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BIOLOGIC WIDTH

Articles by Dr. Frank Spear

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INTRODUCTION



Gregg Kinzer, D.D.S., M.S.D.

I often hear restorative dentists say they don't need to know about the biology because they don't perform surgery in their office.

It goes without saying that for surgical procedures designed to move tissue (e.g., gingivectomy, crown lengthening, root coverage), understanding how the biologic system impacts the treatment plan and outcome is critical. However, the reality is that there are numerous "non-surgical" procedures performed every day in a restorative practice that also require knowledge of the biologic width. In fact, any time you are working near the gingiva and have to think about tissue retraction, the biology needs to be considered.

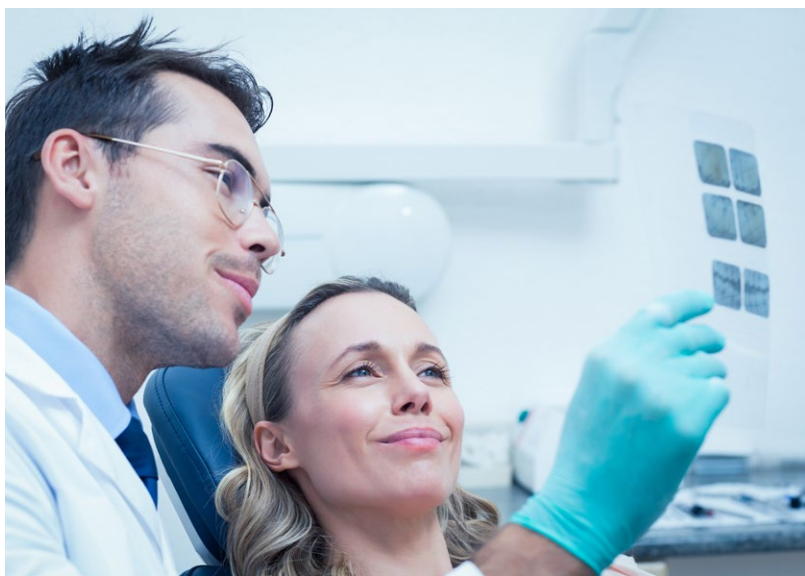
When preparing a tooth for a full-coverage restoration, how do you decide where the crown margin should be placed? If the margin is not placed deep enough under the tissue, there is a risk for recession and potential exposure of the crown margin, which may be esthetically unacceptable. On the other hand, if the margin is placed too deep under the tissue, there is a risk for possible biologic width impingement, which is a significantly greater problem. Ultimately, where the restorative margin is placed relative to the tissue and the subsequent response of the tissue is determined by the biology itself. Hence, it is imperative for restorative dentists to understand "biologic width."

When it comes to integrating basic biologic concepts with restorative dentistry, I believe that there is no one better than Dr. Frank Spear. This is in part due to his dual perio-prosth degree, but mainly it is his unique ability to impart complex clinical processes in a logical, systematic and clear methodology, that is based on empirical research as well as his own clinical experience.

- Dr. Gregg Kinzer

Contents

Biologic WIDTH



14 Margin Placement for Deep Sulcus Patients

26 Managing Facial and Interproximal Biologic Width Violations on Multiple Adjacent Teeth

01 Fundamental Concepts

02 The Term “Biologic Width”

04 Restorative Margin Placement

06 Possible Gingival Presentations

08 Subgingival Margin Placement in Shallow Sulcus Patients

10 Margin Placement for Deep Sulcus Patients

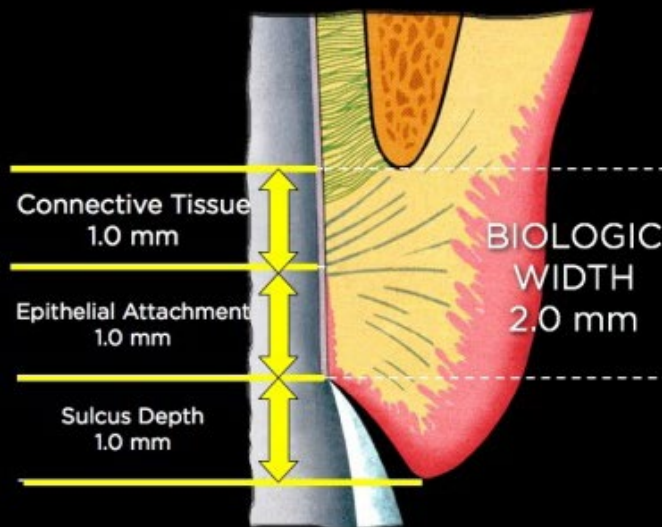
18 Diagnosing a Biologic Width Violation

20 Surgical Correction

22 Managing Interproximal Biologic Width Violation on the Facial Surface Only

Biologic WIDTH

Classic illustration of the average human attachment apparatus as described by Gargiulo, Wentz, and Orban in 1961



The Connective tissue attachment and epithelial attachment form the “Biologic Width” averaging 2mm in most patients

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Figure 1

Fundamental Concepts

B iologic width describes the combined heights of the connective tissue and epithelial attachments to a tooth. The dimensions of the attachment were described in 1961 by Gargiulo, Wentz and Orban in a classic article on cadavers. Their work showed the connective tissue attachment having an average height of 1 mm, and the epithelial attachment also having an average height of 1 mm, leading to the 2 mm dimension often quoted in the literature for biologic width. In addition, they found the average facial sulcus depth to be 1 mm, leading to a total average gingival height above bone of 3 mm on the facial.

(Figure 1)

A

patient

who presented with porcelain bonded crowns placed six months earlier is unhappy with their appearance and the severe gingival inflammation. All margins are within 1 mm of bone.



Figure 2

The Term “Biologic Width”

For historic accuracy, it is interesting to note that Garguilo, Wentz and Orban didn't use the term “biologic width” in their 1961 article; the actual name, biologic width, came in 1962 from Dr. D. Walter Cohen at the University of Pennsylvania.

In 1994, Vacek did further cadaver studies on biologic width that helped give some insight into the clinical findings many of us had seen. He found that biologic width was relatively similar on all the teeth in the same individual from incisors to molars, and also around each tooth. He also found the average biologic width to be 2 mm as the Garguilo group did. What Vacek found that is clinically important was that biologic width varied between individuals, with some having biologic widths as small as .75 mm, and others as tall as 4 mm, but statistically the majority followed the 2 mm average.

The primary significance of biologic width to the clinician is its importance relative to the position of restorative margins, and its impact on post-surgical tissue position. We know that if a restorative margin is placed too deep below tissue, so that it invades the biologic width, two possible outcomes may occur. One, there may be bone resorption that recreates space for the biologic width to attach normally. This is the typical response seen in implants to allow the formation of a biologic width, the so-called funnel of bone loss to the first thread.



Around teeth, the most common response to a biologic width violation is gingival inflammation, a significant problem on anterior restorations. *(Figure 2)*

The importance of biologic width to surgery relates to its reformation following surgical intervention. Research shows it will reform through coronal migration of the gingiva to recreate not just the biologic width, but also a sulcus of normal depth. This means if the surgery doesn't consider the dimensions of biologic width when placing the gingiva relative to the underlying bone, the gingival position won't be stable, but instead will migrate in a coronal direction. In this example, it also has a strong influence on when and where restorative margins should be placed post-surgically. ■

“The primary significance of biologic width to the clinician is its importance relative to the position of restorative margins, and its impact on post-surgical tissue position.”

Biologic WIDTH



Restorative Margin Placement

Earlier I described the fundamental concept of biologic width, the height of the combined connective tissue and epithelial attachment above bone, averaging 2 mm in most patients. I also mentioned the two possible outcomes that can occur if a restorative margin is placed too close to bone: one being bone loss, the other being gingival inflammation, with the inflammation being far more common.

Your Options and Biologic WIDTH

The first option to consider when placing a restorative margin is to decide if the margin can be left supra- or equigingival, or must be placed subgingival. If the margin can be placed supra- or equigingival, the concerns over biologic width don't exist - assuming the gingiva is healthy and mature. Today if the tooth color is acceptable and there is no structural reason to extend below tissue, such as caries, cervical erosion, old restorations or a need to extend for ferrule, the use of a translucent material, such as Lithium Disilicate, can get an esthetically acceptable result without the need to go below tissue.



Figure 1

Patient with a severely discolored left central requiring subgingival margin placement. The right central margin was also carried subgingival, the centrals were restored with zirconia-cored crowns, while the lateral and canine restorations were left supragingival and restored using a translucent feldspathic porcelain.



There are times, however, when it is necessary to place margins below tissue, specifically if structural issues exist, the tooth is extremely discolored, or you need to use a more opaque restoration such as zirconia or metal ceramics. In these instances, a subgingival margin is necessary and the concern of going too far below tissue and violating the attachment exists. (Figures 1 and 2)

When I believed biologic width was the same for every patient, the 2 mm described by Gargiulo in 1961, I thought the solution to margin placement was simple: place the margin 2.5 mm from bone. This would be far enough away from bone that it didn't violate the attachment, but also leave the margin subgingival, as the facial gingival margin is normally at least 3 mm above bone.

An example of a patient I treated in 1983. The left central prep was done by sounding to bone and placing the margin 2.5 mm from bone, the tissue became inflamed within 12 weeks. This photo was taken 12 years later; the tissue still inflamed. The illustration shows one possibility, a taller than normal biologic width, a taller than normal biologic width. In this example, 3 mm. My margin being 2.5 mm from bone would have violated the attachment.

Figure 3

The truth was the 2.5 mm distance worked well for most patients; I would simply use a perio probe and sound to bone to be sure my margin was, in fact, 2.5 mm away from the bone as I prepped. But in many patients, the gingiva became very inflamed following treatment.

The reason was related to what Vacek found in 1994, that, "biologic width is not the same between patients, some having attachment heights as tall as 4 mm." In these patients my 2.5 mm distance from bone was in their biologic attachment. (Figure 3)

Where we really want a subgingival margin is actually easy to describe. We want it below the gingival margin, but above the epithelial attachment - in the sulcus, if you will. The key though, is we can't use bone consistently as a reference unless we actually know that individual patient's attachment height.

In the next part of this series, I'll describe how I have placed subgingival margins since reading Vacek's article in 1994 to predictably achieve the desired position. ■

Biologic WIDTH

Possible Gingival Presentations

Previously, I discussed the concept of biologic width and the concerns about placing restorative margins too deep, violating the attachment and subsequently producing gingival inflammation or bone loss.

In this article, I'll describe the two different types of gingival presentations we encounter when approaching subgingival margin placement, as well as the risks of each. Whenever I contemplate placing a margin subgingival, I always start by probing the facial sulcus of the teeth I will be placing the restorations.

It is important to realize that when we probe the sulcus, the probe routinely enters the epithelial attachment .5 mm, meaning the actual sulcus is typically .5 mm less than the probed depth. In patients with inflamed tissue, the probe penetrates even deeper into the attachment.

In patients with normal or shallow facial sulcus depths, typically 1 mm to 1.5 mm, the risk in subgingival margin placement is going too deep and violating the attachment, as the histologic sulcus depth is probably less than 1 mm. The good news is these patients do not typically present a high risk of recession following placement of the restoration since the gingival dimension above bone is commonly 3 mm on the facial, similar to the Gargiulo diagram in my previous articles. This means there would have to be bone loss for the tissue to recede apically.



A female patient, 50 years of age, with very healthy gingiva and facial sulcus depth of 1 mm. The preps are .5 mm to .7 mm below gingiva to mask the discolored roots of the left central and lateral. The other preps were also carried .5 mm to .7 mm below tissue, to produce a uniform appearance across the anterior.



Above: These are images of the final restorations from the patient in Figure 1. On the left, a month after seating, on the right, 10 years later. Patients with shallow sulcus depths rarely get recession long-term unless they lose bone.

So going below tissue more than .5 mm to .7 mm is unnecessary, and it is unlikely the margin will violate the attachment or be exposed from future recession.

(Figures 1 and 2)

The second presentation is a patient with much deeper facial sulcus depths, 2 mm to 4 mm – or even more. This patient presents a much higher risk of recession following restoration unless the margin is placed farther below tissue. The reason for the risk of recession is due to the fact that there are several millimeters of unattached gingiva above the biologic width. The thickness of the unattached tissue has an influence on the risk of recession; the thinner the tissue and deeper the sulcus, the greater the risk of recession. The good news is it is very difficult to violate the biologic width on these patients as you would need to prep 2 mm to 4 mm below gingiva to reach the attachment. ■

(Figures 3 and 4)

Below: An image of a patient whose crowns were placed six months ago. Both she and the dentist who placed them agree the margins were covered by tissue at the time of placement. A diagram illustrates the typical presentation susceptible to early recession, a facial sulcus depth of 3 or more millimeters.



Above: After removing the old crown and probing the sulcus on the left central, it is easy to see that for the gingiva to have covered the margin, the sulcus depth six months ago would have had to be at least 3.5 mm (green arrow).



Biologic WIDTH

Subgingival Margin Placement in Shallow Sulcus Patients

In patients with sulcus depths less than 1.5 mm, the risk in subgingival margin placement is going too deep and violating the attachment. For these patients, my goal for margin placement, if a subgingival margin is necessary, is to place the margin .5 mm to .7 mm below tissue. This protects the attachment, but still leaves the margin covered by gingiva. And since the risk of recession is low, the .5 mm to .7 mm subgingival placement hides the margin visually.

On the following page I've listed the steps I take to achieve the correct subgingival margin placement are as follows.

1

Prep the tooth completely, right to the existing gingival margin level, leaving only the subgingival margin placement to be completed. (Figure 1)



2

Probe the sulcus and identify that the probing is 1.5 mm or less. (Figure 2)



3

I am a fan of retraction cord for controlled subgingival margin placement on anterior teeth, even though I know many clinicians prefer not to use it. I would now place an Ultradent Ultrapak cord, #00 (thin tissue), or #1 (most tissue). The key is that the cord is placed .5 mm to .7 mm apical to the prep margin, which was left at the height of the gingival margin. The cord is damp, not soaked, with aluminum chloride solution. (Figure 3)



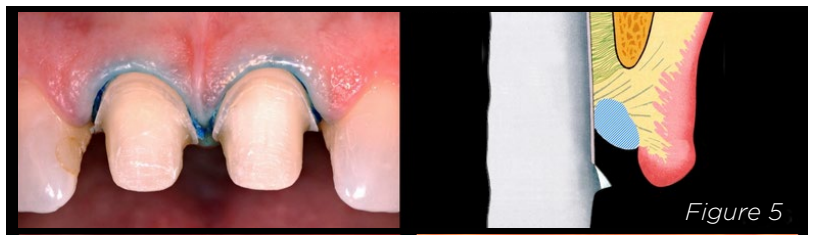
4

The first cord retracts the tissue, and also represents the correct position for the final prep margin, .5 mm to .7 mm subgingival. Prep to the top of the cord using the bur that provides adequate depth and shape for your finish line. (Figure 4)



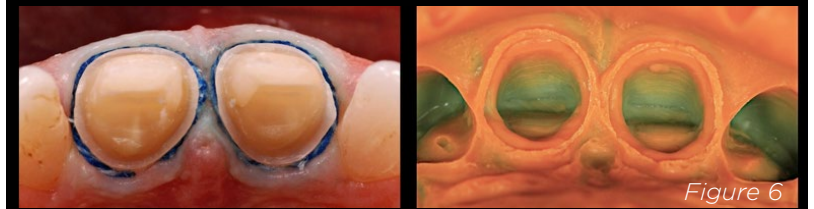
5

Place a second layer of cord, pushing it apically so it sits at the level of the prepped margin. If you can't see the second layer of cord it has been placed too deep; you want to visualize the second cord all around the tooth.



6

Wet the top cord with water, remove it, air dry and impress, traditionally or optically. (Figures 5 and 6)



7

Completed restorations. (Figure 7)

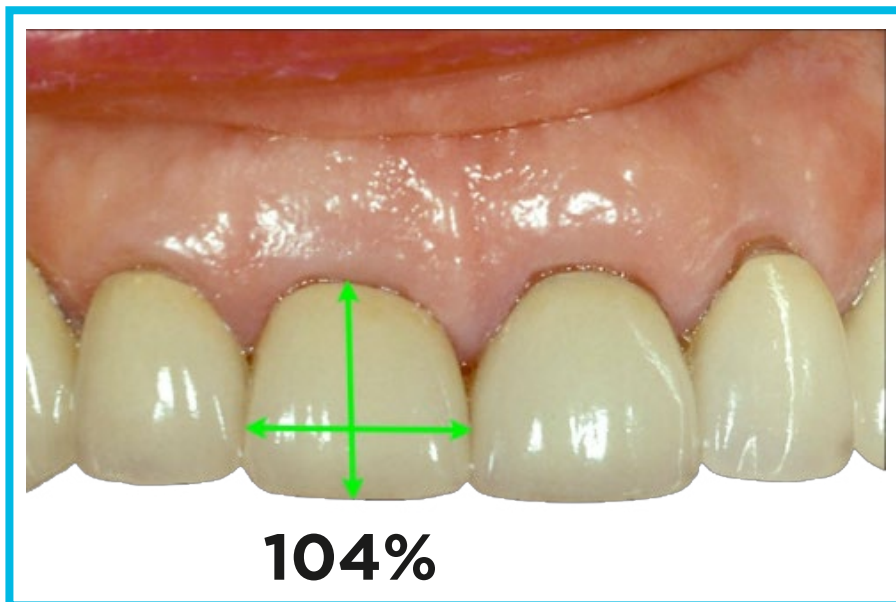


Margin Placement for Deep Sulcus Patients

Previously, I presented a step-by-step approach for the management of margin placement when a shallow facial sulcus is present (less than 1.5 mm), and a subgingival margin is needed.

Biologic

WIDTH



Left: Patient at initial presentation. Her dentist had placed the crowns from canine to canine six months earlier; the margins at the time of placement were covered by gingiva, but within two months the tissue had receded and the margins exposed.

The facial sulcus on the right central is 3 mm, and the width-to-length ratio is 104 percent; the diagnosis is altered passive eruption. She is a perfect candidate for gingivectomies to reduce the facial sulcus down to 1 mm to 1.5 mm, minimizing the risk of future recession, and improving the width-to-length ratios as well.

Figure 1

have also described the fundamental concept of biologic width; the height of the combined connective tissue and epithelial attachment above bone, averaging 2 mm in most patients. I also mentioned the two possible outcomes that can occur if a restorative margin is placed too close to bone: one being bone loss, the other being gingival inflammation, with the inflammation being far more common.



Figure 2

The current facial sulcus on the left central is 2.5 mm. To have covered the margin the sulcus would have been at 3.5 mm six months earlier, a high-risk situation for future recession, as she experienced. I have performed gingivectomies on both centrals correcting their length and leaving 1 mm to 1.5 mm of sulcus depth.

Option 1 is altered passive eruption. Essentially, the gingiva has not receded to a normal position relative to the bone and CEJ. The hallmark of this is the appearance of the teeth having short clinical crown length. If one measures the width-to-length ratio of central incisors with altered passive eruption, the ratios may be in the 90 percent to 100 percent range, or even higher, as opposed to the more normal 75 percent to 80 percent.



Figure 3

Following the gingivectomies, I prepped the margins .5 mm to .7 mm below the tissue and placed provisionals. The left image is the provisional eight weeks after placement. On the right is what the tissue looked like after removing the provisionals and prior to the final impression; the facial sulcus depths are between 1 mm and 1.5 mm.

The good news about a diagnosis of altered passive eruption is that the deep sulcus can be eliminated with a gingivectomy. This eliminates the risk of future recession by leaving a normal 1 mm to 1.5 mm sulcus depth, and it also improves the length of the clinical crowns at the same time. To use a gingivectomy, though, it is typically necessary to perform it across all the anterior teeth so that the gingival levels flow correctly from canine, to lateral, to central. (Figures 1-4)

The other key, if considering a gingivectomy, is to never remove so much gingiva that the remaining sulcus is less than 1 mm in depth, as the tissue will simply grow back if you do.



Figure 4

On the left, how she looked at the time of initial presentation, on the right, five years following placement of the final all-ceramic restorations. Reducing the facial sulcus depth makes it highly unlikely she will get future recession.

The second option for a deep facial sulcus is bone loss, and a lack of recession, effectively created by the attachment migrating apically with the bone loss but the gingiva not following - a pocket formation, if you will. In these patients, the clinical crown lengths are typically normal, so eliminating the deep sulcus with a gingivectomy would actually create excessively long and narrow clinical crowns.

These patients are typically a greater risk to restore than the altered passive eruption patients, as the sulcus depth can't be easily reduced with a gingivectomy to minimize the risk of recession. I'll cover how I approach this type of patient in my next article. ■

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Biologic WIDTH

Margin Placement for Deep Sulcus Patients

Earlier, I discussed the risk of recession when placing anterior restorations on patients with deep facial probing depths. I also showed an example of a patient who had altered passive eruption as the cause of the deep facial sulcus depth. Additionally, I demonstrated how simple gingivectomies could be used to produce a normal sulcus depth, eliminating the risk of future recession, and improving the length of the anterior teeth.

In this article, I'll present a more challenging problem: the patient with deep facial sulcus depths, but the gingiva is at an ideal position. This means that the use of a gingivectomy to reduce the sulcus depth will result in the clinical crown appearing too long. This is typically a patient who has had some facial bone loss, and apical migration of the attachment, but no subsequent recession of the gingiva.

You generally have two options with these patients to reduce the risk of exposed margins from future recession. The first, and often best option, is to place your margin supragingival, not inducing any trauma to the gingiva. This can be readily accomplished if translucent all-ceramic materials can be used, especially if the existing tooth color is acceptable. Now any future recession really isn't very noticeable, as the margin was already above tissue.

"... I would have considered cantilevering the left lateral off of both centrals, but they have large post and cores, and have had apical surgeries as well."

~Frank Spear

If you must go below tissue because of a discolored tooth, or because you need to use a more opaque restorative material (metal ceramics or zirconia for example in the case of an FPD), the risk of future margin exposure is definitely a risk. My approach in these instances is to place the margin below tissue half the depth of the probing. So for a 3 mm facial sulcus depth, I would place the margin 1.5 mm below tissue. The purpose of this is to minimize the risk of margin exposure if some recession occurs, but it can't completely prevent the risk.

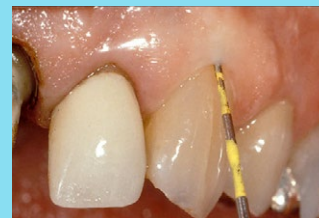
Remember, in these deep sulcus patients, violating the attachment is not a risk like it is in shallow sulcus patients. Therefore, going half the depth of the sulcus below tissue is biologically acceptable, but the challenge is how to do it and not overly traumatize the tissue in the process. The case I am including will show you the step-by-step approach I use to place the margin at the correct depth, and protect the tissue at the same time.

Female patient in her 50s who presents unhappy with the appearance of her old crowns, and who needs the left lateral removed due to a vertical root fracture.

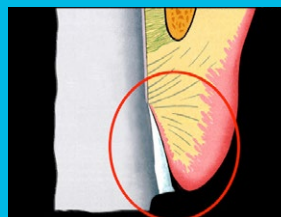
She has refused an implant to replace the left lateral, so an FPD will be used instead. If the centrals were structurally healthy, I would have considered cantilevering the left lateral off of both centrals, but they have large post and cores, and have had apical surgeries as well. I'm going to utilize the canine as an abutment to replace the lateral.



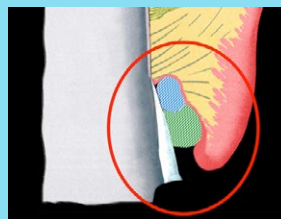
The left canine has a 3 mm facial sulcus, and is the same length as the right canine. A gingivectomy to reduce the sulcus depth would make the canine too long. Instead, I will place the margin half the depth of the sulcus below gingiva, in this case 1.5 mm, to minimize the risk of future margin exposure from recession.



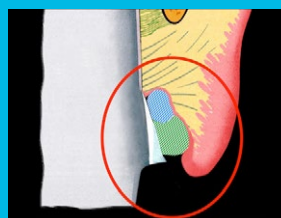
First tooth is prepped completely right to the gingival margin.

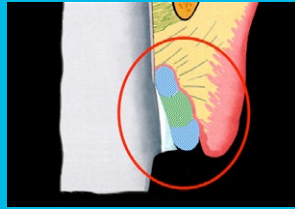


Next, two layers of cord are placed, in this case a layer of Ultrapak #1 first, followed by a layer of Ultrapack #2. I'm using a probe to show that the top of the second cord is 1.5 mm below the previously prepped margin, which means the top of the cord is 1.5 mm below the gingival margin.

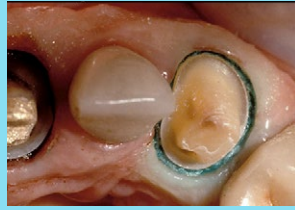
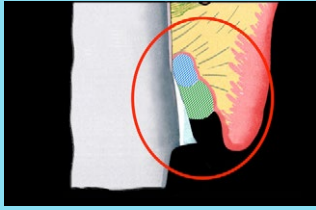


With the cords retracting the tissue out of the way, the prep margin is now dropped to the top of the cord, 1.5 mm below the starting gingival margin level.





A third layer of cord is now placed on the canine, in this case another Ultrapak #1. The cord is placed so it sits between the prep margin and the gingiva, no deeper. It should be easily seen all around the tooth.



The third or top layer is now removed to allow for an impression. Note how the margin, which is 1.5 mm below gingiva, is readily visible, and the tissue hasn't been traumatized. In this case, I'm making the impression to allow for a provisional to be fabricated indirectly prior to removing the lateral.



The lateral was removed after fabricating the provisional, which extended 2 mm into the extraction site.



The provisional on the day of placement.



The provisional on the left, nine months after placement. On the right, what the tissue looked like after provisional removal. Note the margin depth below tissue on the canine, but the tissue health is excellent.



On the left, the final restoration a few months after placement. On the right, a 10-year follow-up. In this patient there has been almost no recession on the canine.

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Biologic WIDTH

Diagnosing a Biologic Width Violation

In previous articles, I have discussed what biologic width is, and described how I place restorative margins based upon the presenting sulcus depth and thickness of the gingiva. This article will start to address how to diagnose inflammation around restorations that exists because the margins have been placed too deep, violating the attachment.

When we see an anterior restoration, particularly a full crown that has significant gingival inflammation, a series of possible diagnoses exist:

- It could be plaque control, but if the adjacent teeth have healthy gingiva, that is unlikely
- It could be marginal fit, which can be examined with an explorer and radiograph
- It could be poor contour, preventing adequate hygiene, again possible to examine
- It could be an allergic response to the restorative material, especially if the restoration was done in the '80s or '90s using a nickel-containing alloy, and the patient is female

But it could be because the margin is placed too close to bone, violating the biologic width. *(Figures 1-3)*

Ideally, if the existing restoration is removed, and a well-fitting temporary placed for at least three months without the return of any gingival inflammation, you would assume the margin location was not the problem, and one of the other etiologies applied. The reason for the three-month wait is that it is not unusual to damage the attachment apparatus when removing an old restoration and placing a temporary. You may see perfectly healthy-looking tissue until it heals and matures, which is usually between eight and 12 weeks, and then the inflammation returns.



Figure 1

Female patient in her 40s who presents with four bonded all-ceramic crowns on her maxillary incisors. She is unhappy with the appearance of the restorations, but especially unhappy with the inflamed appearance of the gingiva, particularly the right central and lateral.



Figure 2

I removed the old crowns to place long-term temporaries and see how the tissue would respond. After removing them, I measured the distance from margin to bone; the probe is on bone showing the margin barely 1 mm away, a definite biological width violation.



Her biologic width violation was corrected surgically. Before and two years after final restoration.

Figure 3

Of course not every patient wants you to take off their restoration to make a diagnosis, so here are some other options to assist in deciding if the margin location is the problem:

First, simply place a perio probe in the sulcus until it reaches the margin; do this circumferentially around the tooth. What you are looking for is pain: a margin in the sulcus will result in no response, a margin in the connective tissue attachment will be painful to probe.

Next, anesthetize the tooth you are concerned about. Place the perio probe on the restorative margin, and read the distance from there to the gingival margin. Keeping the probe against the root laterally, slide the probe down to bone, allowing you to compare the previous probe readings vs. when the probe is on bone.

Third, use a periapical radiograph. While it won't let you see the margin location relative to bone on the facial, it will on the interproximal.

If the margin is painful to probe, is within 2 mm of the bone when measuring it, or on a radiograph, you probably have a biologic width violation, and the only thing you will be able to do to eliminate the inflammation is to correct the problem. ■

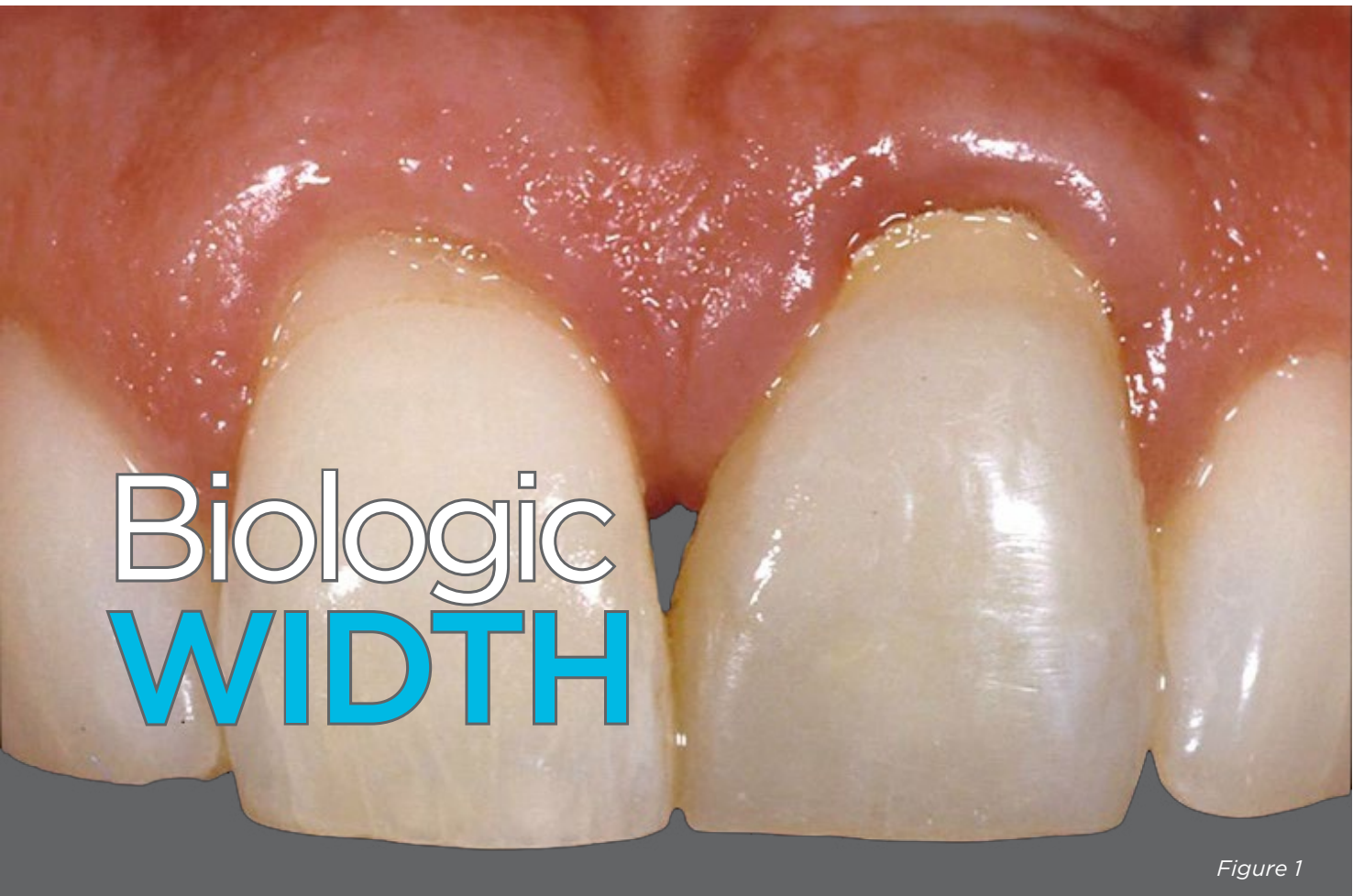


Figure 1

Surgical Correction of a Biologic Width Violation on the Facial Surface Only

When a restorative margin is placed too close to bone, and gingival inflammation occurs, the only solutions to eliminate the inflammation are to move the margin away from bone, or move the bone away from the margin. In most instances the classic measurements from Garguilo, Wentz and Orban would be used for the correction; in other words, create 2.5 mm to 3 mm of space between the margin and bone.

There are two ways to move the margin away from bone, one is orthodontic extrusion, which will be looked at in my next article, the other is to do so-called “root reshaping,” where the old margin is smoothed away, and a new margin prepped at a more coronal and correct level. This approach can be very useful when the previous tooth

Above: I first placed the left central incisor crown in 1983, replacing an existing crown with a deep facial margin, and significant gingival inflammation.

This photo was from 1995, 12 years later, the gingiva is still inflamed, and I have redone the crown three times with different materials. This is a classic example of a biologic width violation.

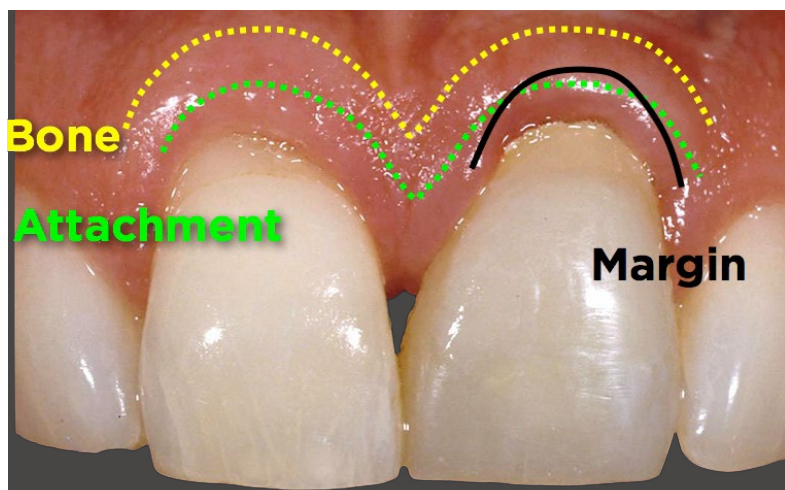


Figure 2

preparation was done with minimal tooth reduction, but is much more difficult if a heavy chamfer or shoulder had been previously prepared.

The more common solution for biologic width violations is to move the bone away from the margin with osseous surgery. The challenge with the osseous surgery is the risk of recession occurring. If you were dealing with a single central incisor that had the margin placed too deep on the direct facial, surgery would definitely be my first choice, lay a facial flap, remove the necessary facial bone and replace the flap to its original position. (Figures 1-5)

If the tissue is normal in thickness it is rare to see much, if any recession. If the tissue is thin, the risk is higher, but it is always possible to come back with a connective tissue graft to cover the root and margin.

The real challenge is if you were dealing with a single central restoration that has a biologic width violation on the interproximal. Now if you remove bone to correct the violation, there is a much higher incidence of getting some loss of papilla and opening of the gingival embrasure.

I will look at how to manage the interproximal violation in my next article. ■

Left: Probing findings

The bone is 3.5 mm - 4 mm apical to the gingival margin (yellow line)

The sulcus on the right central, top of the attachment, is about 1.5 mm deep (green line)

The margin on the left central is 1.5 mm to 2.5 mm from bone (black line)

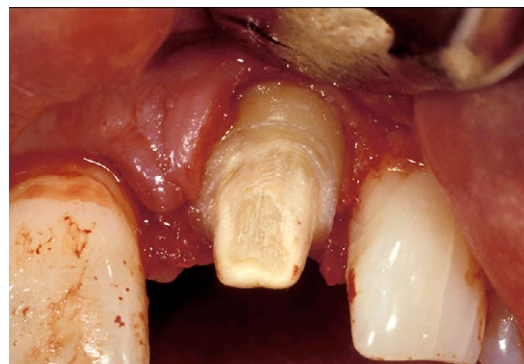


Figure 3

Above: Osseous surgery

- We decided to go ahead and do the crown again, but also remove facial bone to correct the margin-to-bone relationship (biologic width)
- Because the margin was fine relative to interproximal bone, only a facial flap was raised; the facial bone was removed to create a 3 mm space between the facial margin and bone



Figure 4

Above: The gingival appearance three months post-surgery



Figure 5

Above: Final restoration 10 years post-surgery and placement, note the gingival health.

Biologic WIDTH

Managing Interproximal Biologic Width Violations on Single Anterior Teeth

Earlier I described how osseous surgery to remove bone was a viable option for correcting a biologic width violation on the facial of a single anterior tooth, but was rarely a good option if the violation was on the interproximal.

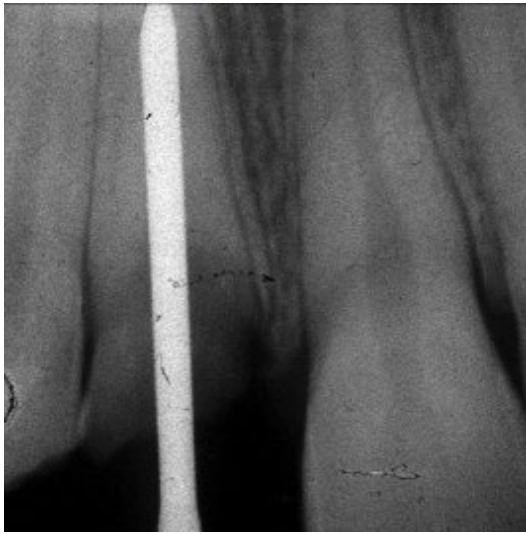


Figure 1

A 23-year-old female who fractured her right central incisor below the crest of bone on the mesial interproximally, as well as below bone across the plate. Her dentist performed endo, a post and core, and placed a temporary to manage the esthetics, but the biologic width violation must be corrected.



Figure 2

In order to expose the 4 mm of tooth necessary to predictably restore the right central, the interproximal bone between the centrals would need to be removed, and would be esthetically unacceptable.

It is important to remember the desired outcome for the correction of the biologic width violation, the margin 2.5 mm from bone, and if it is a tooth with endo and a post and core, an additional 1.5 mm of tooth structure exposed for adequate ferrule. So for teeth with endo and post and cores 4 mm of tooth structure must be exposed coronal to the bone. (Figure 3)

There are two ways to accomplish the extrusion:

1 Slow extrusion of .5 mm to 1 mm per month, which allows the bone and gingiva to follow the tooth. This is then followed by osseous surgery to reposition the bone and gingiva ideally, which exposes the tooth as well. This approach is highly predictable, and is generally chosen, especially when there are other orthodontic concerns as well.

2 The second approach, which is normally chosen only when a single tooth needs treatment, i.e., no other orthodontic needs, or other teeth with biologic width violations adjacent to the tooth you desire to treat, is to use rapid extrusion, generally all of the movement within four weeks. The key to this approach is to perform supracrestal fiberotomies weekly, to discourage the bone and gingiva from following. But it is necessary to retain the tooth in position for at least 12 more weeks to prevent re-intrusion, and to evaluate if osseous surgery is necessary due to the bone and gingiva creeping in a coronal direction. (Figures 4-7)

Finally, in all cases where forced extrusion is being used to resolve a biologic width violation, the amount of root in bone is being reduced by the amount the tooth is being extruded. While often clinicians worry about keeping a 1/1 crown-to-root ratio at a minimum, my experience has been that leaving 8 mm to 9 mm of root in bone has provided a successful long-term solution. In my next article, we will address the most difficult biologic width problem, both interproximal and facial violations on all the anterior teeth.

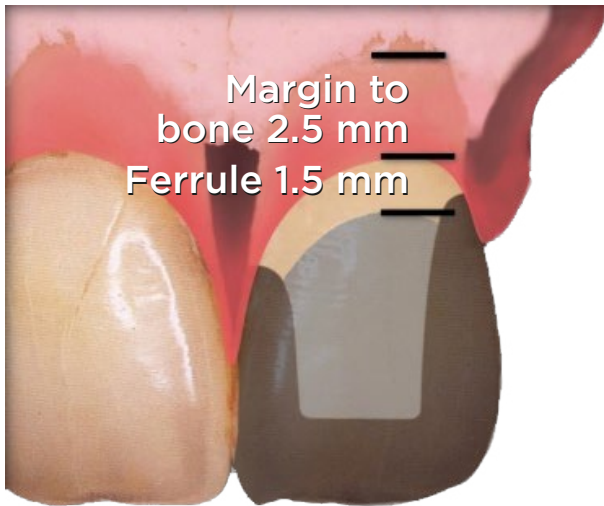


Figure 3

To predictably restore a tooth fractured at or below the crest of bone, room must be created between the future margin of the restoration and the bone. 2.5 mm is needed to accommodate the biologic width, and an additional 1.5 mm is required to have an adequate ferrule for the restoration. This means that 4 mm of tooth must be exposed above the crest of bone to satisfy these requirements. This can be done through bone removal, orthodontic extrusion followed by osseous surgery, or sometimes just rapid orthodontic extrusion.



Figure 4

Removing the temporary shows the fracture extends .5 mm below bone from the mesial, around the palate, and to the distal. The goal will be 4.5 mm of extrusion so that 4 mm of tooth can be exposed above bone.



Figure 5

There are two ways to approach the extrusion. Slow, .5 mm to 1 mm per month, to allow the bone and tissue to follow, followed by osseous surgery to reposition the bone and tissue correctly, very predictable. Or rapid, with weekly coronal fiberotomies to try and prevent the bone and tissue from following, much less predictable.



Figure 5



Figure 6

Following the extrusion, the tooth was retained in position three months, to be sure the bone and gingiva did not creep down in a coronal direction, and to prevent the tooth from re-intruding. With the temp off, we can now see healthy gingiva, and an adequate ferrule all around tooth. The laterals and left central were prepared for veneers as well.

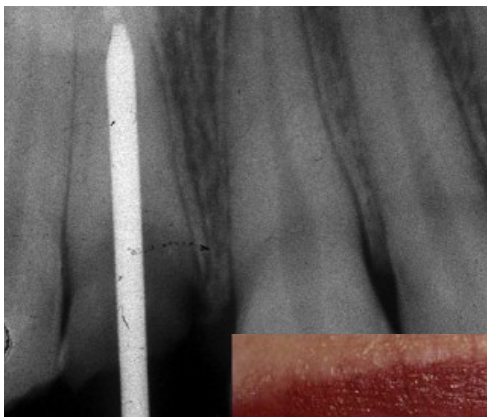


Figure 7

The completed smile on the right, the presentation radiograph on the left. Note in the final smile the papilla levels are level from canine to canine. This would not have been possible had interproximal bone been removed.



Biologic WIDTH

Managing Facial and Interproximal Biologic Width Violations on Multiple Adjacent Teeth

Patients with multiple adjacent existing anterior crowns, prepped essentially to bone, are some of the most challenging esthetic cases to treat. There is usually significant gingival inflammation, and if the crowns were bonded, there is often significant black staining from the bacterial growth that occurs when attempting to bond in a highly contaminated environment, heaviest in the cervical 1/3, and showing through the translucent crowns. (Figure 1)



Figure 1

Above: Patient had full crowns placed six months ago from first premolar to first premolar, all preps are within 1 mm to 1.5 mm of bone on the facial and interproximal. She has significant gingival inflammation from the biologic width violations across all the anterior teeth.
Note the dark gray cervical areas of tall the crowns, evidence of leakage and bacterial growth under the restorations.



Figure 2

Above: When the biologic width violation extends across the facial and through the interproximal on multiple teeth, osseous surgery to remove bone is the most common option for correction. The risk is the unknown of how much facial and interproximal recession may occur following bone removal to position the bone an acceptable distance from the margins.

The only solution that I have found successful in these cases is to start by addressing the biologic width problem first, the margins being too close to bone. This is done with osseous surgery, by correcting the bone-to-margin distance. The bone removal creates the risk of recession, and this risk is especially high when bone has to be removed on both the facial and interproximal. (Figure 2)



Figure 3

Above: Removing the crowns reveals significant leakage due to the dentist attempting to bond the restorations in a deep and inflamed environment.

On these patients, my first step is to remove the old crowns so I can visualize the quality of each tooth, and also assess the distance from the margin to bone using a probe 360 degrees around the tooth. Additionally, it lets me see how heavy the prior tooth reduction was, and if the reduction at the margin was minimal. For example, with a slice type finish line, it is often possible to do minor "root reshaping," by



Figure 4

Left: Temps in place, prior to bone removal, the margins are all within 1 mm - 1.5 mm of the bone.

essentially smoothing out the old margin. This needs to be followed by re-prepping a new margin the correct distance from bone, and eliminates the need for any bone removal. When the preps are heavy shoulders or chamfers, bone removal becomes mandatory. (Figure 3)

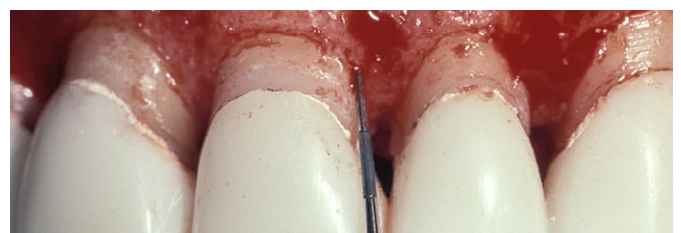


Figure 5

Above: To make sure there was adequate space for biologic width, the bone was moved both facially and interproximally 3 mm from the margins.

The amount of bone removal is dictated by how close the existing margins are to the bone, and whether all the teeth were prepped the same or not. As a rule, I would move the bone 2.5 mm to 3 mm away from the existing margins all the way around the teeth to accommodate the biologic width. It would be unusual for a patient to need more space than that. (Figures 4 and 5)

At the time of suturing, assuming the pre-treatment crown length was acceptable, i.e., no crown lengthening was desired, the flap should be replaced exactly where it was pre-surgically, not apically positioned. The goal is to hope for a longer attachment apparatus rather than a deeper pocket followed by recession. (Figure 6)

I often get asked about how long to wait following healing before proceeding in these types of patients. Remember, this is not a typical crown-lengthening case; the bone has been moved apically, but the tissue has not, so the risk of recession is much higher. Also, we are usually treating a patient who is unhappy about the need for the treatment. I typically wait six months minimum before moving forward. (Figure 7)

Depending upon the patient's gingival thickness, it can be surprising how often no recession occurs on either the facial or interproximal, even when 2 mm of bone has been removed around the teeth. (Figures 8 and 9) ■



Figure 6

Above: The flaps were sutured back to their pre-surgical position; time will tell if some recession occurs and if slow ortho extrusion is necessary.



Figure 7

Above: Six months post-surgery, still in provisionals, no inflammation, and no recession. Recession in these cases is highly influenced by the thickness of the periodontium.



Figure 8

Above: Pre- vs. five years post-treatment, note the lack of inflammation or recession on bottom image.



Figure 9

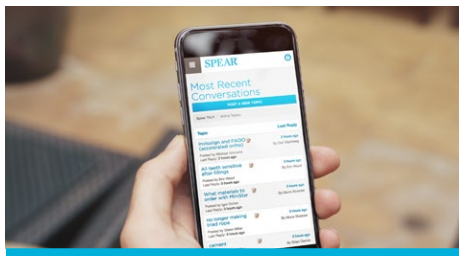
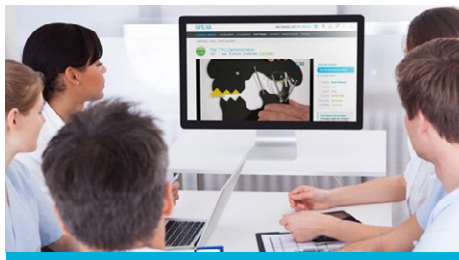
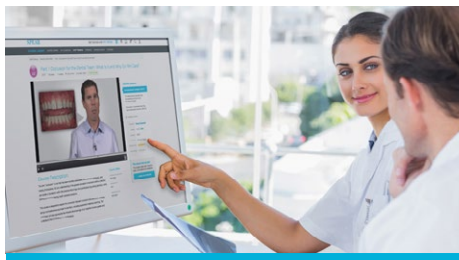
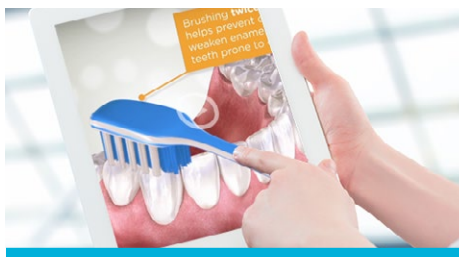
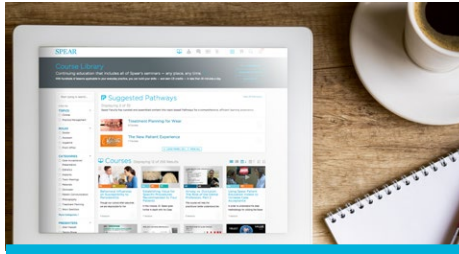
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