

Predictable gingival surgery for the general dentist

Part 1: Pre-operative smile assessment

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Traditionally, dentists have modified gingival anatomy for restorative reasons, gaining access to sound tooth tissue subgingivally for margin placement, or to expose more clinical crown for greater crown retention or perhaps to create a 'Ferrule' for post crowns. Surprisingly, dentists have shown little inclination to alter gingival anatomy for purely aesthetic reasons, but in such litigious times we continue to ignore aesthetics at our peril.

Modern patients are increasingly aware of gingival discrepancies, often seeking advice from their regular dentist first. As clinicians we need to know if we are able to carry out

gingival tissue adjustments predictably in practice, or if the aesthetic problem is something which would need referral, perhaps even significant maxillofacial surgery.

Gingival aesthetics

Gingival aesthetic problems may be divided into two major areas, being either a facially apparent skeletal cause or a localised, purely dental cause.

The 'gummy smile'

Often produced by a facial or skeletal anomaly, the gummy smile affects the entire smile, and

diagnosis depends upon the amount of gingivae exposed when smiling. (Figure 1) Often the gummy smile exhibits all the principles of classical gingival anatomy, but despite this, 2.0 mm or more gingivae visible in a full smile is deemed unacceptable¹. Maxillo-facial surgery is often the only true solution, but patients with gummy smiles often adopt a 'defensive' lip position when smiling in order to reduce excessive gingival display (Figure 2). Early assessment is important as in these cases as maxillo-facial surgery may be the only solution.



Figure 1: The gummy smile exhibits 2.0 mm or more visible gingivae in a full smile traditionally described as the 'EEEEEE' smile



Figure 2: Patients with gummy smiles will often adopt a defensive 'social smile' to reduce the visible gingival display

Figure 3: Irregular smiles reveal irregular gum heights in the smile



The irregular smile

The rules of comparative gingival anatomy are well established with symmetry either side of the midline being key.² Irregular gum heights visible in the smile (Figure 3) may have localised dental causes, hence a full assessment of the ‘irregular smile’ is indicated to evaluate whether any asymmetry could be treatable by localised crown lengthening procedures.

Can we help?

We need to consider smile design in terms of the big picture (face), the teeth (white) and the gingival display (pink), as dental aesthetics involves more than just the teeth.

The classical proportions of an ideal smile in relation to teeth such as golden proportion are well

established, and in seeking to fulfil these principles, too many dental photographs are of the lips retracted type, focussing almost exclusively on the teeth (Figure 4). However, such photographs provide little clue how the teeth look in the face, so are of little diagnostic value when treatment planning for aesthetics. We need full face photography to help prevent errors of orientation, amongst others (Figure 5).

Three photos are required. First is with lips slightly apart in repose, or ‘MMMM’ (Figure 6); second is of a ‘social smile’ (Figure 2) and finally of the widest smile possible, traditionally described as the ‘EEEE’ smile (Figure 1). Using these three photographs we are able to ascertain whether the face and lips are symmetrical, whether the upper

central incisor edges are correctly positioned in the face and decide whether the correct amount of gingival tissue is displayed. Each of these variables can have an impact upon the perfect smile.

Full gingival smile assessment

1. Gingival exposure (gummy smile)
2. Comparative gingival anatomy (symmetry)
3. Gingival papillae and gingival embrasures (black triangles)
4. Gingival scallop; (rounded or flat)

1. Gingival exposure

When diagnosing a ‘gummy smile’ the cause may be skeletal rather than dental, but not always, so we need to consider the following:

- Lips
- Teeth
- Gingivae
- Premaxilla
- Maxilla
- Combination.



Figure 4: Many dental photographs are of the lips retracted type, but these photos provide no clue as to how the teeth appear in the face



Figure 5: Full face portrait photography help prevent major errors

Figure 6: A relaxed 'lips in repose' or 'MMMMMMMM' smile should just reveal the upper incisal edges. Visible canines "in repose" means gingival excess when smiling broadly (see Figs 1 & 2)



Lips (high lip line)

Measured from the base of the nose, a female lip is usually 20-22 mm (Figure 7) and male 22-24 mm, but some lips can be very short indeed

(Table 1).³ The range of lip mobility measured from rest up to widest smile, usually around 8 mm, may also vary dramatically.³ Equally, an irregular lip revealing excess gum



Figure 7: Measured from the base of the nose, a female lip is usually 20-22 mm long with the male averaging 22-24 mm

may be an anatomical variation (Figure 8) or lips may be scarred as a result of trauma. Lip abnormalities may be treated surgically (specialist referral recommended) or non-surgically with Botox.

Teeth (short clinical crown)

A central incisor is around 10 mm long, however, anatomically shorter teeth due to accelerated wear or erosion, coupled with compensatory passive eruption can increase the gingival display in the smile (Figure 9).⁴

Abnormal eruption patterns such as altered passive eruption can also contribute. Short teeth may be treated with crown lengthening surgery and/or reconstructed with direct or indirect restorations.

Gingivae (gingival overgrowth)

During growth, teeth will erupt until they contact the opposing teeth (except notably in class II malocclusions) whereupon eruption ceases. The dento-gingival complex (including crestal bone) follows along with the erupting teeth, and stabilises as tooth eruption stops.



Figure 8: An irregular lip may be anatomical variation or scarred as a result of trauma



Figure 9: Accelerated wear coupled with compensatory passive eruption can increase the gingival display in the smile

Table 1: Gummy smile assessment

LIPS	Length:	Female Male	20 mm – 22 mm 22 mm – 24 mm
	Mobility:	Average	6 -8 mm
TEETH	Length upper centrals:		10 – 11 mm
GINGIVAE	Visible CEJ in gingival sulcus		2.0 mm in ‘EEEEEEE’ smile Delayed Passive eruption
PREMAXILLA	Anterior Gingival Line		Class 2 div II (D.A.E)
MAXILLA	Face Height		Mid 1/3 equals Lower 1/3 (VME)

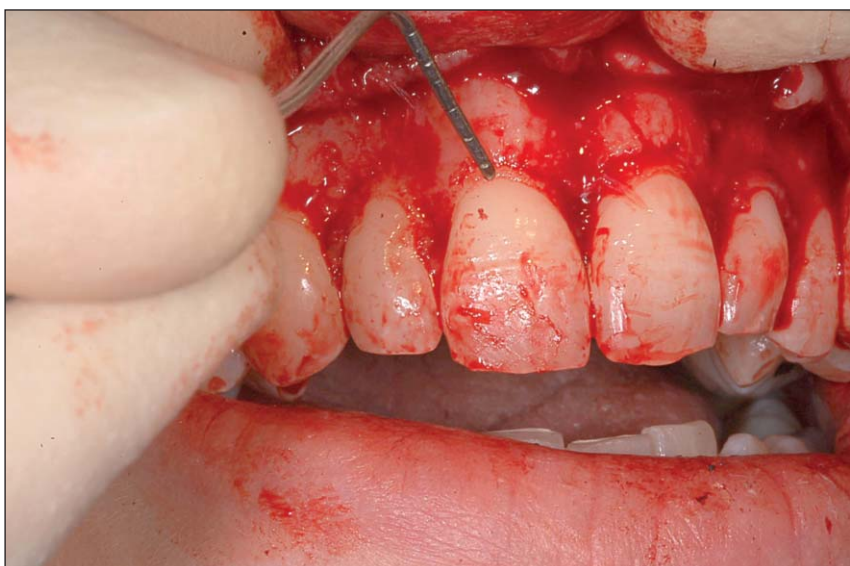


Figure 10: Altered Passive Eruption; the crestal bone overgrows and settles very close to the CEJ with the gingival soft tissue encroaching upon the clinical crown

When skeletal growth finally stops, the gingival soft tissue margins stabilise to a position just coronal to the CEJ, with the bone a further 2.0-2.5 mm apical to the CEJ. However, in a small minority of cases, this tissue stabilisation does not occur,

and the gingival soft tissue encroaches upon the clinical crown with the crestal bone settling very close behind, often covering the CEJ (Figure 10). This phenomenon, known as Altered Passive Eruption, produces teeth with short clinical

crowns and excessive gingival display, and is particularly common in young people after orthodontics (Figure 11).⁵

This condition can be treated by surgically raising the crestal bone back to the ‘normal’ 2.5 mm apical to the CEJ, thereby allowing a conventional dento-gingival complex to reform and re-establish the biologic width. This procedure is often known as a ‘gum lift’ and can sometimes be performed without the need for restorations if cementum is not left exposed.

Premaxilla overgrowth (dento-alveolar extrusion)

Without a cingulum contact in full closure, there is no anterior occlusal stability, and the upper and lower incisal edges will gradually over-erupt. Such ‘passive eruption’ will



Figure 11: Altered Passive Eruption produces short clinical crowns and excessive gingival display, and is particularly common in young people



Figure 12: Without a cingulum contact, the upper and lower incisal edges will over erupt bringing the gingivae along with the teeth resulting excess gingival display

Figure 13: The upper anterior segment can overgrow and display the classic 'gull wing' gingival pattern where the tissue crest of the centrals appears lower than the laterals



bring the gingival complex along with the teeth resulting in overgrowth of both upper and lower anterior skeletal segments. This premaxillary overgrowth is typically seen in class II division 2 malocclusions (Figure 12). This results in the classic 'gull wing' gingival pattern in upper anterior segments where the tissue crest of the upper centrals appears lower than the laterals (Figure 13). The main aesthetic issues occur in the upper jaw, although in extreme cases, the lower anterior segment is an aesthetic challenge too. This may be treatable with orthodontic intrusion in the early stages, with perhaps maxilla-facial surgery in extreme cases.

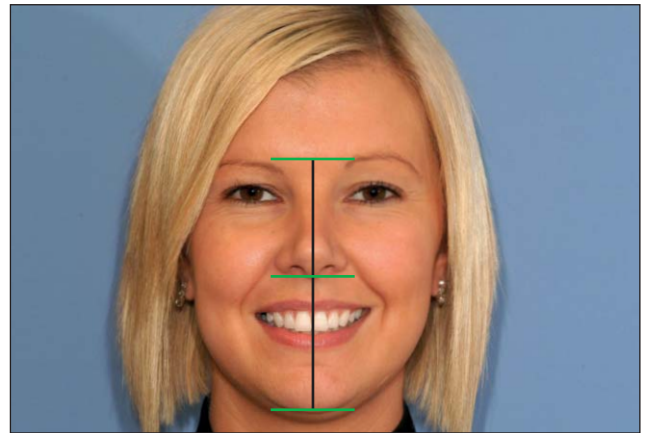
Vertical maxillary excess

In ideal facial proportions, the measurement from the glabella to the base of the nose should be roughly equal to the measurement from the base of the nose to the inferior border of the chin (Figure 14).³

However, in some cases, the maxilla continues to grow down vertically, thereby increasing the measurement below the base of the nose (Figure 15).

In extreme cases, the situation is dealt with by a Lefort 1 procedure coupled with mandibular advancement, obviously well outside of the capabilities of a general dental practitioner.

Figure 14: In ideal facial proportions, the measurement from the glabella to the base of the nose should be roughly equal to the measurement from the base of the nose to the inferior border of the chin



Combination cases

In reality most patients exhibit varying degrees of each of the above, hence the need to diagnose the cause of the gummy smile before deciding whether treatment is possible in dental practice, whereupon the following protocol (courtesy of Dr John Kois) is useful.

Facially generated smile assessment ('Face-White-Pink')

If the gingival issues are dentally caused they can often be dealt with by crown lengthening surgery, and the subsequent approach is recommended:

- Establish incisal edge position (in the face)
- Decide clinical crown length (white)
- Position of post surgical gingival margin (pink).

Face

Many patients have asymmetric features, and a portrait photograph will highlight this. A referral to a maxillo-facial surgeon may be offered at this point if appropriate.

White

The second step in facially-generated smile design requires a decision of how much tooth should be visible. Establishing the correct upper incisal edge position in the

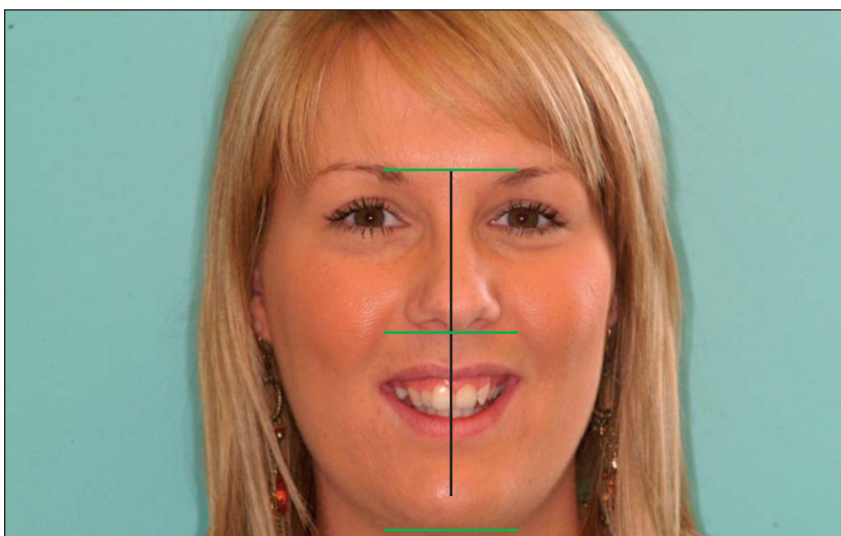


Figure 15: Vertical maxillary excess; the maxilla continues to grow down vertically thereby increasing the measurement below the base of the nose

smile is critical with variations due to age and sex being significant.

Pink

The laws of smile design also apply to the gingival tissue both in terms of symmetry (irregular smile), and the amount of gingival display shown in a full smile (gummy smile). As in most technical exercises, a step-by-step protocol helps in the decision-making process, and when considering gingival aesthetics, it is wise to consider the following.

2. Comparative gingival anatomy

Symmetrical gingival anatomy is the key here, and crown lengthening (occasionally crown shortening; tissue grafting) is often indicated. The gingival heights of the central incisors should be level with the canines, with the gingival zeniths distal to their long axes. The zeniths of the lateral incisors should be in line with the long axes of the teeth

Figure 16: The gingival heights of the central incisors should be level with the canines, with the lateral incisors around 0.5 mm-1.0mm more coronally



and positioned 0.5mm-1.0mm more coronally (Figure 16).⁶

Modern technology now allows us to remove gingival soft tissue with ease, and when striving to create the perfect gingival framework for our porcelain, the temptation to remove a small amount of gum tissue around one maverick tooth is often difficult to resist. However, unless we are familiar with the anatomy of the gingival complex, it can be surprisingly easy to produce biologic width violations by such actions.

Anatomy of the gingival complex

Whenever alteration of the gingival tissue is planned, a full knowledge of the anatomy of the gingival complex is necessary for success.

The dento-gingival complex runs coronally from the osseous crest of the sub gingival bone to the free gingival margin of soft tissue, and falls into three distinct areas (Figure 17) with agreed average dimensions.

Connective tissue

The first 1.0 mm or so, coronal to the crest of the bone, consists of connective tissue which is attached via collagen fibres to both the crestal bone and the cementum of the tooth (Sharpey's fibres). This is a very strong attachment and cannot be breached without causing pain to the patient.

Junctional epithelium

The middle 1.0 mm or so consists of the junctional epithelium which

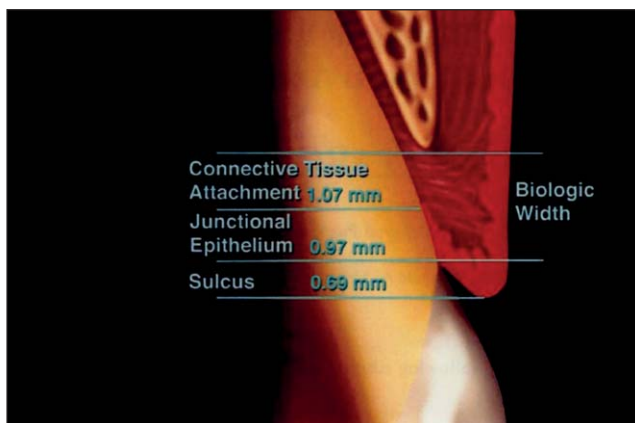


Figure 17: The dento-gingival complex runs coronally from the osseous crest of the sub gingival bone to the free gingival margin of soft tissue, and falls into three distinct areas with agreed average dimensions

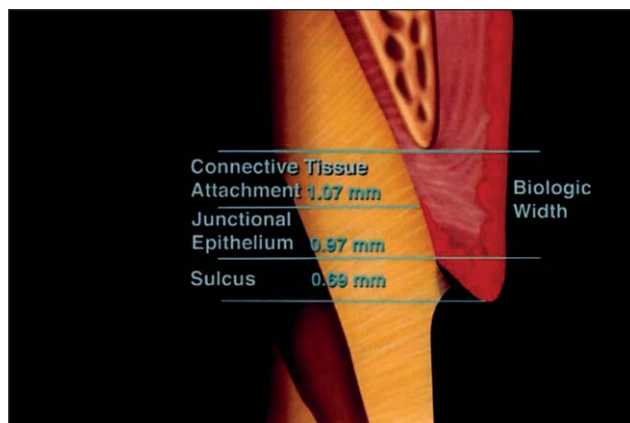


Figure 18: Biologic width consists of the connective tissue attachment and the junctional epithelium, but not the sulcus

Figure 19: To prevent biologic width infringement, restoration margins should be just sitting within the sulcus and no closer than 2.5 mm to the crestal bone

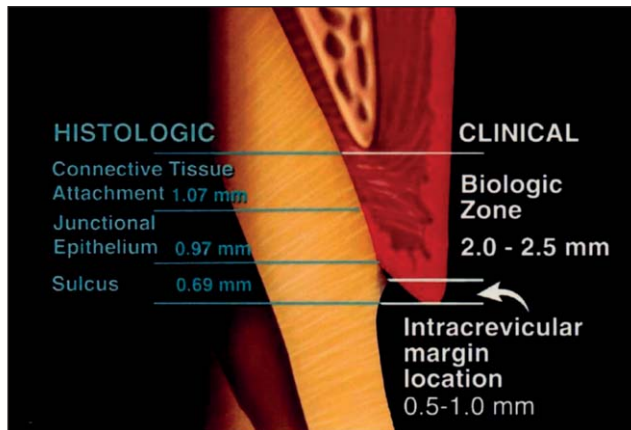
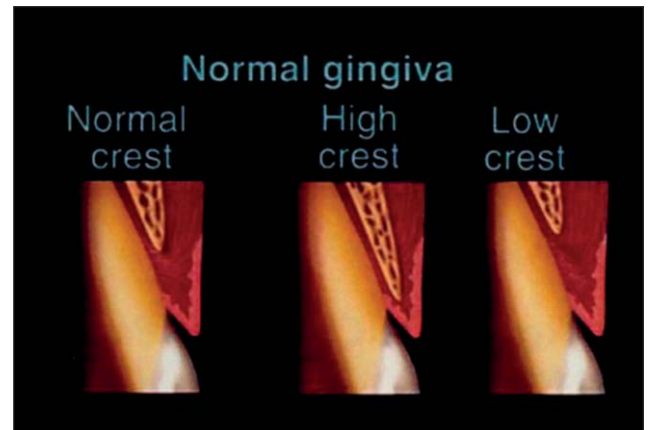


Figure 20: Dr John Kois describes three categories based upon the position of the sub gingival crestal bone relative to the healthy free gingival margin



exhibits a weak hemidesmosomal attachment to enamel. This attachment is easily breached by the periodontal probe, and also damaged by gingival retraction cord. However, it rapidly regenerates, often within six days and consequently is rarely permanently damaged.⁷

Gingival sulcus

The gingival sulcus, perhaps 0.5 -1.0 mm, which is not attached to tooth at all, is the most coronal area. This sulcus depth is measured with periodontal probes during periodontal therapy; however, it is traditionally difficult to record with any accuracy, particularly as the dento-gingival complex is often inflamed, and the base of the sulcus fragile as a result.

Biologic width

Knowledge of the above dimensions helps us to ascertain the biologic width which consists of the connective tissue attachment and the junctional epithelium, but not the sulcus (Figure 18). Biologic width will inevitably reform if altered by ill judged gingival surgery or infringed by injudiciously placed restoration margins.

Gingival soft tissue is seductively easy to alter, but improving gingival anatomy by arbitrary removal of gingival soft tissue without reference to underlying crestal bone risks violating biologic width. Excised soft tissue may well grow back, often

within months, as violated biologic width seeks to re-establish itself hence negating any short-term aesthetic improvements.

Since the 1960s it has been widely accepted that biologic width is 2.04 mm but later research has suggested this measurement is an average, and not the same for everybody hence strict rules are difficult to formulate.^{8,9}

When placing dental restorations, the convention states that there needs to be 2.5 mm of distance between any restoration margin and the crest of the underlying gingival bone; the margin should be just sitting within the sulcus (Figure 19). Any closer than 2.5 mm risks

infringing ‘biologic width’ resulting in classical red tissue margins around our restorations.

Kois classification

Dr. John Kois in Seattle has proposed a more detailed classification of biologic width describing three categories based upon the position of the sub gingival crestal bone relative to the free gingival margin (in healthy gingivae) prior to any treatment¹⁰. (Figure 20).

‘Bone sounding’

The position of the bony crest is located by ‘bone sounding’ whereby the periodontal probe is forced, under local anaesthetic, into the sulcus, (Figure 21) through both the

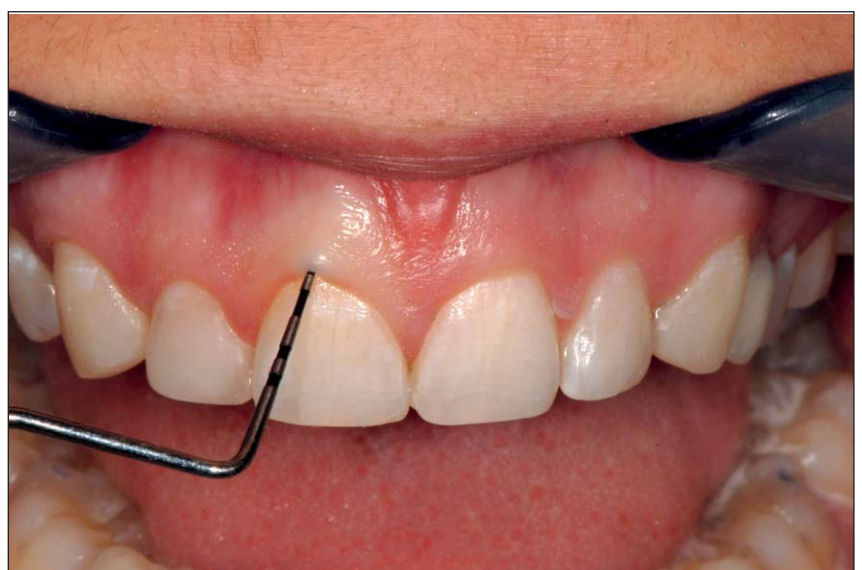


Figure 21: The position of the bony crest is located by ‘bone sounding’ whereby the periodontal probe is forced, under local anaesthetic, down through the sulcus

Figure 22: The probe is forced through the junctional epithelium and the connective tissue until it eventually contacts the crestal bone



Figure 23: Open gingival embrasures (black triangles) are unacceptable to even the undemanding patient



junctional epithelium and the connective tissue until it contacts the crestal bone (*Figure 22*). Kois suggests bone levels should be recorded mid-facially and interstitially. The interstitial measurement is usually around 1.5 mm greater than midfacial to account for the gingival scallop.

Normal crest

In 85% of the population the bone is found mid-facially 3.0 mm apical to the gingival margin, and 4.5 mm interstitially (*Table 2*). In these cases the anatomy of the gingival complex remains quite stable and will readily re-establish itself if altered. Biologic width is therefore easily infringed if soft tissue is removed without also removing the bone beneath by the same amount.

High crest

In 2% of the population the bone mid-facially is found just beneath the gingival crest, often a result of aberrant eruption patterns. When planning to raise the gingival level by even a small amount, it is

mandatory to carry out osseous surgery to avoid biological width infringement. The aim is to surgically change ‘high crest’ into ‘normal crest’.

Low crest

When the mid-facial bone is more than 3.0 mm apical to the gingival crest, the final tissue position after surgery cannot be predicted with any accuracy as the tissue will ultimately settle 3.0 mm from the crestal bone, but when? Predictability is improved if soft issue is removed before restorative treatment to change ‘low crest’ into ‘normal crest’. The fact that 13% of the population exhibit this classification introduces an unwelcome degree of unpredictability to proceedings. ‘Low crest’ has also been described as ‘thin’ gingival biotype.

In subsequent articles of the series, specific clinical examples will be outlined to help understand the processes in more detail.

3. Gingival papillae & embrasures

Open gingival embrasures (black triangles) (*Figure 23*) are always unacceptable aesthetically to patients.¹¹ Reduction of black triangles requires knowledge of Tarnow’s classic work, and the ability to manipulate both the hard and soft gingival tissue.¹² Excellent laboratory communication is mandatory when aiming to provide correctly positioned interstitial contact points in our restorations.

4. Gingival scallop

The classical gingival scallop is around 1.5 mm from papilla to papilla. A flatter scallop, often a result of gingival recession is deemed unattractive (*Figure 24*).¹ Maverick tooth position or toothbrush abrasion may contribute to a deeper scallop which also causes concern. Orthodontics or tissue grafting can be of use in such situations, but a flat scallop remains a challenging problem.

Table 2: Crest position

Normal Crest	%; Stable tissue; place restoration margins no closer than 2.5 mm to Crestal bone. Cannot alter soft tissue without altering the bone beneath by the same amount.
High Crest	2%; Stable tissue; easy to violate Biologic Width, so prepare for Osseous surgery if any Crown Lengthening is planned. (Altered Passive Eruption)
Low Crest	13%; Very unstable tissue; expect recession (warn patient in advance)

Summary

We need to be aware of all the aspects which impact upon a smile when we assess the patient’s suitability for treatment, and not just the teeth. The ‘gummy smile assessment’ can help decide whether a surgical referral is

Figure 24: The classical gingival scallop is around 1.5 mm from papilla to papilla. A flatter scallop, often a result of gingival recession is deemed unattractive



indicated. If not by following the 'face-white-pink' process, coupled with detailed knowledge of patients' individual gingival anatomy, we should be able to predictably alter gingival levels in practice as required.

The aim of this first article is to outline a process of assessment to allow general dentists to ascertain which cases may be treated with minor gingival surgery techniques in their practices, and those where a referral is indicated.

The next article will show clinical cases demonstrating actual treatment provided for a gummy smile and for irregular smiles for each of the three crestal bone positions; normal crest, low crest and high crest.

The final article will explain how knowledge of the gingival complex impacts upon fixed bridge provision with particular reference to the 'Ovate Pontic' concept, and we will outline the theory and practice of dealing with open gingival embrasures (black triangles) and diastema closure.

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