

DESIGNING CROWN CONTOUR IN FIXED PROSTHODONTICS: A NEGLECTED ARENA.

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ABSTRACT

Clinical longevity of any prosthesis is directly related in achieving proper coronal contours. This involves close attention to detail between periodontal and prosthodontic principles during the fabrication of the prosthesis. If not done properly, iatrogenic problems may occur such as "food traps" from open contacts, overhangs, or plunging cusps. This leads to plaque accumulation, inflammation, bleeding, potential bone loss (periodontitis) thus leading to severe periodontal problems. If certain principles of placement of gingival margins and interproximal embrasures are not closely adhered to, an overcontoured restoration may act as a nidus in the rapid failure of the prosthesis.

KEY WORDS: coronal contours, periodontitis, gingival margins, interproximal embrasures

INTRODUCTION

Periodontal breakdown is generally associated with long standing fixed partial prosthesis. After 2-3 years of service; patients usually start complaining of one or the other periodontal problem. At times, patients start complaining of food trap just after cementing the crown.

These common clinical problems are related to improper axial, facial or lingual contour of crown. Contour of artificial crown are not generally made self protective. Overcontouring leads to food trap and hence complicating the periodontal status. Interdental papilla is often neglected due to improper design of interdental space. These shortcomings can be fulfilled by following the general principles of crown designing.

Theories of Axial Contour Design:

Food Deflection Theory

Wheeler proposed this theory in 1961.¹ He advocated that artificial crowns should have convexities in their cervical third which will help in deflecting food away from the free gingiva. Morris noted that the lingual or buccal tooth surface prominence guided the position of gingival margins.

Accessibility and oral hygiene measurements were given prime importance.

Herlands et al¹ questioned the rationale of the food deflecting contour concept. He noted that:

- Mechanism for impaction requires certain criterion to be met. Substances which are impacted must be fairly firm and a propelling force directing it towards an easily accessible area or cul-de-sac must be present.
- Natural crown contour is 0.5 mm from the most convex area which is inadequate for protection against food impaction.
- When prepared tooth is left uncovered for an extended period of time, complete lack of contour is usually seen but the surrounding gingiva is usually healthy.
- Gingival sulci are not an easily accessible cul-de-sac.
- Foreign matter from the gingival sulcus, is flushed by outward current of serum. Heavier muscular action and firmer food particles increase its flow.
- Contours in embrasure areas are possibly even more important than buccal or lingual contours.

Shortcomings of this theory are

- The dietary habits of modern times offer very little chance which could injure the free gingival margin.
- During mastication, proprioceptive response generally provides sufficient protection for the free gingiva.
- Impact of food as the crushed bolus as it passes through axial contour of the tooth is dissipated since it is directed by the cheeks, lips and tongue during deglutition.
- Teeth generally have little clinical bulge and causes no harmful effect on mastication.
- The contours of teeth in lower species of animals does not provide this theoretic protection, as any buccal or lingual bulges are usually subgingival.



Fig.1 Well placed gingival margin



Fig.2 Poorly placed gingival margin

Muscle Action Theory

Herlands et al and Morris¹ introduced this theory. They emphasized on muscle molding and cleansing, rather than food impaction. The theory upholds the principle of constant cleansing and molding action by the muscles of the cheeks, lips and tongue. Perel¹ studies revealed:

- No significant changes in healthy gingiva were seen by undercontoured axial surfaces.

- Inflammation and hyperplastic changes were observed in the marginal gingiva by overcontoured axial surface.

Plaque Retention Theory

According to this theory¹:

- Crown contours should be such that it should not provide any niche for plaque retention and should promote self-cleaning.
- Design of axial contour should be based on muscle-action theory.

Anatomic Theory

It was proposed by Kraus et al. in 1969. According to this theory:

- The contour which duplicates natural anatomy (anatomic/biologic) and is self protecting is preferred.
- Height of contour is located at the gingival third of each tooth and are approximately 0.5 mm wider than the adjoining cemento-enamel junction (CEJ). (Except lingual of mandibular molars and second premolars, where height of contour lies in the middle 1/3).

Physiologic design criteria for fixed dental restorations.

Eissmann HF, Radke RA, Noble WH proposed following criteria²:

I. Physiologic contouring:

An interrelation of form and function is an important consideration. The occlusal form should be such so as to generate the least amount of stress in the supporting tissues. The axial form of teeth should be able to protect and stimulate the investing tissues or the marginal periodontium.

Periodontal Considerations:

- Evaluating periodontal status of the patient is the first and critical step in planning a fixed prosthesis.
- Any existing periodontal disease should be corrected.
- Periodic recall and maintenance programme should be instituted.

II. Placement of gingival margins:

The margin between restoration and the tooth is very critical as it becomes potential site for shelter of bacteria. Therefore:

- Supragingival margins should be given for maximum cleansing action. The contour of the restoration should be such so as to provide optimum cleansing action. (Fig.1 and Fig.2)
- Transition from tooth to restoration should be smoothest.

III. Interproximal tooth contact:

Four major function of interproximal contact area are:

- Stability of dental arch.
- Prevention of food impaction into the interproximal area.
- Sufficient space for interpapillae is provided by proper contouring of embrasure space gingival to the contact area.
- Proper designing of interproximal contact areas also play vital role in cosmetic and phonetic aspects.

IV. Pontic contour:

Contour of pontic should be within musculature of tongue, lips and cheek, edentulous ridge and opposing occlusal surface. Pontic should provide comfort and support to the adjacent tissues; should be conducive to the food flow pattern; hygienic; and of cosmetic value.

Three most common pontic designs are:

1. The saddle: Highly unhygienic but may provide adequate support to the adjacent tissue.
2. The modified ridge-lap pontic: Provides minimal tissue contact with a good cosmetic value and proper cheek support.
3. The Sanitary pontic: Most hygienic but low cosmetic value

Success of a pontic depends on:

1. Gingival contour and consistency.
2. Area of tissue contact with respect to the most obtuse embrasures should be kept small.
3. Tissue and pontic should have smooth approximation in the area of contact.
4. Glazed porcelain should be choice of material for tissue contact.

Other researchers also proposed following points:

According to Ross¹ "roll" around the tooth may be formed if subgingival contour is kept flat and not

supporting the gingiva. In case of supragingival margin convex contour should be placed. Subgingival margin contour should be flat as well as should be supporting the gingiva. Spurow and Lytle⁴ maintained that for determining periodontal status of patient, positioning and contour of interproximal embrasures are very important. Maintaining interproximal embrasure area is also crucial for the health of the interdental papillae. Stein, Kuwata and Presswood defined "Emergence Profile" as the part of the axial contour that extends from the base of the gingival sulcus past the free margin of the gingiva.

Developing crown contours in restorations:

Certain principles⁵ should be followed to develop optimal crown contour.

1. Dimensions of the crown faciolingually is usually kept not more than 1mm larger than the faciolingual width at the CEJ. Mandibular molars and second premolars might be possible exceptions.
2. Generally convexities on the facial side are kept in gingival third and are not bulging more than one-half mm beyond CEJ
3. Convexities on the lingual side are generally kept at gingival 1/3 except mandibular molars and sometimes mandibular second premolar, where convexity is generally kept in the middle 1/3 of crown.
4. Generally it is the occlusal 1/3 where proximal contact points are placed except maxillary molars where it might be placed at the level of the junction of occlusal and middle thirds. Proximal contact points are placed buccal to the central fossa line, except for maxillary molars where it might be in the middle 1/3.
5. Contour of the proximal surfaces between the marginal ridge and the CEJ is kept flat or slightly concave buccolingually as well as occlusocervically.
6. Transitional line angles on axial surfaces should be straight between the proximal contact point and the CEJ, with the exception of the lingual line angles of maxillary molars, where slight convexity might be seen.
7. Height of marginal ridges should be same for adjacent teeth. The tooth is wider facially than lingually. In occlusal view lingual embrasures always appear larger than buccal embrasures.
8. Supragingival crown margins are preferred except where high esthetic zone, existing root



Fig. 3: Clinical photograph showing unhealthy interdental contour

caries, root sensitivity or in cases where crown lengthening is desired to gain additional retention

9. Subgingival contour should be such as to provide optimal support to gingiva.
10. Biologic width should be respected.

Coronal contour and Gingival health:

Gingival health can be maintained by following coronal contour principles:

A. Subgingival contour

- Irrespective of relation of contour of clinical crown to CEJ, it always begins at gingival attachment.
- Gingival crevice is formed at the junction of contour of the tooth coronal to gingival attachment and free marginal gingiva.
- Subgingival contour should support the gingiva, so that the free marginal gingiva does not tend to form a roll around the tooth. A ledge might also be formed upon which the plaque accumulates.
- Contour of the crown should not be bulky as it might tear circumferential fibres and undue stress might be exerted on gingiva beyond their physiologic limits of tolerance.

B. Facial and lingual contours:

Sharp angles or abrupt convexities or concavities should be avoided to maintain tone of musculature of lips, cheek and tongue. Yuodelis et al. questioned the food deflection theory¹. They maintained primary etiological factor for both caries

and periodontal disease is microbial plaque. Incorporation of excessive crown contour generally invites microbial plaque.^{6,7}

Therefore gradual curves should be included in crown contour. Wagman⁸ advocated for convex subgingival contour facially and lingually. This also helps to maintain "knife-like" shape of the free gingival margin. The extent of convexities should not be more than 1/2 of the thickness of the gingiva at the height of the attachment.

C. Interproximal contour:

- The faciolingual width of the contact area is generally in harmony with faciolingual width of the interproximal papilla. Interdental papillae should not be impinged by interproximal surface.⁹
- Width of contact area faciolingually should not be wider than the papilla, as it might create an overhang which will in turn cause plaque accumulations.
- Spaces between interproximal areas which are created due to gingival recession should be closed toward the papilla without impinging them.
- Faciolingual width of contact area and interproximal spaces should be narrow at the occlusal surface and at the papillae in the middle third of the clinical crown on viewing from apical direction.
- There should be flaring in teeth surfaces from the gingiva to the occlusal surface and also from the inside outward. Gingival end of the interproximal connector should be kept narrow faciolingually during splinting so that

probing from the facial and the lingual surfaces is permissible and this in turn will allow cleansing of the undersurface.

General Principles

- Periodontal health and clinical crown contour are interrelated.
- If unavoidable, undercontouring is always preferred over overcontouring.
- Gradual and smooth curvatures should be included in crown contour so as to facilitate the rubbing and cleaning function of the lips, cheeks, and tongue.
- Contour of interproximal area should be self cleansing and patient should be able to clean them comfortably.
- Height of subgingival contour faciolingually should not be more than $\frac{1}{2}$ of the thickness of the gingiva. This protects the gingival crevice and also helps in maintaining knifelike free gingival margin, with plaque control.

Management of Interdental Space:

Epithelium, connective tissue and osseous floor constitute the interdental space.¹⁰ The col area, non-keratinized tissue found below the contact area of two teeth, is low and broad in the posterior region and high and narrow anteriorly. According to Ten Cate underlying connective tissue has a influence on the epithelium. There is state of low grade inflammation in non-keratinized cells and they are loosely adhered making them more permeable to bacterial toxins. Contact of epithelium and adjacent teeth should be reduced to minimum and periodontal pocket should be reduced to minimize area of nonkeratinising tissues. Plaque retaining properties of different crown systems were compared and it was concluded that overcontoured crown attracted more plaque than undercontoured or optimally contoured crowns.¹¹ Therefore, if given choice, undercontoured crowns are preferred over overcontoured crown.

The term contact point best defines initial contact of erupted teeth. Contacts between teeth become broader and flatter as arch stabilizes and teeth eruption gets completed. It also favorably affects emergence profile in natural tooth.¹² Contact areas help in maintaining stability of dental arch and prevent food impaction. Protection of interdental papilla is also one of the major function of proximal contact area. Food impaction might occur in case of narrow contact area and gingival col might become longer if it is kept broad making the patient more susceptible to periodontal disease. The contact

area is not kept too close to gingiva so as to avoid impingement and poor cleansing. Food impaction might occur if contact area is kept too high occlusally creating space above gingiva (Fig. 3).

Material of choice in designing embrasure area is metal, to allow more precise contouring and embrasure area should satisfy all of the aesthetic, functional, biologic, and maintenance requirements.¹³ If teeth are not prepared adequately interproximally then there will be inadequate room for restorative material and thus tissue space will be encroached. Mesial and distal line angles need more reduction with chamfer bevels especially in case of closely approximated tooth. Due to this the amount of keratinized tissue in embrasure area is increased helping in better plaque control. Orthodontic separation of crowded teeth or extraction may be required in some cases. Gingival health maintenance should be of prime importance in designing prosthesis. Harmonious balance between tissue health, cleaning accessibility esthetics, phonetics, restoration strength should be maintained¹⁴. Buccal-lingual width of the col is reduced and embrasure areas are opened up with the help of concavity extending from interdental area to the cusp tip following the line angle. Buccal dimension is kept narrower than the rest of the dimensions. All the above features should also be included in the pontic design.

Function, esthetics as well as the health of the interdental area is maintained by careful planning the restoration design. (Fig. 4).

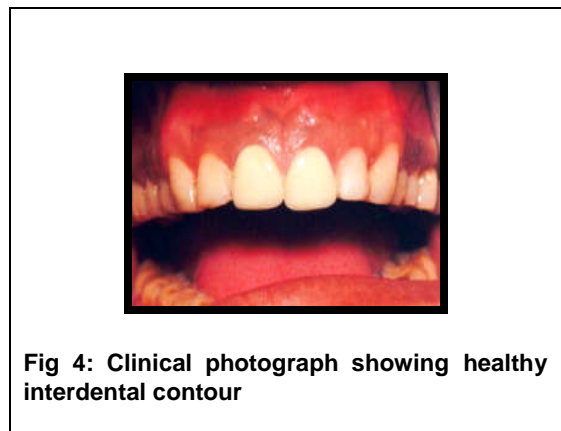


Fig 4: Clinical photograph showing healthy interdental contour

CONCLUSION:

1. Restoration failure due to periodontal breakdown can be minimized by following principle of contour design of crown.
2. Interdental papillae health should be given utmost importance. Sufficient care should be

- given to design interdental space in a way that it should be sufficiently protected. Placement of contact area becomes critical in this regard.
3. Facial and Lingual contour should be made self protective and should help in self cleansing and avoiding food trap.
 4. Overcontouring of restoration has to be avoided in every case.
 5. Subgingival margin should be avoided. But if placed, then sufficient attention should be given to its contour so that it can support the gingiva.
 6. Contour of restoration should be such that it should provide maximum cleansing action.
 7. With proper planning of restoration design, not only esthetics but periodontal health can also be maintained.

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