

MARGINAL INTEGRITY AND EMERGENCE PROFILE:

AN OVERVIEW

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INTRODUCTION

Any prosthesis that replaces body tissues partially restores function and esthetic appearance but, at the same time, takes its toll in tissue irritation. This biologic price may be reduced but not eliminated. The precision of marginal seal is paramount in a dental restoration, whether to satisfy biologic, physical, or cosmetic requirements. Nevertheless, cosmetic demands of the patient (or dentist) often, if not always, result in a compromised ceramo-metal margin in an attempt to eliminate or mask the metal cervical collar.

Marginal restoration can survive in the biologic environment of the oral cavity only if the margins are closely adapted to the cavo- surface finish line of the preparation. The configuration of the preparation finish line dictates the shape and bulk of metal in the margin of the restoration, and can affect the fit of the margin.

In dento-gingival complex, the tooth has certain fundamental contours that aid in protecting the gingiva during function, any deviation from this basic contour would lead to serious consequences to the future health of the gingiva, which in return would affect the support of the tooth.

Wheeler¹ has stated "the basic contours of a tooth that would provide protection to the periodontium included - contours of the proximal surfaces, contact areas, occlusal and middle third & cervical third of the labial and the lingual surfaces when viewed from the mesial/distal aspect." A good prosthodontist will have no difficulty in restoring the simple form of the

middle and occlusal one third, but it is questionable whether the same applies while restoring the cervical one third. It is so often observed that this area is always neglected. Restoring the basic contour in the cervical third is critical, as this is in close relation to the junction of the hard and soft tissue, also known as the "CRITICAL AREA" of the periodontium.

As we are aware of the fact that local irritants in the gingival sulcus is one of the prime causative factors for the irritation of the disease process, and it has been noted that clinically plaque retention is greatest at the emergence profile and the cervical third of the axial surfaces, hence further attention should be given to this area at the time of fabrication of the restoration, keeping plaque control as the prime objective.

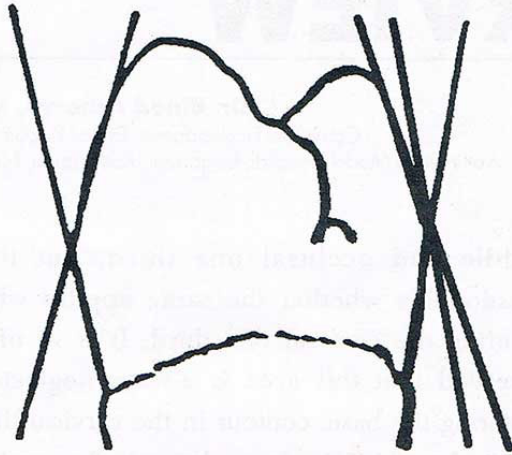
Marginal integrity can be defined as biofunctional continuity between the two extremes approximating each other at the junction so that the dentogingival complex is not affected.

In other words, marginal integrity can be defined as the structural and functional continuity between two approximating surfaces.

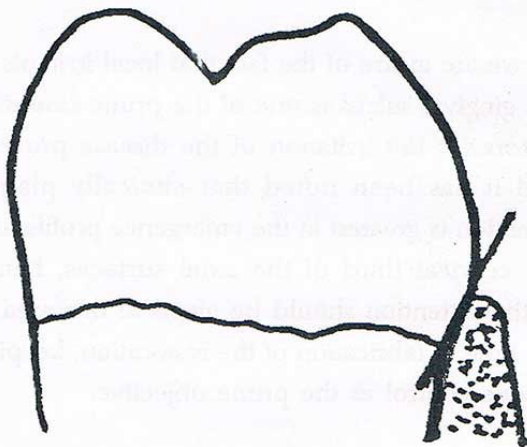
Emergence profile is the contour of a tooth or restoration, such as a crown on a natural tooth or dental implant abutment, as it relates to the adjacent tissues. (The glossary of prosthodontic terms-7, 1999).

Methodical and precise calibrations of natural teeth reveal that close to cervical third of the tooth

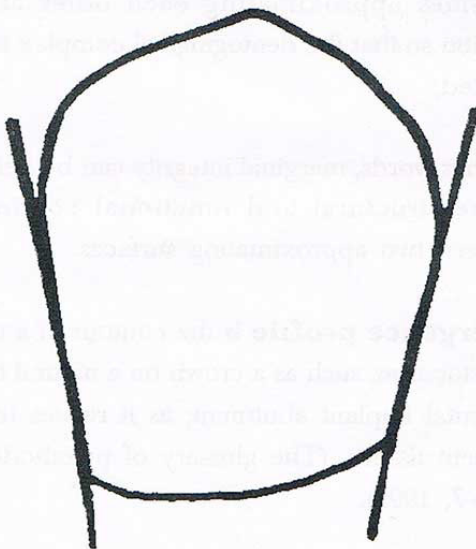
Fig. 1: Show "Emergence Profile" on different tooth.



Calibration technique showing "Emergence Profile" on premolar.



Straight "Emergence Profile" on molar that is biocompatible with gingival marginal tissues.



Straight "Emergence Profile" on canine which usually extends to height of contour.

profile as it emerges from the gingival sulcus is straight. Ignorance of this characteristics of human tooth morphology is directly responsible for much of the marginal gingival disease surrounding crowns. If the emergence profile of the finished crown is incorrectly formed, all interrelated contours will be incorrect and, accordingly, the defective mechanism will be impaired.

REVIEW OF LITERATURE:

Importance of each factor affecting marginal integrity and emergence profile.

Marginal integrity is one of the principles of tooth preparations.

The completed restoration should go into place without binding of its internal aspect against the occlusal surface or the axial walls of the tooth preparation; in other words, the best adaptation should be at the margins. If the indirect procedure is handled properly, there should be no noticeable difference between the fit of a restoration of the die and that in the mouth.

Cast metal restorations can be made to fit preparations with a high degree of precision, but even in well fitting castings there is some discrepancy between the margin of the restoration and the preparation. All these started way back in 1925 by Gottlieb. He said the venerable concept of "extension for prevention" must be critically examined in the light of the difficulty in achieving subgingival margin excellence. He contended that this principle was not valid. He repeated his statements many times and particularly in 1933 in his and Orban's text. Gottlieb stated "the practice of extending the margin of any metal restoration underneath the gingival must prove detrimental.

The margins of any crown must therefore be placed on the coronal side of the gingival margin. There, the margins can be easily seen and properly fitted without overhangs. It is well known that restorations placed underneath the gingiva

are commonly ill-fitting and in that way serve as an additional source of irritation.

In 1963, Rosner⁵ presented experimental evidence that beveled finish lines exhibit compensatory characteristics capable of reducing the marginal discrepancies of full cast restorations. The diagrammatic simulation of a shoulder preparation with bevel in Fig. 2 illustrates

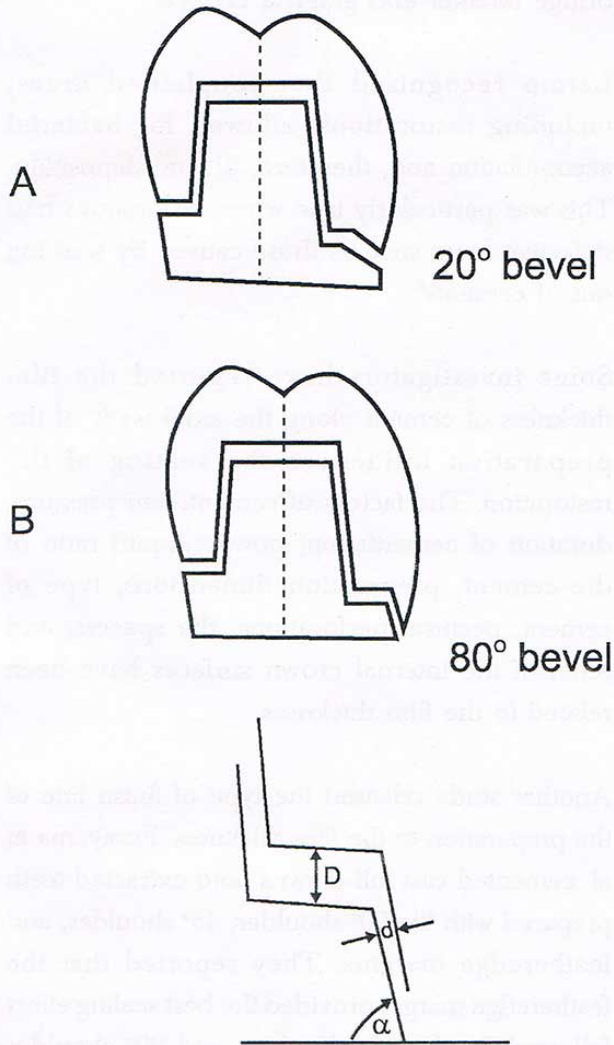


Fig. 2: Where:

D = Vertical displacement between the crown and the tooth (Discrepancy).

α = The angle formed by the bevel and the horizontal plane.

d = The distance between the internal surface of the crown and tooth.

So, trigonometrically, the relationship is expressed by $d = D \text{ Cosine } \alpha$.

As the angle approaches 90° , d approached 0° since the $\text{Cosine } \alpha = 0$.

Rosner's findings. It is evident that 4 mm gap at the horizontal shoulder is effectively reduced to under 2 mm at the bevel.

Rosner's thesis is a rediscovery of an established principle applied by machinists and engineers, a common application of this principle may be found in the tapered fit joints which machinists used to join consecutive shafts. Any dentist who has had to struggle removing a jammed arbor band assembly or a rag wheel cone assembly from the shaft of his dental lathe can attest to the stubborn efficacy of the tapered fit joint.

In 1967 Marcum⁶ placed 66 gold crown in 6 dogs. Dogs were selected because there is no significant difference in tissue reaction of dogs and man. The finish line were placed above, below and even with the gingival crest. He concluded, crowns with margins above the crest produced a slight to severe inflammation; crowns with margins below the crest produced a slight to severe inflammation and the majority of the crowns with margins even with the crest produced little or no inflammation. May be due to a better marginal finish, and a better crown contour that deflects food away from the gingival crevice.

Various authors have tried various methods of tooth preparations to improve marginal integrity. McMath recommended the gingival groove at the axiokingival line angle to increase retention, while Fusayama and Lucca defended the chamfer for crowns, claiming that it is better both periodontically and mechanically. Conond found that for jacket crowns an acute or right angle was preferable to an obtuse angle of the shoulder in relation to the axial surface of the preparation. Kanders and Smith reported that the basic consideration for periodontal health was "to maintain a knife or a featheredge" in dental restorations. Wilson and Lang agreed with that approach because it provides a definite marginal finish line with a minimum removal of tooth structure, and it has adequate strength and even greater retention hence more tooth structure, is

circumscribed. Rosner presented the rationale for bevelling margins in gold castings. Rosentiel reported that marginal fit and retention were the two main criteria for a good restoration and that the bevel angle should be between 30° and 45° to insure good "edge strength". In 1965, Miller and Belsky pointed out that full shoulder preparations were superior for periodontal health because they had a clearly defined finishing line and less tooth structure is removed in the area of pulpal horns.

In 1973, Shillingburg, Hobo and Fisher⁸ studied preparation design and margin distortion in porcelain fused to metal restorations and concluded shrinkage of porcelain is the primary reason for marginal distortion which can be minimised by increasing the bulk of metal. The shoulder finish lines studied seemed to resist distortion best thereby increasing the marginal integrity. Marginal stability of porcelain-fused-to-metal restorations having the shoulder finish lines, with or without a bevel, were found to produce significantly less distortion in labial margins of porcelain-fused-to-metal restorations than do chamfer finish lines with and without a level.

In 1973, Richter^{4,16} said there are number of contraindications to the placement of supragingival finish lines, like :

1. When clinical crown is short.
2. Old restorations with subgingival margins are present.
3. Crowns with facings are to be placed in areas requiring an esthetic appearance, and
4. Caries, abrasion, or erosion has degraded the gingival third of the clinical crown.

He continued saying, perhaps the most significant factor in consideration of the location of the margin is the health of gingival tissues in close approximation to this margin.

Karlsen placed supra and subgingival gold crowns, porcelain crown, and gold and acrylic resin inlays in dogs and monkeys. Gingival

inflammation increased with poor fit and subgingival placement of the restorations. He found that the marginal fit was important.

Silness and Loe observed that roughness of bridge retainers seated below the gingival crest accumulated more plaque than did control teeth. He said that this was probably due to the plaque-retention properties of rough surface areas of bridge retainer and gingival crevice.

Larato recognised that roughened areas, including restorations, allowed for bacterial accumulation and, therefore, plaque deposition. This was particularly true when restorations had defective areas such as those caused by washing out of cements⁹.

Some investigators have reported the film thickness of cement along the axial walls of the preparation influences the seating of the restoration. The factors of cementation pressure, duration of cementation, powder/liquid ratio of the cement, preparation dimensions, type of cement, occlusal perforations, die spacers, and relief of the internal crown surfaces have been related to the film thickness.

Another study released the type of finish line of the preparation to the film thickness. Fusayama et al. cemented cast full crowns onto extracted teeth prepared with the 90° shoulder, 45° shoulder, and featheredge margins. They reported that the featheredge margin provided the best sealing effect followed by the 45° shoulder and 90° shoulder respectively. In an earlier study, Fusayama et al. found that, even without cement, crowns fail to seat completely owing to the numerous variables associated with the casting process.¹⁰

In 1981 Gavelis et al¹⁰ did study on the effect of various finish line preparations on the marginal seal and concluded featheredge and parallel bevel preparations showed the best marginal seal, followed by 90° should, 45° shoulder and finally 90° shoulder with 30° and 45° bevels.

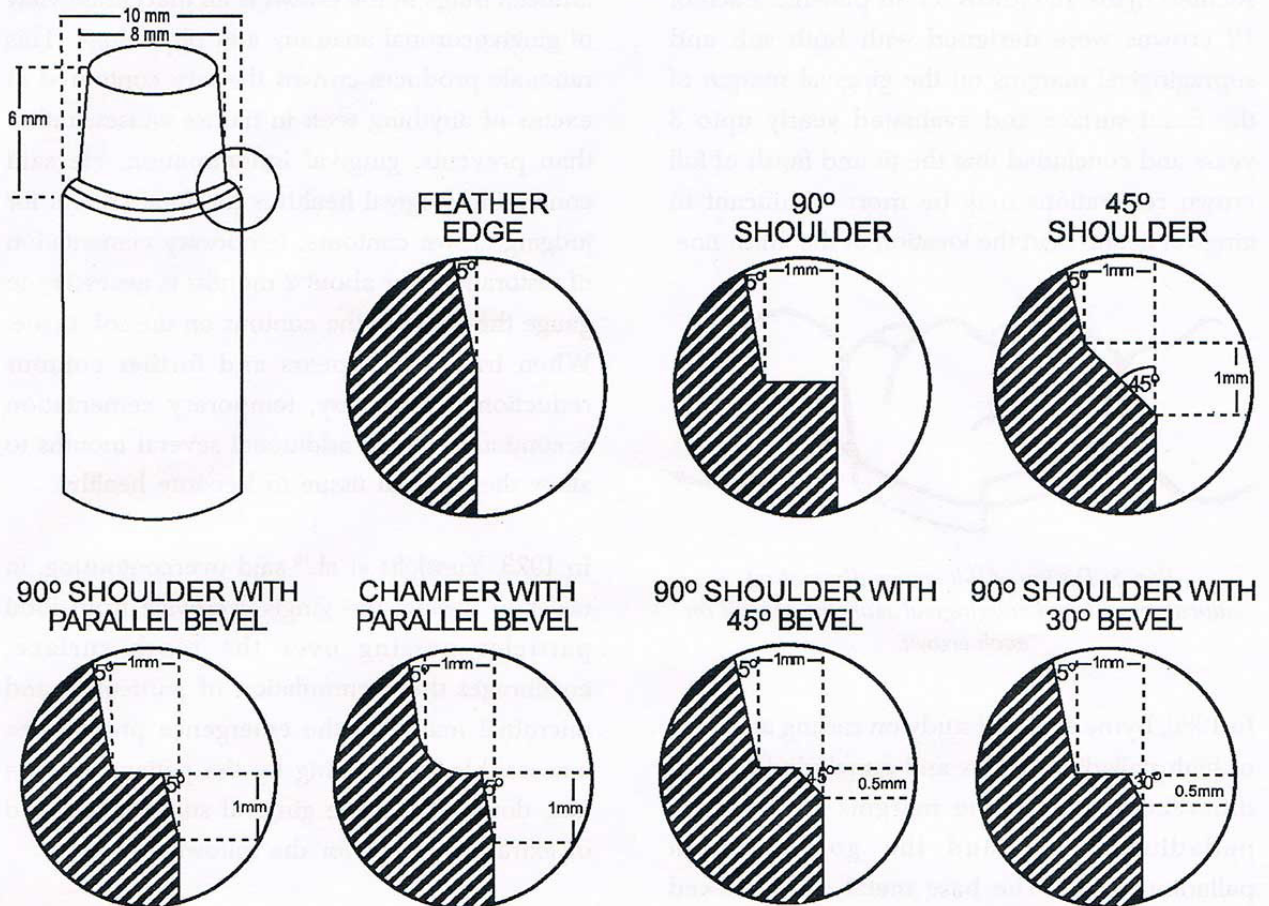


Fig. 3: A diagram of the standard die used in the study, with the various finish line preparations in inserts.

In 1981 Strating¹¹ et al. conducted a study on the evaluation of marginal integrity of ceramometal restorations on hollow ground tooth preparation concept, recommended by Lusting et al. Combines the advantages of both the shoulder and featheredge preparation. He concluded that:

- i. Hollow grinding provides on adequate preparation for anterior ceramometal restorations.
- ii. Non-precious (Ni-Cr) alloys can be cast as accurate as semiprecious or precious ceramometal alloys.
- iii. Metal distortion is not significant in a collarless or a collar coping design, if 0.4 mm metal thickness is used.
- iv. A hairline metal-collar coping design is recommended for hollow-ground preparations where a non-precious alloy is used.

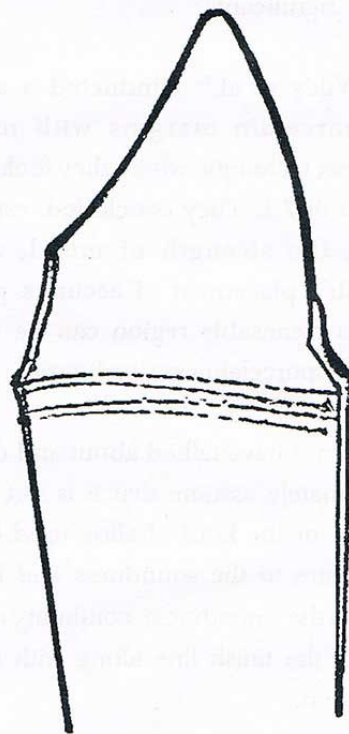


Fig. 4:
Proximal view of a hollow ground preparation.

Richter⁴ made 12 crowns on his patients. Each of 12 crowns were designed with both sub and supragingival margins on the gingival margin of the facial surface and evaluated yearly upto 3 years and concluded that the fit and finish of full crown restorations may be more significant to gingival health than the location of the finish line.

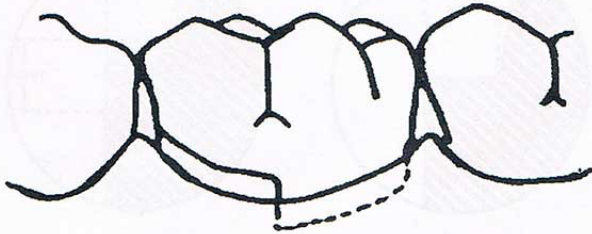


Fig. 5: Design of full crown illustrating supragingival and subgingival margins placed on each crown.

In 1986, Byrne et al. did study on casting accuracy of high palladium alloys and concluded that no difference between the margins of the high-palladium alloys and the gold-platinum palladium alloy. The base metal alloy showed slightly rounded margins, but this was detectable only at high magnification and was not considered significant.

In 1986, Wiley et al.¹² conducted a study on esthetic porcelain margins with modified porcelain wax technique where they took powder-to-wax ratio of 7:1. They concluded, esthetics of porcelain, the strength of metal, and the biocompatible placement of accurate porcelain margin in a cleansable region can be obtained by using the porcelain-wax technique.

After all that we have talked about and discussed we can ultimately assume that it is not the type of finish line or the kind of alloy used but what really attributes to the soundness and health of the gingiva is the smoothness, continuity and good definition of the finish line along with the fit of the restoration.

In 1962 Morris¹³ did a study on artificial crown contours and gingival health concluded that the

artificial bulge in the crown is an inaccurate view of gingivocoronal anatomy and physiology. This rationale produces crowns that are contoured in excess of anything seen in nature causes, rather than prevents, gingival inflammation. He said continuing gingival health is the final criteria for judging crown contours, temporary cementation of restorations for about 2 months is necessary to gauge the effect of the contour on the soft tissue. When irritation appears and further contour reduction is necessary, temporary cementation is continued for an additional several months to allow the gingival tissue to become healthy.

In 1973, Yuodelis et al.¹⁵ said overcontouring, in order to protect the gingival crevice from food particles passing over the tooth surface, encourages the accumulation of particulate and microbial matter in the emergence profile area inaccessible for cleaning by the patient. It is, in fact, doubtful that the gingival sulcus is in need of extra protection for the following reason:

1. There is very little in our modern diets that would injure the free gingival margin.
2. Proprioceptive response usually provides adequate protection for the free gingiva during mastication of hard foods.
3. The potential impact of food as the crushed bolus passes over the axial contour of the teeth is usually dissipated by the time the food reaches the gingiva.
4. Most of the crushed bolus never reaches the gingiva, since it is directed by the cheeks, lips, tongue and other parts of the mouth into a position for deglutition.
5. Most human dentitions have little if any clinical bulge and yet show no deleterious effect of mastication.
6. Dentitions suffering from abnormalities like enamel hyperplasia or peg-shaped incisors

do not have cervical bulges but do demonstrate normal gingival tissue.

Yerodelis concluded, flattening the facial and lingual contours of restorations showed excellent gingival response, most probably because the cervical region is made more accessible for routine home care.

Perel¹⁴ did overcontouring of the buccal surfaces of full-grown mongrel dogs with self-curing resin, which was not in contact with the gingiva. The results showed that undercontouring caused no apparent gingival pathoses; whereas overcontouring gave rise first to inflammation and later to the collection of debris, hyperplasia and engorgement of marginal gingiva, scant keratinization, and deterioration of the fibres of the gingival collar. The unhealthy state of the gingiva after four weeks of overcontouring reveals that the so-called "protective" convexity not only served as a food trap but also prevented massage of the gingival margin.

In the mean time so many authors came out with different theories regarding the supragingival contours and its significance in the preservation of the adjacent gingival health.

1. **Food deflection theory:** Wheeler, stated that exaggerated convex contours in the cervical third of the crown provided protection against food impaction into the facial and lingual sulci.
2. **Muscle action theory:** Morris, stated that gingiva and teeth were cleaned by the action of the lip, cheek and tongue, hence, proposed restored surfaces to be flat to mild convexities.
3. **Under contouring concept:** Perel, stated that under contoured restoration caused less damage to the gingiva than the overcontoured restoration.
4. **Plaque retention theory:** Yuodelis,

stated that convexities provided to protect the gingiva against food impaction should be avoided, as these areas facilitate plaque accumulation.

5. **Flat facial and lingual contour concept:** Eissmann and associates stated that flat facial and lingual contours of restorations resulted in positive gingival response.
6. **Anatomic theory:** Tjan and Miller, stated that the anatomic/biologic concept of the tooth contour, as a contour which stimulated natural healthy teeth. They considered that a biologic contour was a self protective contour to the supporting structures.

In 1996, Bassiouny and Yearwood¹⁷ described a technique that would reproduce gingival morphology on the working cast after the conventional die trimming concept was executed. The authors stated that overcontouring or under contouring were both extreme departures from the norm of axial morphology, which could seriously influence the esthetic outcome of the restoration. They have also mentioned that such axial contour alterations could effect the phonetics.

In 1998, Patil and Dushyanth¹⁸ conducted a study and concluded that the angles measured between the emergence profiles, the height of contours of teeth and the prominence of marginal gingiva shows statistically significant correlations. Therefore these angles could be used as a guide in developing the contour of restorations.

At the end of this review after hearing what different authors have stated regarding emergence profile, we can ultimately conclude that it is not the over contouring or the under contouring facial/lingual aspect of the tooth that matters but rather it is following the natural contour of the tooth which contributes to a healthy marginal gingiva.

SUMMARY

The treatment of dental defects by the placement of full crown restorations suggests that we consider the proper location of the margin of the restoration with respect to the gingiva. The choice to be made, either subgingival or supragingival, is particularly important to the full crown restoration, because the extent of the margin next to the gingival tissue is much greater than that for other types of restorations. However, the same biologic principles are common to all restorations, and therefore, any additional light shed on this problem should be considerable significant.

Though the proponents of the various theories defend their concepts, the shortcoming such as the difficulty of maintaining health of the marginal gingival still exists. The authors mentioned that the most baffling enigma is when the dentist has to place the margin of the preparation subgingivally and develop the subgingival contour without causing irritation to the tissues of the critical area. Clinical experience of these authors suggest that careful evaluation of the morphology or architecture of the marginal gingiva is a must for a successful fixed prosthodontic treatment.

CONCLUSION

A successful restoration must be considered from the point of view of contour, occlusal anatomy, marginal adaptation, proximal contacts, esthetic and function. The tooth must be looked upon as a harmonious part of the whole dentition. All of the above factors are equally important in the success of any dental restoration. The correct external morphology of all the restorations is important, but this must be borne in mind particularly during dental procedures involving full-coverage restorations. It is the complete artificial crown that most takes our ability to recreate the original anatomy. For this reason, the facial and lingual contours of full-coverage restorations and their relationships to periodontal health must keep in mind while preparing the same.

RE-PRINT REQUEST

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