Gingival esthetics

Charles J. Goodacre, D.D.S., M.S.D.*
Indiana University, School of Dentistry, Indianapolis, Ind.

Achieving the most desirable gingival appearance enhances the esthetic result achieved with fixed prosthodontic restorations and is most often realized when gingival health is optimized before treatment and gingival trauma is minimized during treatment. Methods of optimizing gingival appearance by avoiding soft tissue contact are discussed as are factors considered important to maintaining good gingival appearance when subgingival margins are necessary. (J PROSTHET DENT 1990;64:1-12.)

The word esthetic denotes beauty as opposed to the merely pleasing, indicating that the most desirable attributes are present. Achieving optimal oral beauty involves many factors, one of which is gingival appearance.

The goal of gingival esthetics is to maintain normal healthy gingival appearance around teeth that must be restored. Achieving this goal requires that gingival health be optimized and trauma be minimized during fixed prosthodontic procedures.

AVOIDING GINGIVAL CONTACT

The best way to enhance gingival health and minimize trauma is to avoid contact of the gingiva with restorative materials. This goal can be accomplished in several ways.

Partial veneer crowns can be used to avoid contact with facial gingival tissue, which is more sensitive to tooth preparation procedures and the presence of restorative materials. In many situations, these restorations can be designed to avoid display of metal and tooth discoloration by not covering visible or thin translucent surfaces of the tooth (Fig. 1).

Gingival contact can also be avoided by using supragingival margins in preference to subgingival margins whenever possible. Supragingival margins increase the potential for achieving optimal gingival health around restored teeth. It is particularly important in adolescent patients to avoid subgingival finish lines because they are more likely to accelerate gingival recession or interfere with the normal cervical relocation of the gingiva as adolescents mature (Fig. 2). Both of these factors may create biologic and esthetic problems that often cannot be eliminated even with replacement of the restoration.

Supragingival finish lines can also meet esthetic demands. It has been shown that in 33% of the people studied, the gingival aspect of their most visible anterior teeth did not show during a normal smile. With an exaggerated smile, 16% of those studied did not show the gingival portion of their most visible anterior teeth. Posterior teeth were found to be less visible than anterior teeth.

Some patients will accept supragingival margins even if they are visible, and many patients prefer the potential of optimal gingival health over esthetics. It is possible to design metal ceramic restorations, even with cervical collars of metal, that do not extend subgingivally and yet are esthetic because the collars are not visible during speaking or smiling (Fig. 3).

For those patients who display the cervical aspect of their teeth, it is possible to avoid gingival contact and meet esthetic requirements by using collarless metal ceramic restorations with finish lines located at the gingival crest (Fig. 4). This design is particularly advantageous when the attached gingiva is minimal, since even minor procedural trauma during placement of a subgingival finish line may cause recession.

In situations where gingival recession or periodontal disease has resulted in exposed root surfaces, it can be esthetically and biologically advantageous to use collarless metal ceramic restorations with supragingival finish lines. Donaldson indicated that the more recession found on a tooth before treatment, the greater the possibility of further recession if the tooth is restored with subgingival margins. A supragingival collarless metal ceramic restoration margin can simulate the cervical line (Fig. 5). This placement avoids the difficult task of establishing a subgingival finish line on the root where less tooth structure is available for reduction and fragile soft tissue may be present.

SUBGINGIVAL FINISH LINES

While subgingival finish lines are not periodontally advantageous, they are required in certain situations to gain sufficient retention, cover existing restorations or fracture sites, eliminate caries, or achieve a better esthetic result.
Gingival health and position can be maintained in the presence of subgingival finish lines, but it requires careful execution of clinical procedures and the presence of excellent restorations. Achieving this goal requires careful consideration of several factors.

Preprosthetic periodontal health

Patients with existing periodontal abnormalities often have exaggerated responses to the slightest tissue insults, whereas slight trauma will not produce lasting effects if the gingiva is healthy before the procedure. It is imperative that optimal tissue health be established before fixed prosthodontic procedures are initiated and that extreme care be exercised during all stages of treatment.

Assessing periodontal health requires a thorough evaluation of periodontal probing depths and the condition of the gingiva. The gingival index described by Loe is a valuable tool in assessing gingival condition. It considers qualitative gingival changes such as color, presence of edema, and tendency to bleed when a probe or blunt instrument is run along the soft tissue wall at the entrance of the gingival crevice.

When gingival inflammation is noted by color changes, edema, or bleeding on probing, adequacy of brushing and flossing must be evaluated and corrective instruction implemented as needed. When fixed prostheses are
involved, the patient’s knowledge of and adequacy in using floss threaders and interproximal brushes must be ascertained and appropriate instruction provided. Only when optimal tissue health is present should prosthodontic treatment begin.

Tooth preparation

Care must be exercised not to injure the gingival tissues during subgingival tooth preparation, especially where the gingiva is thin and delicate. When there is minimal attached gingiva, injuries are more likely to cause recession. The epithelial attachment is the most vulnerable of all the supporting structures and procedural trauma can initiate its apical migration and result in periodontitis or recession. Subgingival finish lines should be terminated at least 0.5 mm short of the epithelial attachment. In most instances the deeper the subgingival extension, the greater is the risk to the epithelial attachment. Rotary instruments can severely injure or obliterate the gingiva, resulting in esthetically poor soft tissue contours, which can produce problems in maintaining periodontal health. The interdental papilla is particularly susceptible and easily traumatized (Fig. 6).

To ensure optimal gingival appearance around ceramic restorations with subgingival margins, the restoration must be a continuation of normal tooth contour and not be overcontoured, a condition that promotes plaque accumulation and resultant gingival inflammation. When the gingival surface of a tooth has insufficient axial reduction, color in the thin porcelain cannot be controlled, or the crown must be overcontoured, resulting in poor gingival esthetics (Fig. 7).

Adequate tooth reduction is required to provide space for both an esthetic thickness of ceramic material and normal tooth contour. The use of depth-guide cuts in the early stages of preparation ensures adequate and uniform tooth reduction (Fig. 8). The deepest parts of the cuts can
be compared with the unprepared surface, measurements made when needed, then the entire surface reduced.

The type of subgingival finish line being formed is related to the potential for gingival trauma. A shoulder finish line can be established subgingivally while keeping the entire rotary instrument diameter within peripheral tooth contours where there is less chance of gingival contact. The formation of chamfers and beveled shoulders requires that part of the rotary instrument diameter be located outside peripheral tooth contours, with greater potential for gingival trauma (Fig. 9). This relationship does not mean that greater gingival trauma will always occur with chamfers and beveled shoulders but it does indicate the need for extra care when these finish lines are being formed subgingivally.

Gingival retraction cord and hand instruments can be used to minimize soft tissue trauma from rotary instruments as subgingival finish lines are formed.

**Use of retraction cord**

Retraction cord can be placed in the gingival sulcus to displace the gingiva temporarily and reduce the soft tissue injury often observed during tooth preparation when a finish line is extended into the gingival sulcus. When used in a careful manner on healthy gingival tissue, retraction cord produces no prolonged harmful effect on the periodontal tissues.23

One procedure in using retraction cord is to prepare the tooth first, establishing preparation form and reduction depths at or slightly incisal to the gingival crest so that rotary instruments do not contact soft tissue (Fig. 10, A). Retraction cord is placed in the sulcus, displacing the gingiva laterally and apically (Fig. 10, B). Rotary instruments are then used to extend the finish line farther cervically to the level of the displaced gingival crest (Fig. 10, C). When the cord is removed and the gingiva returns to its normal position the finish line will be located subgingivally (Fig. 10, D).
Fig. 6. A, Interdental papilla between maxillary right central and lateral incisors severed during tooth preparation. B, Approximately 1 month after cementation of restorations, patient complained of severe gingiva bleeding when it was touched. Examination revealed that new tissue granulated into injured area and displaced original gingiva. New tissue was irregular in form, exhibited prolonged bleeding on contact, and resulted in poor gingival esthetics. C, Interdental papilla was obliterated and tissue that granulated into area produced poor gingival form. Patient's chief complaint was dark shadow that was present in facial cervical embrasure between two central incisors. She wanted two crowns replaced for this reason. D, Tissue was extensively damaged during tooth preparation and existing restorations have poor margin adaptation and interproximal contour. Normal gingival health unlikely even with crown replacement.

An alternative order of procedure is to place the retraction cord in the sulcus and then complete the entire tooth preparation. This procedure is not likely to produce excessive trauma when the tooth is prepared quickly. It could cause excessive trauma when a time consuming, difficult tooth preparation is encountered and retraction time is increased. There is a direct relationship between the time that retraction cord is in the sulcus and the potential for adverse gingival responses such as recession. It has been suggested that total cord retraction time ideally should not exceed 15 to 20 minutes.

Loe and Silness found that retraction cords caused necrosis of the crevicular epithelium in dogs after 10 minutes of retraction but the wound was lined with epithelial cells in 6 to 9 days. Harrison found that increasing the retraction time in dogs increased the relative degree of injury when comparing 5, 10, and 30 minutes of retraction time with different chemicals used in the retraction cords. Healing occurred histologically in 7 to 10 days for all but one of the chemicals tested. However, in both of these studies the tissue healed against intact tooth surfaces.

Factors other than time deserve consideration in using retraction cord and attempting to minimize soft tissue trauma.

Too large a retraction cord or too many cords can cause excessive trauma. With healthy tightly adapted anterior gingival tissue, one small diameter cord usually produces adequate retraction without excessive trauma.

Placing retraction cord in the gingival sulcus often severely the epithelial attachment, but healing occurs in a few days with no prolonged harmful effects if the procedure was carefully executed. The use of excessive instrument pressure when placing cord into the sulcus can produce excessive damage and recession. When the
Fig. 7. A. Overcontoured crowns resulted in abnormal gingival color. B. Removal of restorations reveals inadequate cervical tooth reduction, which promoted overcontouring to achieve adequate thickness of ceramic material.

Proper cord size is selected and careful instrument pressure used, the tissue blanching often observed immediately after placement of the cord rapidly disappears.

A histologic study showed that removing retraction cord when the cord and tissue were entirely dry tore away the entire epithelial layer from the underlying connective tissue.

Studies which evaluated the chemicals used in retraction cord are limited but have determined that zinc chloride caused unacceptable levels of gingival injury, particularly in high concentrations. Other tested chemicals injured the sulcular epithelium but adequate healing occurred in 7 to 10 days. In neither of these studies were the teeth prepared and provisional restorations placed. The tissue healed in contact with clean smooth tooth surfaces.

Retraction cord impregnated with epinephrine produced no permanent histologic gingival changes, but increase in the patient's heart rate and blood pressure have been observed. Epinephrine impregnated retraction cords did not produce a change in heart rate or blood pressure in dogs when intact gingiva was present. However, when the tissue was deliberately traumatized there was systemic absorption. Three inches of cord containing 1 mg of epinephrine per inch produced an increase in heart rate in all the dogs and an increase in the blood pressure of some of the animals. Larger doses produced severe changes in both heart rate and blood pressure. A knowledge of this negative effect is imperative when treating individuals with cardiovascular disease.

One report advised against using epinephrine-impregnated cord around large numbers of teeth.
Hand instrument technique

Hand instruments with flat blades can also be used to retract the gingiva instead of or in addition to retraction cords while a subgingival finish line is being formed, thereby preventing the gingiva from being abraded with rotary instruments (Fig. 11).

Impression procedure

An impression must provide detailed information about the prepared teeth, surrounding teeth, and associated soft tissues. The impression must record the form of all prepared surfaces and some of the unprepared tooth cervical to the finish line.
Fig. 13. A, Maxillary right central and lateral incisors prepared for ceramic restorations after traumatic injury. Note preexisting recession on lateral incisor and canine. Finish line not extended into gingival sulcus in center of labial surface of lateral incisor. B, Definitive restorations provide environment for maintenance of existing gingival form, color, and position.

Fig. 14. A, Early clinical sign of unfavorable gingival response. Visible blood vessels in marginal gingiva of maxillary left central incisor cause reddish zone to develop. B, Reddened zone present in marginal gingiva is larger and more generalized. Some edema is present, gingival margin is not as sharp as normal, and there has been some loss of stippling.

Fig. 15. A, Preparation of maxillary right central incisor resulted in gingival trauma. When patient returned for cementation of definitive restoration, gingival tissue was still red and edematous. B, Patient practiced good oral hygiene and gingiva returned to reasonably normal level of form and color in 2 weeks.
Gingival retraction cord is often used during impression procedures to (1) help control fluid seepage and/or bleeding and (2) to help provide space so that the impression material can record subgingival finish lines and unprepared tooth structure cervical to the finish line. The cord is sometimes left in the sulcus during impression making to help control fluid seepage. When possible, however, it is advantageous to remove the cord so that the impression material can record the maximal amount of unprepared tooth contours. The die is then most helpful in developing a restoration that is a continuation of natural tooth contours and not overcontoured.

After removal of an impression from the mouth, it is important to check the gingival sulcus and remove all remnants of retained impression material. Adverse tissue reactions from impression materials retained in and around the gingival tissues have been reported. The gingival response can be so severe as to produce permanent gingival changes and esthetic problems. Aqueous and nonaqueous elastomeric materials alike have been shown to affect soft tissue when left in the sulcus. Periodontal hazards of retained impression materials were reviewed and each material's potential for producing inflammatory reactions by mechanical or chemical means have been reported. The radiopacity and color of elastomeric impression materials should be controlled to facilitate the detection of material left behind.

The provisional restoration

Provisional restorations serve many purposes, one of which is to preserve the position, form, and color of the gingiva while the definitive restoration is being made. To accomplish this goal, the soft tissue must rest in its normal location against a provisional restoration that is properly contoured, is well adapted to the finish line, and has a smooth surface. Provisional fixed partial dentures must exhibit all of these attributes plus pontic and cervical embrasure forms that provide access to the soft tissue by oral hygiene aids (Fig. 12). Gingival recession has been associated with improperly contoured provisional crowns and rough surfaces have been shown to promote plaque accumulation.

After cementation of the provisional restoration, it is important to remove all traces of provisional cement from the gingival sulcus to prevent unfavorable gingival healing.

The patient must receive instructions on how to properly clean provisional restorations; meticulous attention to the prescribed regimen is necessary. The timing of clinical appointments and laboratory fabrication should be arranged so that provisional restorations are in position for as little time as possible preferably no more than 2 to 3 weeks. One study of gingival recession associated with provisional restorations found that the longer a provisional restoration was in place, the greater was the recorded recession.

When provisional restorations must be used for longer than usual time periods, the level of home care practiced by the patient is extremely important. Many adverse soft tissue reactions observed around definitive restorations have been initiated by faulty provisional restorations or good provisional restorations that were poorly cleansed and/or left in the mouth too long.
One final comment regarding provisional restorations is necessary. Nothing will improve the quality of provisional restorations as much as inspecting them on the die to ensure accurate marginal adaptation and proper contour.

The definitive restoration

The quality of the definitive restoration must provide an environment that promotes long-term maintenance of optimal gingival health (Fig. 13). The restoration should have good marginal fit because marginal defects permit plaque formation and have been associated with reduced periodontal bone levels. Facial, lingual, and interproximal surfaces should be normally contoured and should not impinge on the soft tissue because overcontouring promotes plaque accumulation and resultant gingival inflammation. The profile of the restoration as it emerges from the gingival sulcus is particularly important. All restoration surfaces should be smooth, especially those that contact the gingiva. The normal intensity, location, and form of proximal contacts must be present and marginal ridges of adjacent teeth should be of even height.

Pontics and their relationship to soft tissue health have been described. Pontic design was found to be the most important factor in obtaining inflammation-free pontic-ridge relationships. Minimal soft tissue contact designs are biologically advantageous and the sanitary or hygienic design should be used whenever esthetics permit. Embrasures should be opened as much as practical to permit access with oral hygiene aids. In visible surfaces, a “modified ridge lap” design that minimizes pontic-ridge contact lingually and eliminates concavities has been suggested. Some authors prefer glazed porcelain for ridge contact whereas others indicate that after 6 months there is no difference in soft tissue response to either porcelain, gold, or resin.

Postplacement care

A definitive restoration must routinely receive thorough cleansing. Proper oral hygiene should be verified at postcementation appointments and instructions reemphasized when needed. Inadequate oral hygiene can produce detrimental biologic and esthetic changes even in the presence of excellent restorations and careful execution of technical procedures. The finest subgingival restoration is not as smooth and easy to clean as an intact tooth surface. Particular attention must be focused on the marginal gingiva because unfavorable gingival responses begin here. A progression of clinical signs occur in unfavorable gingival responses. The blood vessels in the marginal gingiva become visually apparent, a reddened zone forms around the restoration, the gingiva becomes edematous and blunted, and there is a loss of gingival stippling (Fig. 14). If these signs are related to margin adaptation, contour, or smoothness, a new restoration should be made. If early gingival problems are a result of trauma produced during treatment or inadequate oral hygiene, they can be alleviated by detection and effective plaque removal (Figs. 15 and 16).

Sulcular brushing with soft toothbrush bristles using a gentle vibratory motion and the use of unwaxed dental floss are essential to proper hygiene. The gingiva cleansed thoroughly two to three times a day will usually return to normal within a few weeks. If early symptoms are undetected or patient cooperation is not achieved, chronic poor gingival form and color develop. After a few months poor gingival form and/or color frequently cannot be totally reversed, even in the presence of adequate oral hygiene (Fig. 17). Early detection of gingival problems is the responsibility of the dentist who initially places a restoration with a subgingival finish line because it is that individual's execution of treatment procedures and postcementation observations that often determine long-term gingival esthetics.
SUMMARY AND CONCLUSIONS

The goal of gingival esthetics is to maintain normal healthy gingival appearance around restored teeth by optimizing gingival health before treatment and by minimizing soft tissue trauma occurring during treatment. Gingival contact should be avoided whenever possible through the use of partial veneer crowns, supragingival margins, or collarless metal ceramic restorations with margins located at the gingival crest.

When subgingival finish lines are required, particular attention must be paid to several factors: (1) achieving optimal preprosthetic gingival health; (2) minimizing gingival trauma from rotary instruments during tooth preparation; (3) careful use of gingival retraction cord; (4) sulcus inspection following impression making to remove any residual impression material; (5) well fitting, properly contoured, and smooth provisional and definitive restorations; and (6) postplacement observations of oral hygiene adequacy and re-emphasis as needed.

REFERENCES

The effect of 25% tannic acid on prepared dentin: A scanning electron microscope-methylene blue dye study

Norman C. Bitter, D.D.S.*
University of Southern California, School of Dentistry, Los Angeles, Calif.

The presence and importance of the smear layer after reduction of dentin with rotary instruments has been a subject of investigative concern. The residue remaining on the surface of prepared dentin consists of particles of dentin and debris and may contain microorganisms. Removal of the smear layer with acids and demineralizing solutions increases the permeability of prepared dentin and may result in pulp injury and an increase in the potential for bacterial invasion of the dentinal tubules. Tannic acid, a protein coagulant, is a vegetable tanning agent that attaches itself to collagen by means of hydrogen bonds. Tannic acid reinforces the organic and inorganic constituents of dentin, constricts the orifices of the tubules, is well tolerated by the pulp, and offers a beneficial method of smear layer removal. Dilute citric acid has been advocated for removal of the smear layer. The citric acid enlarges the apertures of the dentinal tubules, which permits formation of composite tags and improved bonding. However, the application of 6% citric acid for 15 seconds increases the permeability of the remaining dentin and should be considered hazardous to the pulp.

This investigation describes the influence of two smear-removal agents on the permeability of the dentin.

*Clinical Associate Professor, Restorative Dentistry Department.
10/1/17195