

Embrasure and Papilla Form in Anterior Esthetics

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The beautiful smile is a combination of teeth, gingiva, and lips to create unity, harmony, and esthetics.



Achieving excellent restorative results in the anterior dentition requires that interdental papilla and gingival embrasure form are managed appropriately. This can be extremely challenging, particularly when the patient suffers from periodontal disease or the teeth are mal-positioned.

All excellent treatment planning begins with recognition of how the patient presents and an image of what normal or ideal would be. Additionally, it's helpful to know what would be acceptable (although not ideal), and what would be undesirable. This broad view of the patient's current condition and the possibilities to achieve or approach the ideal helps the accomplished clinician understand what compromises in treatment are possible, how those compromises affect the predictability or longevity of the outcome, and what parts of therapy absolutely must not be compromised. Thinking in this manner about gingival embrasures will ensure beauty in the eye of the beholder.

Regarding the interdental embrasure and the papillae that occupy it, a study of well-aligned unworn natural teeth found that when comparing the length of the contact area and the height of the papilla, approximately a 50/50 relationship existed. That is, 50% of the overall tooth length was contact and the remaining 50% was papilla. Utilizing this formula, a pair of 11mm long central incisors would have a contact 5 mm long and a papilla 5 mm tall. In addition, under these ideal circumstances the papilla will be at the same level inciso-gingivally across all six anterior teeth (FIG 2). This identifies the ideal, but doesn't describe what parameters exist within which the result is acceptable. In general, two undesirable circumstances can occur.



The first of these is an isolated problem that exists because a single papilla is more apically positioned than its neighbor. This is typically associated with an open gingival embrasure or “black triangle,” but may be associated instead with an excessively long contact. This can occur in the natural dentition due to tooth mal-position, or in the restored dentition due to altering a restoration form to extend the length of the contact apically. In either case, lengthening of the contact in an apical direction makes the teeth look squarer and therefore less natural. Whether this is an esthetic problem or not depends upon where the long contact exists. If the problem area is between the central incisors and all the other papillae are normal, the long contact may not be as noticeable. If it is between the central and lateral on one side with all the other papilla being normal in height, it will create an asymmetry that jumps out at the observer. The more asymmetric the contacts across the smile, the more visible it will be.

The second possible problem that can lead to an unacceptable result is a situation in which all the papillae are positioned apically. This most commonly occurs as a sequela of periodontal disease or periodontal surgery, and results in multiple open gingival embrasures. The primary challenge for the restorative dentist in treating these teeth is management of the outline from of the restorations. The decision to create a natural appearing tooth and leave open embrasures, or close the embrasures and create very square looking teeth with long contacts must be made before restorations are fabricated. In general, as long as the contacts are equal in length and the papilla heights relatively level, square tooth form is preferable to the open embrasures (FIG 2, 3).

Having identified acceptable parameters for the outcome of treatment, it's time to examine the specific options available to achieve that outcome. When an open embrasure exists, it will be due either to a papilla not extending coronally enough to fill the embrasure, or a contact not extending apically enough to reach the papilla. To diagnose the problem, and through that create a decision tree of appropriate treatment choices, we will begin by discussing the papilla as an entity unto itself.

The height of the papilla is determined by 3 things: the level of the interproximal bone, the biologic width, and the size and shape of the gingival embrasures (FIG 4). When interproximal bone level moves coronally, as in passive tooth eruption, the papilla moves coronally. When the bone level moves apically, as in periodontal disease, the papilla has the potential to move apically.

The remaining two factors, biologic width and the volume of the gingival embrasure, influence the actual distance the papilla stands above the bone for a given individual. While average biologic width is 2mm, Vacek found variations ranging from .75 mm to 4.3 mm. These variations result in some papillae extending significantly more coronal to the bone than the average. In addition to variations in biologic width, variations in gingival embrasure form can significantly alter the height of the papilla.



FIG 2



FIG 3

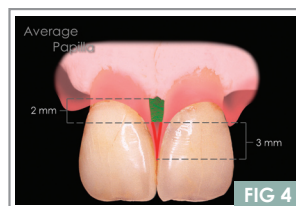


FIG 4

FIG 1 – A well aligned unworn dentition showing a normal relationship between contact length and papilla heights and papillae at the same level across the anterior.

FIG 2 – A classic presentation of periodontal disease showing apical migration of all the papilla and open gingival embrasures.

FIG 3 – The final restorations were created to close the open embrasures but this results in long contacts and square teeth.

FIG 4 – An average papilla with a 2mm biologic width and 3mm sulcus. The tip of the papilla extending 5mm above bone.



FIG 1

FIG 5 – Tarnow's findings on contact height above bone and open embrasures.

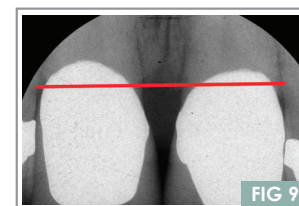
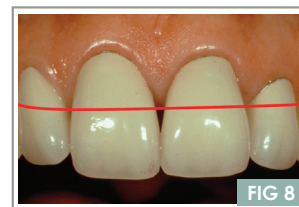
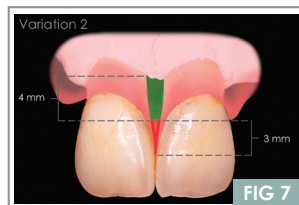
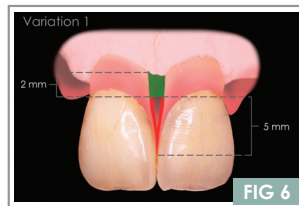
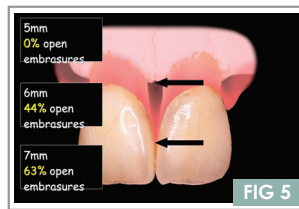
FIG 6 – An unstable papilla. 7mm above bone, a 2mm biologic width, and 5mm sulcus.

FIG 7 – A more stable variation. 7 mm above bone, 4mm biologic width and 3mm sulcus.

FIG 8 – A patient presents wanting her anterior restorations replaced and unhappy with the open embrasure. The papilla between the centrals is 1mm apical to the papilla between the centrals and laterals.

FIG 9 – The radiograph of the patient from FIG 8. The bone is at the same level between the centrals as on the laterals. This means the reason the papilla is 1mm apical is that the embrasure is too large.

FIG 10 – The final restorations extending the contact apically and narrowing the cervical embrasure to move the papilla coronally.



Imagine placing a water balloon on a table between your hands and squeezing slightly. If you consider the surface of the table to be the coronal margin of the biologic width, the balloon represents tissue setting above attachment in the embrasure. Move your hands farther apart and the water balloon will sag and become shorter in height relative to the tabletop. If you squeeze your hands together, the balloon moves higher above the tabletop. If your hands were teeth, their relationship to each other, whether squeezing or opening the embrasure space, would elicit the same response from tissue that your hands do from the water balloon. The more open the embrasure, the flatter and more apical the papilla will be positioned. The more closed the embrasure, the more pointed and coronal the papilla will be positioned.

A papilla of 6 or even 7mm above bone may be normal and stable if the patient has a biologic width significantly taller than 2mm. For this reason I usually use sulcus depth rather than distance above bone as a way of assessing the likely behavior of a papilla during treatment. If the papilla is 6 or 7mm above bone and has a sulcus depth of 2 to 3mm, it is usually stable. If that same papilla height of 6 or 7mm exists with a sulcus depth of 5mm, it has a high probability of recession during treatment. The risk of recession is also linked to the biotype of the tissue, thick vs. thin (FIG 5, 6, 7).

With an understanding of the biology of the interproximal papilla, we can discuss definitive diagnosis and treatment of specific clinical situations.

Let's look at a common problem. A patient presents with an open gingival embrasure between an isolated pair of anterior teeth expressing unhappiness with the "hole" (black triangle) between the teeth. As previously discussed, this situation occurred because the papilla is apically positioned, or the contact doesn't extend apically enough to meet tissue.

To select an appropriate therapeutic regimen we must identify which of these two options is the cause in this specific case. To determine this, evaluate the height of the papilla in the problem area and compare it to the height of adjacent papillae where there is no "hole" (black triangle). Two findings are possible. One, the papilla in the problem area is even with adjacent papillae where no black triangle exists. Two, the papilla in the problem area is apical to the adjacent papillae. When the problem papilla is apical to the adjacent one, there has either been bone loss or there is a wide embrasure resulting in a flattening of the papilla. This can be ascertained by probing the sulcus. We know that even after surgical removal, papillae will regenerate a sulcus depth of 2 to 3mm. Any probing depths less than 2mm almost guarantee that the papilla will move coronally by narrowing the gingival embrasure to create a sulcus of 2 to 3mm (FIG 8, 9, 10).

When the papilla is found to be apical to the adjacent papillae that don't have an open embrasure, two treatment options exist. If bone is the problem, treatment will be needed to bring bone coronally. Achieving this outcome by grafting bone between adjacent teeth in a coronal direction is rarely successful and completely unpredictable. Orthodontically erupting bone by erupting the teeth adjacent to the problem area is almost always successful and highly predictable. If the area is healthy, the interproximal bone will move coronally and bring the papilla with it. It is necessary to shorten the incisal edges as the teeth are being erupted, a process resulting in a decrease in overall crown length. This must be compensated for through crown lengthening on the facial of the teeth being erupted. Care must be taken to remove facial aspects of the bone without touching the interproximal bone and tissue.

When bone is not the problem, the embrasure is too large, a situation that can result in an open embrasure even when papilla levels are ideal. Large embrasures are usually due to divergent roots or tapered crown forms, and when present must be diagnosed radiographically. If the roots are divergent, orthodontics is most likely the most appropriate solution to create ideal papilla levels. Paradoxically, this problem can be created by orthodontics in an adult with overlapped incisors. For incisors to be overlapped, the roots must be divergent, but in an adult, the incisal edges may have worn even. When the orthodontist places brackets level to the worn incisal edges and begins to align them, the roots remain divergent and the contact moves incisally, opening the gingival embrasure and creating a large black space. This may often be unrecognized and be diagnosed as a periodontal problem. By placing the brackets perpendicular to the mesial surface and replacing the arch wire as the roots become more parallel, the contact moves apically, the embrasure decreases in size, and the papilla moves coronally to its ideal level. It is then necessary to restore the incisal edges to their pre-orthodontic position. In addition, the patient needs to be made aware that during the orthodontic therapy to correct the gingival embrasures, the incisal edges will begin to look worse until they are restored (FIG 11-14).

If the root angulation is found to be parallel, but the contact doesn't extend apically far enough to contact a normal papilla, this is usually because the crown is excessively tapered. The taper can be addressed by reshaping the teeth to create small diastemas, and then orthodontically closing the spaces extending the contact apically. The downside of this approach is two-fold. The teeth are narrowed, potentially creating a less pleasing width to length ratio, and the patient requires orthodontics. The more direct solution to correct an overly tapered crown form is restoration, either directly with composite resin or indirectly with veneers or crowns. Using restorations to alter interproximal embrasure form requires that the restorations be carried subgingivally 1 to 1.5mm to gradualize the contour change. Leaving margins at gingival levels will create ledges and will not impact the papillary form (FIG 15, 16, 17).

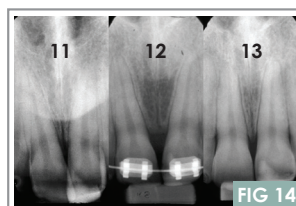


FIG 11 – A patient with overlapped centrals and divergent roots.

FIG 12 – As the teeth are aligned, but the roots not paralleled, a large open gingival embrasure exists.

FIG 13 – As the roots are paralleled the embrasure closes and the papillae fill in. Note the severity of incisal wear.

FIG 14 – Radiographs showing the 3 stages of the patient in FIGS. 11, 12 & 13. Far left FIG 11 initial, middle FIG 12, far right FIG 13.

FIG 15 – A patient with excellent papillae, parallel roots, but an open gingival embrasure she is unhappy with

FIG 16 – A metal matrix is extended 1 – 1.5mm subgingivally to allow direct composite to be placed moving the contact apically and narrowing the embrasure.

FIG 17 – A 2-year recall of the direct composites to close the gingival embrasure.

FIG 18 – A patient who desires replacement crowns on both central incisors.

FIG 19 – The margins are carried 1 to 1.5mm subgingivally on the interproximal.

FIG 20 – The technician scrapes the sides of the papilla on a solid model to create ideal papilla form.

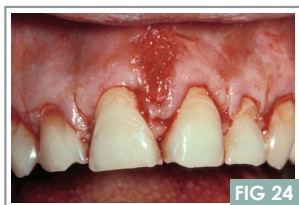
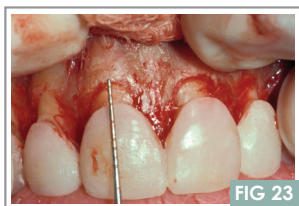
FIG 21 – The final restorations at 1 year recall that were baked on the solid model.

FIG 22 – A patient with wear and some secondary eruption, papilla levels are good, but the gingival scallop particularly on the centrals is flat.

FIG 23 – A surgical guide in place to aid in knowing how much bone to remove on the facial only.

FIG 24 – At suturing, notice the tips of the papilla remain untouched, only a facial flap was raised. Note the increased gingival scallop.

FIG 25 – A 5-year recall. Note excellent papilla height to contact length relationship from facial surgery and lengthening the incisal edges



It's vital for the technician to fabricate the restorations on a model that has a soft tissue profile present so that the desired interproximal embrasure form can be created. It is commonly necessary for the technician to reshape the papillae on the soft tissue model prior to fabricating the restorations (FIG 18-21).

Thus far we have focused on the role of the orthodontist and restorative dentist in the management of gingival embrasure problems. The periodontist can impact gingival embrasure form through alteration of the gingival scallop. By leaving the papillae alone during surgery and removing only facial bone and gingiva, the papillae appear taller and allow creation of a pleasing crown form restoratively. It is particularly effective for patients with a flat peridontium and short teeth since it also increases overall crown length (FIG 22-25).



Finally, the patient may present with a contact area that is too short without having an open embrasure. This almost always occurs in cases of severe tooth wear in which the incisal edges of the teeth have worn away reducing the contact length while the papilla and gingival embrasure remain normal. If the incisal edges of the worn anteriors are correctly positioned and level with the occlusal plane, it is highly likely the teeth erupted as they wore away. In this case, the papillae and free gingival margins are coronally positioned relative to ideal. Orthodontic intrusion, crown lengthening, or a combination of the two will appropriately reposition the teeth and the papillae (FIG 26-30).

If the teeth have not erupted as they wore, the treatment plan needs to focus on gaining space so the incisal edges can be restored to their correct position, re-creating a normal length contact and proportion to the tooth.

Proper diagnosis of embrasure issues requires knowledge of the ideal. Whether a problem of bone level, an issue of embrasure volume, or inadequate contact length, the correct diagnosis leads to the correct decision tree process and an appropriate solution. In issues regarding embrasure, that tree is a multi-disciplinary one. The observation skills required to properly diagnose mucogingival issues and the Decision Tree process that teaches appropriate application of therapy are part of Facially Generated Treatment Planning, the first hands-on workshop in The Spear Education curriculum.



FIG 26



FIG 27



FIG 28

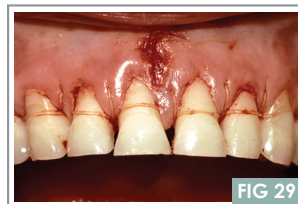


FIG 29



FIG 30

FIG 26 – A patient with severe tooth wear and secondary eruption. The incisal edges are correctly related to the face but the papillae and free gingival margin levels need to move apically.

FIG 27 – Due to the lack of tooth structures for restoration, crown lengthening was chosen to move the papilla and gingival margin.

FIG 28 – Unlike the patient in FIGS. 22 – 25, this patient's papillae will need to be apically positioned to correct the contact length.

FIG 29 – Following suturing it is evident that the papillae were moved apically to correct the contact length and the free gingival margins were moved apically to correct papilla height and tooth length.

FIG 30 – A 5-year recall showing the pleasing relationship between tooth length, papilla height, and contact length.