

**“The Placement of Restorative Margins is of  
Critical Importance in the Maintenance of  
Periodontal Health and Especially Important  
within the Smile Line” – A General Dentist’s  
Perspective**

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## **Introduction**

“What is the longest word in the dictionary?” asked a school teacher to her class. “Smiles”, answered young Jimmy, “because between the two S’s you have a whole mile.”

Even though a smile is subjective, never the less it is an important part of a person’s make up. A smile goes a long way, when you smile the whole world smiles with you.

Until recently dental aesthetics pertaining to the smile of a person was generally limited to alterations of the teeth themselves.<sup>1</sup> Clinicians would try and create the optimal relationship of the teeth to the upper lip, lower lip and the commissures of the mouth, thereby creating the desired ideal smile<sup>1</sup> and at times orthognathic surgery and/or long term orthodontics was sought<sup>1</sup>.

But today the approach to obtain a harmonious smile that is aesthetically pleasing has changed with the advent of soft tissue periodontal plastic surgery. The emphasis in periodontal plastic surgery, is not only to obtain a functional result as muco-gingival surgery did in the 80’s, but also an aesthetic result.<sup>2</sup>

In achieving an aesthetic result the placement of restorative margins will have a tremendous influence on the periodontal health of the surrounding tissues.

The purpose of operative and restorative dentistry is to restore and maintain health and functional comfort of the natural dentition combined with a satisfactory aesthetic appearance. Thus, all dental restorations should comply with established requirements for periodontal physiology and health with regard to both surface and functional characteristics.<sup>3</sup>

## **Biologic and Aesthetic Periodontal Principles – The Anatomy of a Smile**

Being able to understand and recognise normal periodontal tissue enables one to diagnose deviations from the normal and to be able to treat this appropriately, and thus it becomes imperative for a dental care provider to understand the biologic, anatomical and aesthetic periodontal principles in order to realise the full potential of dental aesthetics.

The periodontium is a functional system of different tissues, investing and supporting the teeth, including cementum, periodontal ligament, alveolar bone and gingiva.<sup>4</sup> Anatomically the term is restricted to the connective tissue interspaced between the teeth and their bony sockets.<sup>4</sup> The most vulnerable part of the periodontium is the junction between the gingival epithelium and the tooth. The prime function of the oral epithelium is to protect the underlying connective tissues against bacterial, mechanical, chemical, and thermal injury and to protect the balance of the electrolytes and other homeostatic mechanisms in these tissues.<sup>3</sup>

The erupting tooth makes a break in the continuity of the gingival epithelium, and in order to maintain the protective function of the epithelium, a bacteria-proof seal, the epithelial attachment to the tooth surface, is established. The epithelium that joins directly and adheres to the tooth surface is called “junctional epithelium,”<sup>1</sup> while the attachment itself is called the “epithelial attachment”. Mechanically, the epithelial attachment is weak, although it is supported and maintained by the tonus of the firm free and circular gingival collagenous fibres that hold the gingival closely to the tooth. Only part of the gingival epithelium facing the tooth is attached junctional epithelium, while the coronal aspect of the dentogingival epithelium is unattached crevicular epithelium, which permits penetration of bacteria and metabolic products between the tooth and the epithelial lining until the junctional epithelium is reached. The width and proportionate relationship between the junctional and crevicular epithelium vary considerably with the gingival status of health or disease, and possibly with age.

Both the junctional and crevicular epithelium is made up of a renewing cell population with a turnover time of approximately 7 to 10 days,<sup>1</sup> which means that a continuous shedding of cellular debris is expelled into the gingival crevice. Such debris, as well as foreign material that may have entered the gingival crevice, is eliminated by an expulsion mechanism, the nature of which is not fully understood. It has been suggested that this expulsion is facilitated by a flow of gingival fluid.<sup>1</sup> However, investigations have shown that seepage of gingival fluid has to be provoked,<sup>1</sup> mainly by mechanical means, and the fluid has to be considered as an exudate reaction that is closely related to an extensive migration of polymorphonuclear cells into the gingival crevice in response to the presence of bacteria and bacterial products. The expulsion of foreign material from the gingival crevice is enhanced by mastication and by tooth brushing with gingival massage. The tooth moves slightly with the pulse wave of the heartbeat,<sup>1</sup> and it is not known if these movements also facilitate crevicular cleansing.

Any roughness on the tooth surface such as calculus or the junction between a restoration and the tooth, will interfere with the self-cleansing mechanism of the physiologic gingival crevice.

If the junctional epithelium is mechanically separated from the tooth as commonly occurs in scaling of teeth, impression technique, and other restorative procedure, the epithelial attachment is re-established by regenerating epithelial cells within a week; during this regeneration, bacteria are eliminated by polymorphonuclear cells, and a sterile junctional epithelium is gradually re-established starting from the basal cell layer.<sup>1</sup>

It should be noted that clinically normal gingival exists under conditions of low-grade defence, that is, in the presence of microbial and antigenic challenges that are compatible with clinical health.<sup>5</sup>

## **The Smile**

The perfect smile requires an optimal relationship between the lip, gingival scaffold and the teeth. When a disharmony exists between any of these three components, the result is a smile that is likely to be perceived as unaesthetic.<sup>6</sup>

Ideal anterior aesthetics require a healthy periodontal environment with sufficient relevant tissue volume to fill the interproximal spaces. Left and right side symmetry should exist so that there is no disparity between contralateral like tooth types.<sup>1</sup> Each tooth type exhibits a distinct incisogingival length and mesiodistal width, which in harmony builds a maxillary anterior unit that is visually pleasing.<sup>6</sup> Generally, aesthetic dentistry pertains to the smile line, which is normally related to the maxilla and is usually from teeth 16-26. One should be aware that each case is different and at times lower teeth are implicated in the patient's smile and one should treat appropriately.

When a person is smiling, generally the cusps of the upper maxillary teeth should touch and follow the lower lip, and the necks of the upper teeth should follow the upper lip. About 0 - ± 1mm of gingiva can be showing between the upper lip and the necks of upper maxillary teeth.

Even though beauty is in the eye of the beholder, nevertheless we as dental care providers can educate our patients to a certain degree. One should however take into consideration our diverse ethnic population in South Africa and understand that what may be pleasing to some, may not be pleasing to others.

## **The Biological Width**

Probably one of the most important principles in maintaining periodontal health around a restoration is the biological width, which is a measurement from the gingival margin to the crest of osseous bone. One should use caution when using a periodontal probe as a

tool to measure the biological width since the pressure used by different practitioners can vary. The distance can vary from 2-5mm.

The biological width is viewed as a critical sub-gingival physiologic dimension and encroachment of a restorative margin results in the initiation of gingival inflammation and bleeding, and alternately leads to gingival recession, apical migration of the junctional epithelium and alveolar bone loss. The biological width cannot be ignored when any restorations are taken into account.<sup>7</sup>

It must be noted that future relationships between the margin of the restorations and the gingival tissues cannot be assessed with certainty in areas of gingival inflammation and periodontal pockets until about 1 month after prophylaxis and instruction of good home care.

Where violation of biologic width becomes evident, conservative periodontal measures may help keep this inflammation under reasonable control. At other times, however, surgical treatment may be necessary to re-establish proper biologic width.

In health, the facial aspect of the biological width has a  $\pm 3$ mm depth, and the interproximal surfaces have depths ranging from 3 - 4,5mm. The interproximal variation depends on the amount of the scallop of the interproximal alveolar bone. The gingival scallop is always equal to or greater than the underlying scallop. The osseous scallop parallels the cemento-enamel junction circumferentially. For purposes of cosmetic restoration or periodontal plastic surgery, maintaining or recreating the biologic width remains one of the most important principles in maintaining periodontal health.

### **Diagnosis and Treatment Planning**

Too often in dentistry, one attempts periodontal plastic surgery or cosmetic restorations without a proper diagnosis and treatment plan. This can result in an unhappy patient and

can mean that the work has to be redone and can also lead to legal proceedings against the dental care provider.

(date)  
Steven Morrow DDS; Oakland, California, reminds us to maintain complete records. In a court of law there is no substitute for accurate records.

One should always remember that there is a patient behind the procedure we are going to perform. A complete medical and dental history should be taken and thereafter a thorough intra-oral and extra-oral examination should take place.

Careful communication is essential for the dentist to determine what the patient would like to achieve and if his or her expectations are realistic.

Dental care providers should also educate their patients in that time is needed for optimal healing of periodontal tissues before final and permanent restoration can be done. Fitting or finishing final restorations are often done too quickly without optimal healing of the surrounding periodontal tissues resulting in patient dissatisfaction and work having to be redone.

Professor Hanlie de Waal of Stellenbosch University has an examination routine which is essential in establishing a formidable understanding of the patients facial and oral aesthetics. It is a very comprehensive examination and can be very useful. Even though one could create their own type of examination method, I firmly believe that the wheel is too often re-invented and one should first see what is available and only if one cannot find something suitable for themselves, should one create their own aesthetic examination routine.

One must bear in mind that for optimal treatment a multidisciplinary approach involving an orthodontist, a periodontist, an orthognathic surgeon and a restorative dentist should always be kept in mind.



Composition of a beautiful smile, the form, balance, symmetry and relationship of the elements make it attractive or unattractive. An expanse of soft tissue should not be considered to be unaesthetic per se, but the way this soft tissue is arranged, relative to the teeth and lips, is of aesthetic concern. Thus a high lip line or gummy smile may not be unaesthetic, but due to today's mass media influence, many people consider even the slightest excessive display of gingival tissue unattractive.<sup>1</sup>

It is important to note that the definitive diagnosis of the gummy smile is crucial and determines the treatment. The gummy smile may be due to either altered passive eruption or vertical maxillary excess.<sup>1</sup>

Thus in a proper diagnosis, one would know to refer the vertical maxillary excess gummy smile for orthognathic correction, whereas the altered passive eruption "gummy smile" could be corrected by gingival surgery.<sup>1</sup>

The above example of a "gummy smile" is to illustrate the importance of correct diagnosis.

## **Periodontal Plastic Surgery**

Periodontal plastic surgery includes a broad range of procedures varying in complexity from the simple frenectomy to procedures requiring multiple surgeries. Most periodontal aesthetic procedures can be grouped into one of the following: Crown lengthening, alveolar ridge preservation or augmentation, soft tissue grafts and correction of an open interproximal space. Each of these procedures is not only capable of enhancing the beauty of a patient's smile, but also may create restorative opportunities.<sup>8</sup>

Before any restoration of margins in the "*aesthetic smile zone*" can be completed, it is important to note that any relevant surgical changes to the gingival scaffold should be done first. Gingival aesthetics should be optimal before placement of dental restorations. Most desirable is a gingival margin closely adapted to the enamel, with the papillae

filling the interproximal spaces. The gingival tissue should be firm and dense, the colour uniform pale pink with or without melanin pigmentation. No bleeding or visible secretion should appear to touch or light crevicular probing. The gingival tissues may be equally healthy with gingival recession, thick margins and loss of papillae, but the aesthetic appearance of the dentition then is not optimal and plaque control becomes more complicated.<sup>3</sup>

### **Clinical Crown Lengthening**

When disparity in clinical crown lengths exists between contralateral teeth, resulting in a left side/right side height discrepancy, aesthetic surgical correction can be provided to enhance the cosmetic result before restorative measures.

The most basic of cosmetic crown lengthening procedures is the removal of excess gingival tissue by gingivoplasty or gingivectomy. One begins by creating bleeding points at the level of the gingiva is to be excised as determined by the tooth length analysis. To preserve his or her perspective and prevent the removal of too much tissue initially, the surgeon should remove the excess tissue by scalpel, one tooth at a time, rather than in large segments.<sup>8</sup>

If the clinician determines that the removal of bone is necessary to preserve the biological width, he or she must begin planning the incisions and flap design.

Aesthetic crown lengthening surgery is essential to regain tooth and gingival symmetry. For purposes of achieving gingival aesthetics only a facial flap can be raised, thus preserving the precious interdental papillae and avoiding the appearance of black holes interproximally.<sup>8</sup>

Careful reflection of the facial flap allows for the direct visualisation and measurement of the restorative margin to crestal alveolar bone distance. If the permitted measurement of between 3-5,25mm exists, then no osseous bone reduction is needed. If it does not,

judicial facial osteoplasty is necessary.<sup>8</sup> Once the flap is placed in its original position and sutured, one can allow for healing of the gingiva. The patient can return after 6 weeks to a few months, or maybe even longer and have a gingivectomy done, either with a gingivectomy bur or by cavities to enhance the aesthetics even more. This is a two-stage procedure.

### **Recession**

Before any grafting procedures are performed, the clinician must be certain that the cause of the recession has been controlled. Various grafting procedures to cover up exposed roots of teeth have become much more predictable, and prior to crown preparations on anterior teeth with gingival recession or clefts, gingival grafts are often indicated. Coronally positioned periodontal grafts or flaps have been used to cover defects including those following caries removal in anterior teeth, rather than filling defects.<sup>8</sup>

Free gingival grafts are also used sometimes when there is a lack of attached gingival for abutment teeth or for projected areas of contact for pontics.<sup>3</sup>

Total root coverage is achieved when the marginal tissue, after complete healing, is at the CEJ, the sulcus is 2mm or less and there is no bleeding or probing.<sup>3</sup>

A classification system of gingival recession by Miller<sup>9</sup> allows the practitioner and the patient to have realistic expectations regarding the outcome.

### **Suturing**

Usually, for aesthetic reasons, the suture knot is placed lingually. If the papillae was included in the flap, the suture technique used to position the papillae determines much of the final cosmetic result. The surgeon must stabilise the papillae by using a vertical mattress suture in such a way that it is positioned in the interproximal area, with the facial and lingual flaps in contact. One should avoid too much tension.<sup>8</sup>

## Ridge Augmentation/ Resection

The loss of a tooth is likely to lead to changes in the dimension of its residual ridge. The preservation of facial bone in the maxillary anterior segment is vital to maximise the aesthetic potential of this area to act as a future site, for example a pontic.<sup>6</sup>

Gingival irregularities should be corrected surgically in the area where missing teeth are to be replaced. For aesthetic purposes, the pontic should make light contact with the mucosa of the alveolar ridge. This contact should always be with keratinised attached gingival. Sometimes the pontic has to be extended over an area of the ridge that is not covered by attached gingival, then a free gingival graft can be placed to cover this area prior to placement. Seibert<sup>10</sup> classified ridge defects into three classes:

- CLASS I – Buccolingual loss of tissue with normal ridge height in an apico-coronal dimension.
- CLASS II – Apico-coronal loss of tissue with normal ridge width in a buccolingual dimension.
- CLASS III – Combined buccolingual and apico-coronal loss of tissue resulting loss of normal height and width.

Often the loss of ridge width results in the need to resort to a modified ridge lap pontic design, this can sometimes compromise aesthetics.

Ideally, though surgical intervention is necessary i.e. ridge augmentation, soft tissue grafting, sufficient ridge width should be available to allow the pontic to appear to sit well within the confines of the residual ridge, resulting in an emergence profile that is maximally pleasing. It is also possible to create an ovate pontic form during the time that bone is remodelling after the extraction of teeth. Calderan et al<sup>1</sup> showed that by placing an ovate pontic directly into an extraction site at the time of tooth removal, the residual ridge could be guided to achieve an aesthetic concave pontic receptor site.

The ovate pontic form has been advocated as providing the most ideal aesthetic solution in the maxillary out segment.<sup>11</sup> While performing the osseous resection, one must constantly visualise the ideal alveolar ridge architecture rising and falling as it follows the CEJ, but one must recapture it at a more apical level. The exception to this rule is the interproximal bone. Because the position of the interproximal bone determines the position of the interproximal papillae, any osseous reduction in the area must be judicious. The clinician can verify the amount of bone removed by placing the probe at the newly created osseous crest then passively replacing the flap to its postgingivectomy position. The probe is then read ensuring the biologic width between the newly created gingival margin and the osseous crest.<sup>8</sup>

### **Restorative Margins in the Aesthetic Zone**

One must take into account all the principles we have discussed previously and one should understand that aesthetic treatment can never be learnt from fixed rules, recipes or patterns. There are simply too many variables. All signs, symptoms and special test information must be considered in the light of basic science knowledge and then analysed logically at the level where the treatment that is to be performed is localised.

It would be ideal to place all restorations supra-gingivally and minimise the inflammatory response around the restoration, and make it easier for the patient to ensure the restorative margins are being cleaned.

The main reason for sub-gingival placement of margins are listed below:

1. Sub-gingival fractures of teeth, position of caries, or placement of previous restorations.
2. Aesthetics
3. Retention and prevention of fractures<sup>3</sup>

If fractures, caries or previous restorations extend apically to the free gingival margin following periodontal therapy, the new restoration will have to be extended sub-gingivally but to the minimal extent dictated by these conditions.

Sub-gingival extension of restorations for the purpose of caries prevention is, however, controversial. It was reported in a study that sub-gingival placement of margins of crowns did not afford reliable protection against new caries, and a large percentage of the margins that had been placed sub-gingivally became supra-gingival after 3 years.

However, aesthetic consideration in the maxilla may necessitate sub-gingival placement of the margins of restorations. In such instances the restorations should not be placed more than 0,5 – 1mm wider than the free gingival margin.

One should always select the type of pre-restorative periodontal therapy which provides the most normal anatomic form. Surface gingival appearance and health will always depend on adequate supra-gingival plaque control, while crevicular health and lack of bleeding tendency requires additionally a clean, smooth tooth surface sub-gingivally. Ideally, preparation of the teeth for restoration should be done under rubber dam to assure that the gingiva is protected from injury, however, this may be impractical for certain types of restorations.

One must be careful not to injure soft tissue in preparing a tooth for a restoration sub-gingivally, inadvertently trauma does occur but the tissues will heal without any permanent ill effects if only the soft tissues are injured, but if the preparation of the tooth is accidentally extended apically to the bottom of the epithelial attachment, the injured cementum often becomes covered by epithelium instead of regrowth of the connective tissue attachment. The result then may be some permanent loss of periodontal support.

The loss of interdental papillae may be caused by a variety of restorative and conventional surgical resection techniques. Many new techniques have been developed

to minimise post-surgical gingival recession, preserve the interdental papillae and correct gingival asymmetry.<sup>12</sup>

When the restoration margins are placed apically to the bone of the sulcus, they impinge on two anatomic components namely, the junctional epithelium and the connective tissue fibrous attachment. Epithelium loses its capacity for keratinisation when it abuts enamel, dentine, cementum and artificial substrates such as porcelains, acrylic resins and metals.

Unfavourable gingival reactions to alloys used in the oral environment have been documented. In addition, certain metals have been shown to leak out from alloys used for indirect restorations. Nickel-containing alloys appear to carry the greatest risk. It should be noted that alloy reactions responsible for aberrant gingival changes still appear to be very rare. Salivary glycoproteins may neutralise some of the effects of alloy hypersensitivity. Since contact dermatitis is the most common mode of adverse reactions, the removal of the offending restoration should result in rapid resolution of the gingival irritation.<sup>7</sup>

When preparation is performed too close to the osseous crest, the restoration margins impinge of the supra-crestal fibres. This error results in a violation of the biologic width, and iatrogenic damage to the periodontal support structure results.

### **Marginal Fit**

Clinical parameters of what constitutes acceptable margins have never been established. The degree of marginal opening may be related to cement dissolution, wear and gingival inflammation, but does not directly correlate with microleakage, recurrent caries or the progression of periodontal disease.

Scientific data indicate that virtually all margins are open. The average opening is about 100µm, since bacteria are 1-5µm in size, there is clearly enough room to harbour

bacterial plaque even around the best fitting margins of a restoration. However, many of these restorations can still be considered clinically successful, suggesting that microbial virulence and patient resistance play more important roles on maintaining health than the mechanical aspects of the margin design.<sup>7</sup>

Dentists strive for the least marginal opening possible, but excellent margins may do more for the dentist emotionally than for the patient biologically.

### **Temporary Restorations**

Temporary restorations will always be a source of gingival irritation if they are extended subgingivally. Rough surfaces and rough margins on temporary restorations also will enhance plaque accumulation and predispose to gingival irritation even if the restoration does not come into to direct contact with the gingival tissues. It should be realised, however, that short-term irritation of the free gingival margin is not by any means as significant to the preservation of the periodontal support as is irritation at the bottom of the gingival crevice, since inflammation in the latter area may initiate or aggravate pocket formation. Temporary restorations or cements should never be placed apically to the border of any preparation. When the gingival contacts a flat tooth surface there is a tendency for the gingival margin to become thick while a thin gingival margin can be maintained only if it is protected by or related to a normal tooth contour.<sup>3</sup>

### **Orthodontic Movement**

The great advantage of moving teeth orthodontically is that the entire attachment apparatus, incorporating the osseous structure, periodontal ligaments and the soft tissue components, moves together with the tooth.<sup>1</sup>

From an aesthetic perspective, this means that any intrusive or extrusive movement can be used to develop symmetry of the gingival margin in a non-surgical mode. This is particularly useful when any form of restoration is necessary, as a surgical procedure



invariably exposes root structure, where the mesiodistal dimension of the tooth is now considerably narrower. In attempting to restore this, it becomes necessary to prepare the tooth and the tissue in such a way that an emergence profile can be developed from deep within the sulcus to avoid lateral horizontal extensions from the preparation line on the narrower root surface to the desired wider form of the restoration. If there is a dramatic diminution of the mesiodistal width of the root at the original gingival level versus the desired level, then orthodontics may be the treatment of choice.<sup>1</sup>

### **Implants**

The anatomic structures and physiologic mechanisms of the dentogingival junction seem to be the same for implants penetrating the mucosa as for teeth, providing this junction is not disturbed by some type of irritation.

However, the achievement of an aesthetic implant supported restoration is a constant challenge to the restorative dentist. Because of the circular shape of the implant and its smaller diameter, when compared with the root of a natural tooth, a dilemma inevitably occurs of how to construct an artificial crown and abutment system that imitates the natural tooth crown form when emerging from the gingiva with narrow margins to fit the implant head. In natural teeth, the emergence profile is relatively straight.<sup>13,14,15</sup> Any attempt to reproduce this angle in an implant-supported crown results in a restoration that in most cases appears unnatural and artificial.<sup>12</sup>

To compensate for the discrepancies between the implant head and the natural root diameter, there are proposed techniques for reshaping the gingival profile, provided that a sufficient volume of soft tissue is present.

The dental care provider and the dental technician should discuss and plan an implant case together, in order to achieve optimum aesthetic success in the placement of the implant restoration.

## **The Contour of Restorations**

Overcontouring of restorations or faulty placement of contour is a much greater hazard to periodontal health than lack of contour, since both supra-gingival and sub-gingival plaque accumulation may be enhanced by overcontoured crowns and to overcontoured gold-porcelain combination crowns because an inadequate amount of facial tooth substance was removed during the preparation. Such an overcontour interferes with the sealing effect of the gingival against the tooth and the self-cleansing mechanism of the gingival sulcus.<sup>7</sup>

Another common error is when the technician makes the crown short of the cemento-enamel junction, which results in an anatomically abnormal relationship among the contour of the patient's tooth, the restoration and the gingival, leading to increased plaque retention at the dento-gingival junction.

Overcontouring of composite restorations, bulging and thick margins on cast restoration, and wide pontics may change the anatomy of the interdental space and thus accentuate the normal col between the buccal and lingual papillae in the posterior region of the mouth, enhancing plaque retention there.

## **Conclusion**

Creating and maintaining periodontal health at the restorative-gingival interface continues to represent one of the most difficult challenges for the restorative dentist. The proper margin location of a restoration relative to the alveolar bone may be one of the most important parameters in managing to ensure long term health.

It must be noted that once treatment by the dental care provider has been done, management and care of the periodontium should always be maintained by both the dental care provider and the patient themselves. This will ensure long term success.

As we grow in years and looking back at dental school days, one can see the rapid advancements in dentistry. It is imperative to keep up and maintain the knowledge that is being developed, and this is constantly changing and growing.

As we have discussed previously, the “*aesthetic smile zone*” is a very important part of the make up of a human being. With the advent of periodontal plastic surgery and knowledgeable placement of restorative margins one can obtain optimal aesthetics.

It is our duty as dental care providers to inform and educate our patients in what aesthetically can be achieved by cosmetic restorations and/or periodontal plastic surgery, bearing in mind what is in our range of expertise.

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