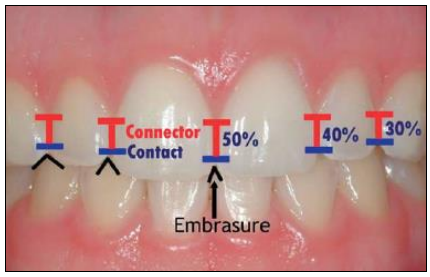

Fig 8: Space connectors

Golden Proportion: Levin first introduced the Golden Ratio in 1978[16]; it specifies a width proportion of the front teeth when seen in the frontal plane. According to Levin, the upper lateral incisor visibility during smile should be 62% of the width of the central incisor and that of adjacent canine be 62% of lateral incisor width [19].
To reiterate, the Golden Proportion states that the , central incisor, lateral incisor, and canine should have relative diameter proportions of 1.618:1.0:0.618, respectively. (Fig. 9).

Fig 9: Golden proportion

Width/Height Ratio: A maxillary central incisor should have a breadth to height ratio of around 80%. Nevertheless, this ratio is flexible and may range from 66% to 80%. The tooth appears more squared off with a lower width-to-height ratio, and more extended with a greater ratio [15]. (Fig. 10).

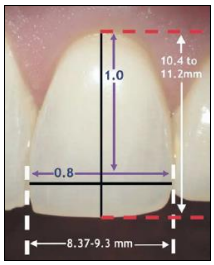

Fig 10: Width to Height ratio

Position of the Incisal Edges of the Anteriors

Aesthetically, there should be a distance of 0.5-1.0 mm for men and 1.0-1.5 mm for women between the central and lateral incisors. Also, the incisal edge of central incisor should be below the cusp tip of the canine for the best consonant arc [17]. (Fig. 11).

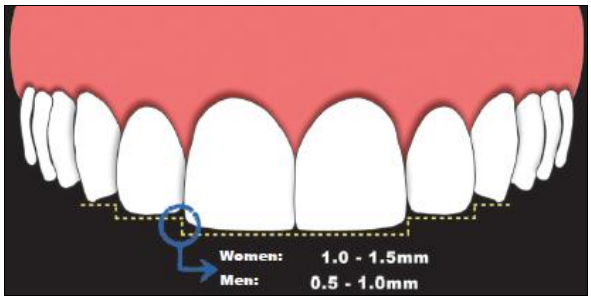

Fig 11: Level of the Incisal edges in the Anteriors

Gingival components

1. Gingival Margins
2. Gingival Embrasures
3. Health of the Gingiva

Gingival Margins: The following traits are often seen in the most beautiful smiles:

- The central incisors' gingival borders are either flush with the canines' or set half a millimetre to a millimetre below them.
- A space of 1-2 millimetres between the central and lateral.
- Gingival exposure of 1.0 mm to 2.0 mm.

These proportions contribute to a balanced and harmonious smile [18].

Gingival Embrasures: Up to the sites of contact, the interdental papillae should occupy the gaps between teeth. However, if the contacts are too tight or misaligned, the papillae may fail to completely fill the embrasure spaces.

Unsuitable gaps between teeth might persist. In central incisors, the papilla and contact form a 1:1 connection, which is why the interdental space is divided evenly between the two [17].

Black Triangles: A "black triangle," may result from the papilla's absence above the place where the central incisors meet for a number of reasons, such as severe periodontal disease, triangular tooth morphologies, or root divergence. This issue could be resolved by extending the contact area and moving it apically towards the papilla with a slenderization procedure. The central incisors' mesial surfaces are flattened and aligned parallel to the roots during this procedure [10].

Why to protect the smile arc?

The smile arcs of orthodontically treated individuals were seen to be flatter than those of an untreated group with normal occlusions, which often led to the development of a "denture mouth" look. In a another research, only two out of thirty untreated people showed signs of a flattening of the grin arc, but one-third of the thirty treated patients did [3, 9, 10].

Bracket positioning for smile arc protection (SAP)

Bracket placement that safeguards or improves the grin arc is called SAP [21].

To safeguard the grin arc, two bracket placement options have been suggested:

A novel approach to vertical bracket placement based on the effect on the grin arc was proposed by Dr. Tomás Castellanos and Thomas Pitts [20]. In their view, the occluso-gingival location of the bracket slot and the occlusal cusps or incisal margins must remain diverged in order to provide an attractive grin curve and a functionally appropriate occlusion. A key factor in the ultimate appearance of the smile is the divergence, which is measured in millimetres from the second molar tube to the maxillary central incisor.

The amount of overbite that will be attained at the conclusion of treatment may be predicted by comparing the millimetre difference between the slot height at the central incisor and the height at the second molar tube, which is a key divergence (Fig. 12). It has an effect on the occlusal plane's cant as well.

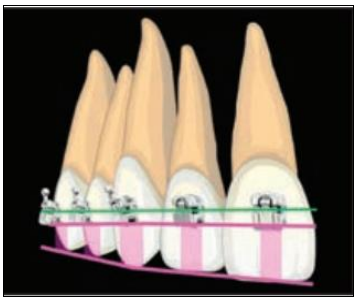

Fig 12: Maxillary anterior brackets should be positioned more gingivally for SAP than in traditional techniques. Divergence of the wire rom the cusp tips or incisal edges increase from posterior to anterior

Improving the smile curve and enamel visible by further extruding the maxillary incisors might lead to a deeper bite by increasing the overbite. The table recommends repositioning in the mandibular canine-to-canine brackets to compensate and avoid this result.

Procedure for Using the Chart

Some patients may need to undergo recontouring before they can use the chart to get their teeth to look the way they want. This could involve ameloplasty and gingivoplasty to properly shape both the teeth and the gingiva.

Once the ideal dental morphology is achieved, the following steps should be followed to select the appropriate bracket bonding heights for the maxillary arch (Fig. 13):

1. Measure the length of the maxillary canine crown from tip to gingiva.
   Locate this measurement in the GPS-A table's columns and choose the row that corresponds to it. The optimal placement of each bracket is denoted by this numerical value.
2. Apply the same technique to the mandibular arch:

a. After recontouring and gingivoplasty, quantify the length

of the mandibular canine crown, starting at the incisal edge and ending at the gingival zenith.

b. Select the next number in the matching row when you locate this measurement in the GPS-A (Guide Position Smile-Arc Lower) column. You may use this number as a reference to determine which bracket goes on which mandibular teeth.

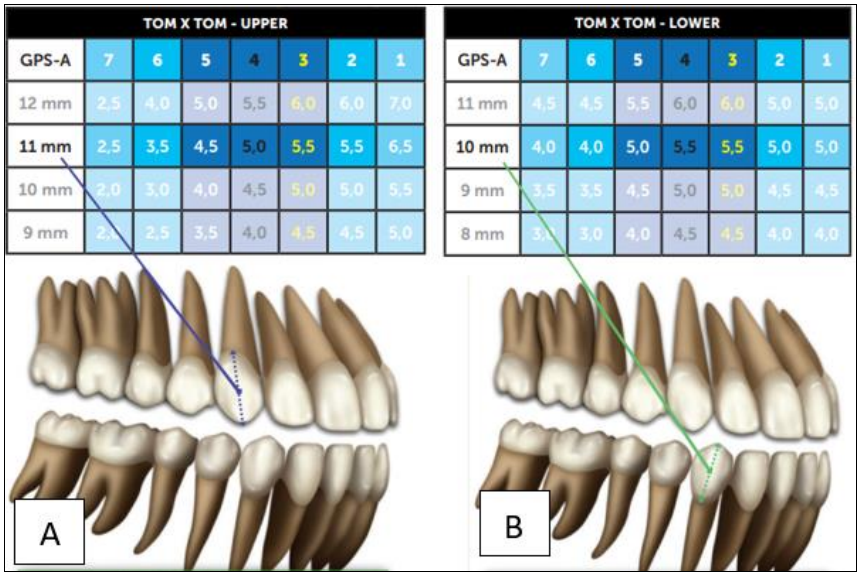

Fig 13: A. TOM Bracket positioning chart for maxillary teeth B.TOM TOM Bracket positioning chart for mandibular teeth

Thomas Pitts has also revised the positioning of anterior brackets [21]. After any required recontouring of the canines and lateral incisors, place the canine bracket wings gingivally relative to the mesiodistal contact line; this is analogous to closing the self-ligating bracket clip.

Next, measure the distance between the canine bracket slot and the canine's incisal edge. As shown in Figure 14, the recommended placement of the central incisor brackets is 1.5 mm more gingival as compared to canine.

At last, place the lateral incisor bracket 0.75-1.0 mm further gingival to the canine bracket.

Fig 14: Bracket positioning steps

He has also given Active Early Case Management Principle in his system that includes,

1. Case management strategies,
2. Bracket positioning,
3. Occlusal guides/bite turbos,
4. ELSE (Early, Light, Short, Elastics)
5. Flipping and flocking of the anterior brackets.

Protecting and Enhancing Smile Arcs

It may be more difficult to preserve or improve smile arcs when undergoing orthodontic treatment for a number of reasons, such as:

- Improper placement of the brackets due to traditional methods, which might decrease the arc and wire plane while aligning the teeth.
- How steep or level the occlusal plane is; an uneven surface makes cosmetic smile arc management more challenging.
- Incisor proclination, whether already present or brought on by the therapy.
- A large space between the canines, which flattens the grin arc, and an exceptionally wide anterior archform.
- Canine brackets that are too far from the incisors and have too steep of points for the upper teeth.
- The canines and incisors are disproportionate or have an abnormal form.

These factors can complicate achieving the ideal smile arc, requiring careful planning and adjustments during treatment.

SAP Bracket Placement and Its Impact on Smile Arc Factors [21]

SAP bracket placement can positively influence several key factors in orthodontic treatment, as outlined below

Impact of Bracket Position on Wire Plane

In the case of Class II, Division 2 malocclusions generally intrusion of the upper incisors is not ideal for aesthetic reasons. Instead of only placing brackets, patients with gummy smiles may have SAP bracket placement paired with TADs or intrusive utility arches to create a more visually attractive grin arc.

Impact of Bracket Position on Proclination

- The closest to the center of resistance force application is the most effective, and controlling torque is highly dependent on bracket positioning. Placing the maxillary anterior brackets in the gingival position is often cautioned against, as it reduces the torque generated within the slot.
- This issue is addressed by SAP bracket positioning through reducing the effective torque prescription.

Brackets can be used inverted 180° with .017″ × .025″ wires in .022″ × .026″ H4 bracket slots for greater control of proclination to manage upper anterior flaring.

Impact of Bracket Position on Occlusal Plane

Clockwise rotation of the maxillary occlusal plane increases incisor display and produces more convex, more aesthetically pleasing smile arc. Conversely, counterclockwise rotation (which may be produced from placing upper anterior brackets more incisally than recommended by SAP guidelines) yields a flatter smile arc that may be less visually appealing.

Bracket positioning - smile arc and marginal ridge approach (SAMRA) [23]

This innovative technique achieves the optimal arrangement of the brackets over three surfaces by combining aspects from prior approaches. Direct and indirect bonding are both possible with it.

Procedures

1. **Recontouring:** Prior to placing the brackets, smoothen off any rough incisal edges and replace any damaged cusp tips.
2. **Bonding the Posterior Segment:** Start by bonding the posterior segment first. Use the MR line (Marginal Ridge line) as a vertical reference from the terminal molar to the canine. Identify and mark the mesial and distal marginal ridges (MRs) on the dental models. Next, project these marks buccally and connect them using a sharp pencil to form the MR line (Fig. 15A).
3. **Marking the SL Line:** Mark the end of the buccal fissure and draw the SL line (Smile Line) parallel to the MR line.
4. **Measuring Distance:** Measure the distance (X) and transfer this measurement to the adjacent teeth (Fig. 15B).
5. **Maxillary Arch Bracket Placement:** Align the canine and lateral incisor brackets in the maxillary arch so that they are both perpendicular to the incisal border.
6. **Central Incisor Bracket Placement:** For larger teeth, place the bracket for the central incisor about 0.25 to 0.50 mm further gingivally than the lateral incisor.
7. **Measuring Vertical Distances:** Determine the Smile Lines (SLs) and Facial Axis (FA) on the dental model. Find the intersection of the FA and SLs by measuring and recording the vertical distance using calibrated digital callipers or a gauge with 0.25 mm increments from the cusp tips or mid-incisal margins.

Transferring Intraorally: Transfer these measurements intraorally (Fig. 15C).

This approach helps ensure accurate bracket positioning for both smile arc and marginal ridge alignment, contributing to better overall aesthetics.

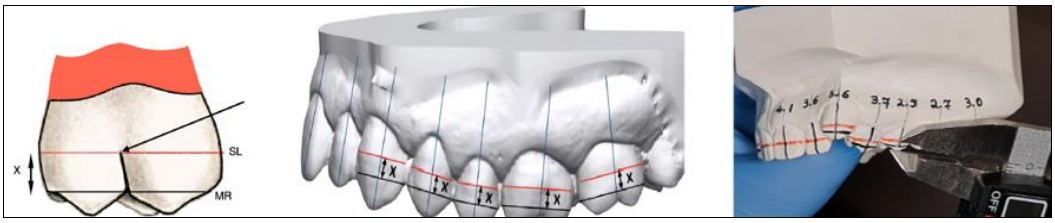

Fig 15: A. Construction of MR and SL. The distance between MR and SL is X. B) X is transferred to all the teeth till canine C. Transferring measured bracket positioning in the cast to the patient using calliper

Significance

Because it lines up with the "green zone" for optimal torque expression, the correct vertical slot alignment is critical. When compared to attaching to the incisal surface, gingivally bonding to the green zone produces more negative torque. Due to their more convex buccal surfaces, posterior teeth, including mandibular premolars and molars, need more caution while bonding.

Variations of just 2.13° are caused by small variations inside the "safe zone" (±0.5 mm), which have no impact on the torque expression. Nevertheless, placing bracket beyond this area—especially for posterior teeth (±1.5 mm)—can cause a significant 9.04° torque discrepancy.

This highlights the importance of precise bracket placement to maintain proper torque and ensure optimal tooth alignment throughout treatment.

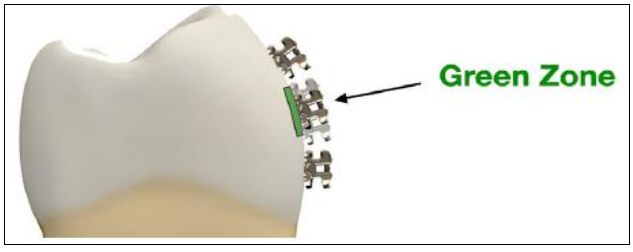

Fig 16: Green zone

Conclusion

In orthodontics, the primary aesthetic goal is to create a "balanced" smile. The elements that contribute to a smile—such as tooth position, arch form, and facial features—should not be seen as rigid rules but as flexible guidelines that help orthodontists tailor treatment to each patient's unique needs. Achieving a harmonious balance is key, with the ultimate aim being to craft a smile that is not only functional but also aesthetically pleasing and well-suited to the individual's facial features.

Conflict of Interest

Not available.

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