

The Great Tooth Killer: Epidemic of Cracked Teeth, the Science of Strong Teeth

drclark
@bioclearmatrix.com

Disclosures:
Dr. Clark has financial interest in Bioclear

A scenic photograph of a sunset over a calm body of water. The sky is filled with vibrant orange and yellow clouds, with the sun low on the horizon. A dark silhouette of a forest line is visible in the middle ground, and its reflection is clearly visible in the still water in the foreground.

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The screenshot shows the Bioclear Resource Library website. At the top, there is a dark navigation bar with the phone number 1.855.712.5327 on the left and links for 'Instructions For Use', 'Contact Us', and 'Account' on the right. Below this is a white header with the Bioclear logo, a search bar, and navigation links for 'Products', 'Education', 'Find A Doctor', 'About Us', 'Library', and a shopping cart icon showing '\$0.00 0 items'. The 'Library' link is highlighted with a red box and a red arrow pointing to it. Below the header is the 'Bioclear Resource Library' section, which includes a search bar for resources, a 'Sort by' dropdown, and a row of filter buttons: 'All', 'Articles', 'Free', 'Presentations', 'Tips & Tricks', 'Videos', and 'Webinars'. The 'Presentations' button is highlighted with a red box and a red arrow pointing to it. Below the filters, the 'Presentations' section is displayed, featuring three presentation cards. The first card is titled 'Simply Better Composite Restorations' by David Clark DDS. The second card is titled 'The Great Tooth Killer: Epidemic of Cracked Teeth, the Science of Strong Teeth' by David Clark DDS (@bioclearmatrix.com). The third card is titled 'Modern Composite Dentistry: CRUSH your next Class II' by David Clark DDS and Lauren Wilson DMD, dated March 18, 2026. A 'Back To Top' button is visible at the bottom right of the presentation grid.

- 1) Go to [bioclearmatrix.com](https://www.bioclearmatrix.com)
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- 3) Click "Presentations"

Resource Library — Mobile



1) Scan the QR code

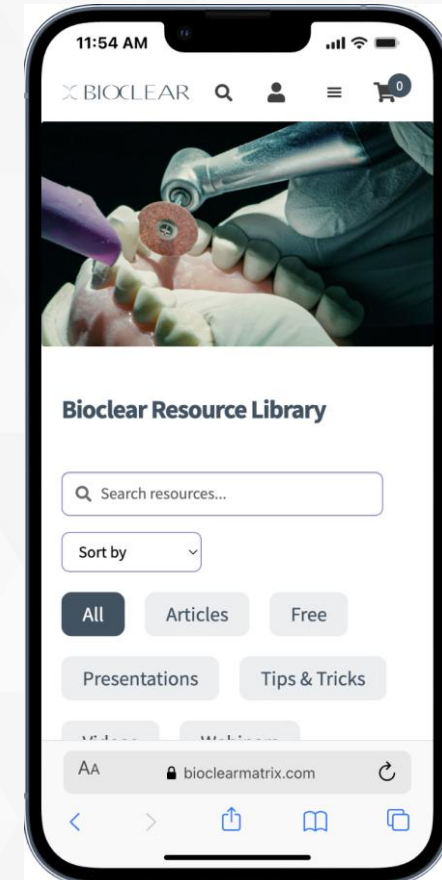


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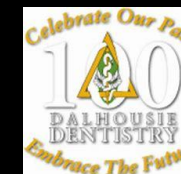
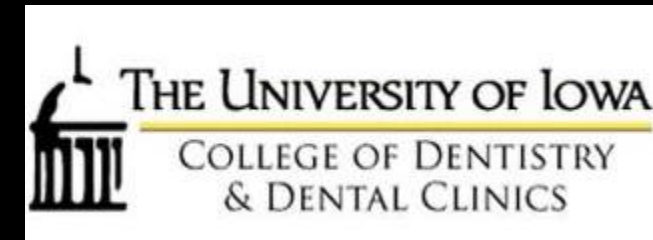
2) Fill out the form

A screenshot of a mobile browser showing the 'Resource Library Form' page. The page has a white background with a dark header containing the BIOCLEAR logo and navigation icons. Below the header, the text reads 'Resource Library Form' and 'FILL OUT THE FORM BELOW TO GET STARTED'. A sub-header says 'After filling out the form you will be redirected to the Resource Library page.' The form fields include 'Participant's Name (Required)' with a text input, 'First' and 'Last' with separate text inputs, and 'Practice Name' with a text input. The browser's address bar shows 'bioclearmatrix.com'.

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The **Bioclear Learning Center** provides a new pathway for dentists and their office to transition from traditional **GV Black dentistry**, to the extraordinary world of **modern direct dentistry**.



English pg. 21 Images pg. 130 Microimages pg. 100

DENTISTRY TODAY

October 2004

BETTER RESULTS THROUGH

MAGNIFICATION

BETTER RESULTS THROUGH MAGNIFICATION

Let's Meet the Best Dentists pg. 34

How Common is Dental Fear? pg. 62

Composite Resin vs. Temporary Cementation pg. 68

The Epidemic of Cracked and Fracturing Teeth



Tooth and restorative failure in dental numbers. Cracked and fractured teeth are now the third leading cause of tooth loss in industrialized nations.¹ Restorative teeth with conservative anatomy and construction are wearing and being chased, fractured off at three levels. Fractured teeth treated with veneers are exhibiting a 50% off-axial fracture (Figure 1). Additionally, endodontics are reporting that cracked teeth are now replacing crown teeth for operative strategy in a number of patients referred for endodontic treatment.

We assume that the reason of this period and growing problem are not too long longer. In our stress levels are rising and chewing and bruxism are also more prevalent, at the advent of the half-speed handpiece, spread billions of hermetic TTY. Most every preparation that have work and powder teeth (Figure 2) and the old deep axial composite preparation in the case of powder condition, and yet aggressive "cross-hatch" subodontia change is definite, now and then.

Dentistry has great capacity (including a poorly understood process). A dramatic change in the form of combining dental education, research, dentistry, blending, and implants has shifted our attention more from some of the most integral aspects of the building and conditioning, and finally, top that. But, we now find our profession faced with a tremendous problem that will require a significant reevaluation and reevaluation of



Figure 1. In an anterior right, one fractured with a restoration. In the preparation, the tooth was placed the back to the back and the other fractured half of an anterior showing immediate therapy.

means to address appropriately. There is no need to assess. Many, to most simply will require diagnosis and part to work.

BRINGING DIAGNOSIS AND PREVENTION OUT OF THE ROOM
Microscopic and operative-driven diagnosis have been the accepted modalities for the diagnosis of cracked teeth. The following list

of signs of the lack of visual confirmation create therapies that education can be able to the treatment process. One looking first impression of cracks through the clinical appearance is the staggering array of cracks that come within each structure (Figure 3). Traditional visual examination (or longer) limits the clinician's ability to assess the progression of cracked teeth. The following list

Table 1. How Can We Eliminate Teeth Fracturing?

Phase 1:	Phase 2:	Phase 3:	Phase 4:	Phase 5:
Diagnose the crack or defect in the crown or root of the tooth.	Recognize if the crack is deep enough to penetrate into the pulp chamber.	Recognize if the crack is deep enough to penetrate into the root canal.	Recognize if the crack is deep enough to penetrate into the root canal.	Recognize if the crack is deep enough to penetrate into the root canal.
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Table 2. Quick Reference Guide for Microscopic Cracks in Posterior Teeth.

- 1) Most teeth in aging adults display enamel cracks.
- 2) Cracked teeth, even traumatic cracks, do not necessarily indicate that the tooth is cracked.
- 3) Only enamel cracks do not penetrate significantly into dentin.
- 4) Only enamel cracks that do not penetrate into dentin.
- 5) Three types of crack propagation patterns exist: enamel cracks, dentin cracks, and subodontia cracks (not contributing to microleakage around a restoration).
- 6) Dentin cracks should be considered as structural cracks.
- 7) Dentin cracks that penetrate into the pulp chamber, generally positioned in the middle of the pulp chamber, are "horizontal" and often generally confined to the pulp chamber only (Figure 4).
- 8) There have been two types of dental cracks: impact cracks and structural cracks. Impact cracks will be less frequent than early recognition and treatment. All teeth with dentin cracks should be considered as structurally unsound.

Microscopic/Microscopic Findings:

- 1) Microscopic cracks in restorative materials can indicate a lack of correct structural integrity.
- 2) Microscopic cracks in a cast-in place or outside a top of denture integrity.
- 3) Microscopic cracks in a cast-in place or outside a top of denture integrity.

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and the Scandinavian Academy of Esthetic Dentistry

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Prognostic Diagnosis of Early Enamel and Dentinal Cracks Based on Microscopic Evaluation

DAVID J. CLARK, DMD
COURTNEY G. SHEETS, DDS
JACINTHE M. BAQUETTE, DMD

ACT
The detection of cracked teeth and incomplete coronal fracture have historically been symptoms of the dental operating microscope at x16 magnification can fundamentally change a clinician's ability to diagnose such conditions.
We have been observing cracks under extreme magnification for nearly a decade. Patients come into our office that can lead to appropriate treatment prior to symptoms or deterioration to fracture occur. Conversely, many cracks are not structural and can lead to misdiagnosis and treatment. Methodical microscopic examination, an understanding of crack progression, and appreciation of the types of cracks will guide a doctor to making appropriate decisions.

Teeth can have structural cracks in various stages. To date, diagnosis and treatment are very often at an end stage of crack development.
CLINICAL SIGNIFICANCE
This article gives new guidelines for recognition, visualization, classification, and treatment of cracked teeth based on the visual use of x16 magnification. The significance of enamel cracks as they relate to dentinal cracks is detailed.
(J Esthet Restor Dent 15:XXX-XXX, 2003)

Microscopic and symptom-driven diagnoses have been the accepted modalities for cracked teeth. The inherent limitations of the lack of visual confirmation mask it therapies that often come too late in the treatment process. One lacking first impression of vision through a clinical microscope is the staggering array of cracks that exist within tooth structures. Traditional visualization (or limited or ocular) analysis limits the clinician's ability to assess the presence or severity of the majority of these cracks (Figure 1).
At extreme magnification levels (x14 and greater), the translucent nature of enamel yields a wealth of information. Subtle color changes within the enamel may indicate early decay, microleakage, and a lack of structural integrity of dentin and

President, Academy of Microscopic Esthetic Dentistry,
Tennessee; Director, Newport Great Oral Facial Institute, Newport Beach, CA; clinical professor,
Restorative Dentistry, USC School of Dentistry, Los Angeles, CA, USA
Tennessee; Director, Newport Great Oral Facial Institute Newport Beach, CA; associate professor,
Restorative Dentistry, USC School of Dentistry, Los Angeles, CA, USA

THE SCIENCE OF STRONG RESTORED TEETH



DR. DAVID CLARK



DR. ALEX FOK



Dr Alex Fok is a Mechanical Engineer with expertise in solid mechanics, structural analysis and mathematical modeling. He is currently the Academic Director of the Minnesota Dental Research Center for Biomaterials and Biomechanics (MDRCBB). The MDRCBB is an international leader in the development and application of novel characterization techniques for dental biomaterials, with long-standing collaboration with dental materials manufacturers. Dr Fok's research focuses on the development of techniques for material characterization, nondestructive examination, lifetime prediction and shape optimization of dental restorations. A principal aim of his research is to instill more engineering principles and analytical techniques into the design and assessment of dental restorations and treatments so as to improve their longevity and effectiveness.

In this case-based lecture
today we explore:

- Coronal (vertical and cuspal)
Fracturing
- Snap-Off Fracturing

A close-up clinical photograph of a tooth with a snap-off fracture. The fracture is a clean, horizontal break in the enamel and dentin, exposing the underlying pulp chamber. The pulp chamber is filled with a dark, necrotic material, likely a cast resin core. The surrounding gingiva is pink and appears slightly inflamed. The text "Snap-Off Fracturing" is overlaid in a dark grey box with light blue text.

Snap-Off Fracturing

Today's Summary

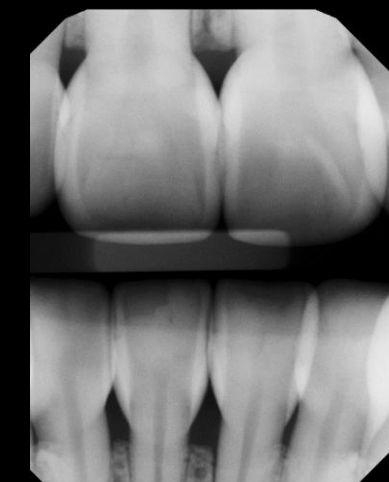
- Why things break...
- Modern cavity preparations
- Injection Overmolding as a 3rd option
- FEA of loading of teeth & composite
- Long term outcomes & case studies of composite overlays for cracked teeth
- When to endo, when to extract.

Modern Approach to Composite Restorations

Posterior
Restoration



Black Triangle



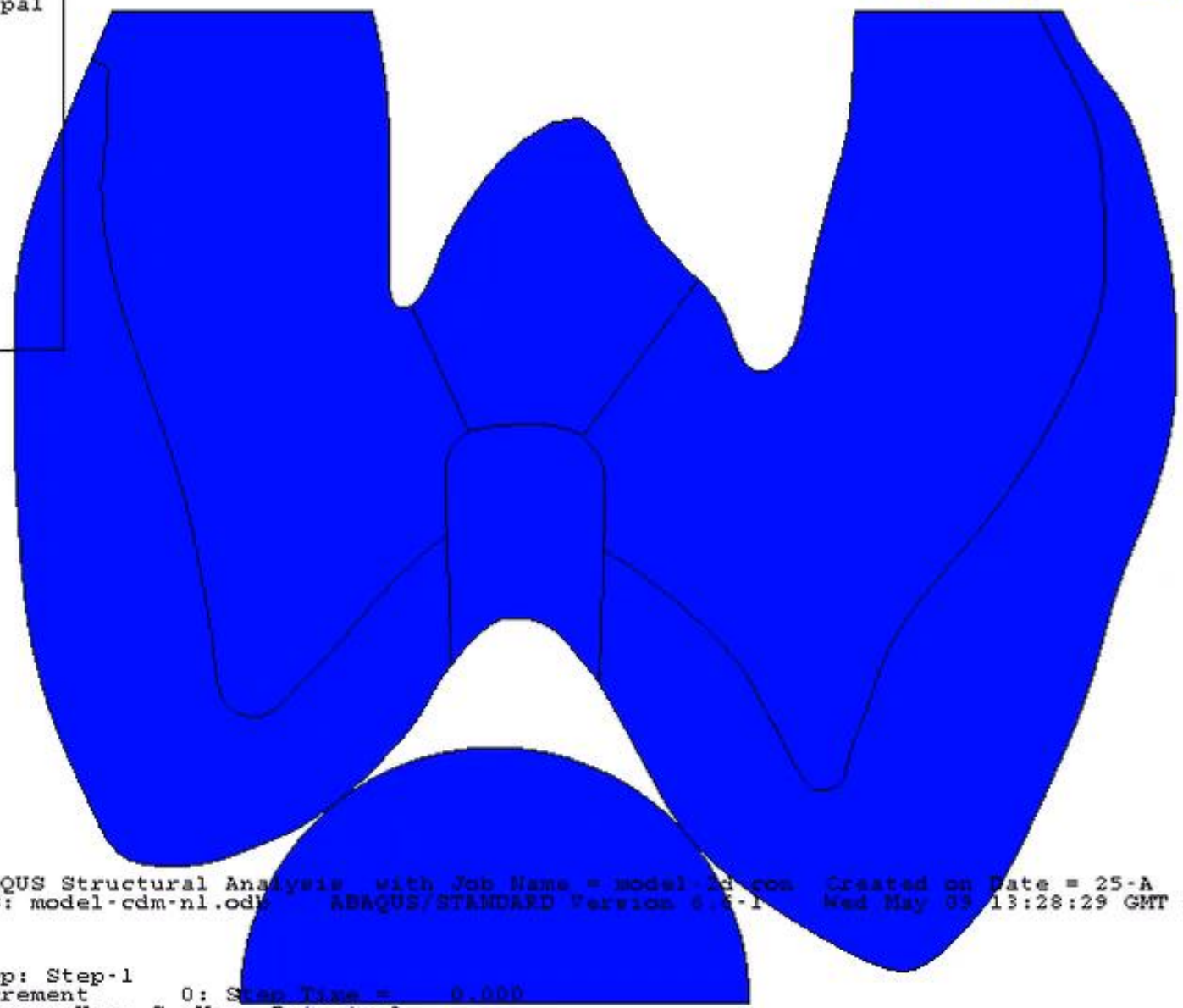
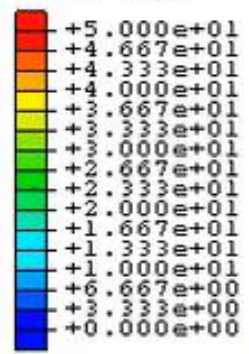
Glossary

- Bending
Mode of loading that creates curvature, resulting in tension on one side and compression on the other
- Compression
Squeezing of an element
- Hooke's law
This is obeyed when the strain of a material is proportional to the stress applied
- Shear
Force or displacement that results in an angular change in shape of an element
- Spring
Most fundamental structural element in solid mechanics
- Strain
Displacement per unit length
- Strength
Maximum stress required to cause fracture or debonding
- Stress
Force per unit area
- Stress concentrator
A structural feature that results in raised stresses within a small region
- Structural analysis or design triangle
Material, geometry and load
- Tension
Stretching of an element
- Toughness
Energy required to create unit surface area
- Shape Optimization
- Modulus
- Brittle Materials vs. Ductile and Tough Materials
- Surface Resilience
- Cyclic Fatigue

Epidemic of Cracked Teeth



S, Max. Principal
(Avg: 75%)



ABAQUS Structural Analysis with Job Name = model-cdm-nl.odb Created on Date = 25-A
Wed May 03 13:28:29 GMT Daylight
ABAQUS/STANDARD Version 6.5-1

Step: Step-1
Increment 0: Step Time = 0.000
Primary Var: S, Max. Principal
Deformed Var: U Deformation Scale Factor: +1.000e+01



Courtesy Dr. Charlie Regalado

Case Study “Joe”: Contralateral bicuspids fracture nine years apart

2012: Catastrophic fracture tooth #12. Endo
tooth w/ traditional Class II Resin Restoration

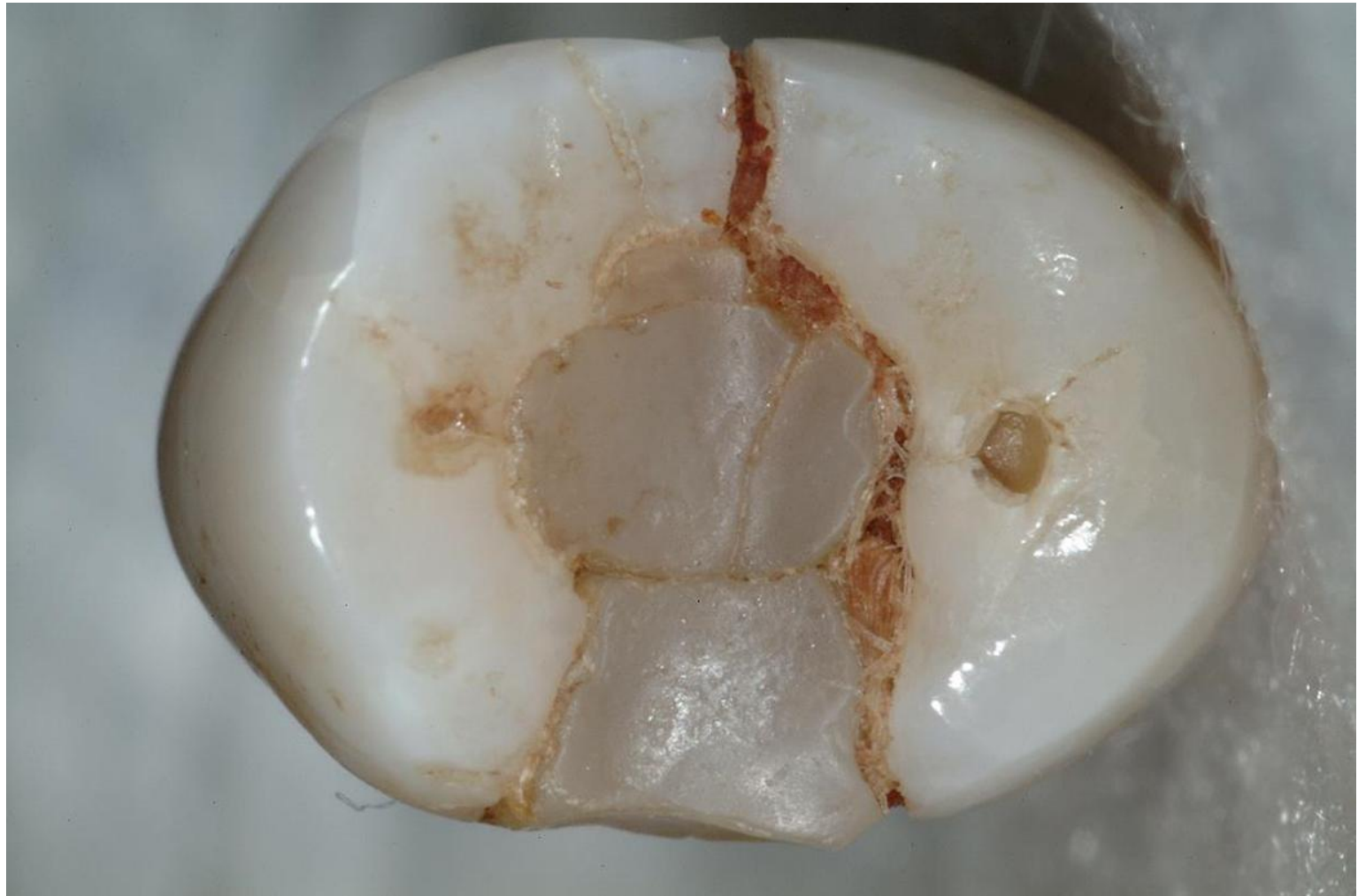


2021: Catastrophic fracture tooth #5. Virgin
Tooth



Case Study 1 “Joe”: Contrateral bicuspids fracture nine years apart

2012: Catastrophic
fracture tooth #12.
Endo tooth w/
traditional Class II
Resin Restoration



Case Study Joe bilateral bicuspid fractures



2005: Catastrophic fracture tooth #12. Endo tooth w/ traditional Class II Resin Restoration



Case Study Joe bilateral bicuspid fractures

2021: Catastrophic fracture of #5. Virgin Tooth



Case Study Joe bilateral bicuspids fractures

2021: Catastrophic fracture #12. Virgin Tooth



Case Study “Joe”: Discussion

2012: Catastrophic fracture tooth #12. Endo tooth w/ traditional Class II Resin Restoration



2021: Catastrophic fracture tooth #4. Virgin Tooth



Case Study “Sue”: Traditional Parallel Walled Cavity Preparation (PWCP) 10 years post operative

2021: Asymptomatic tooth at New Patient Examination

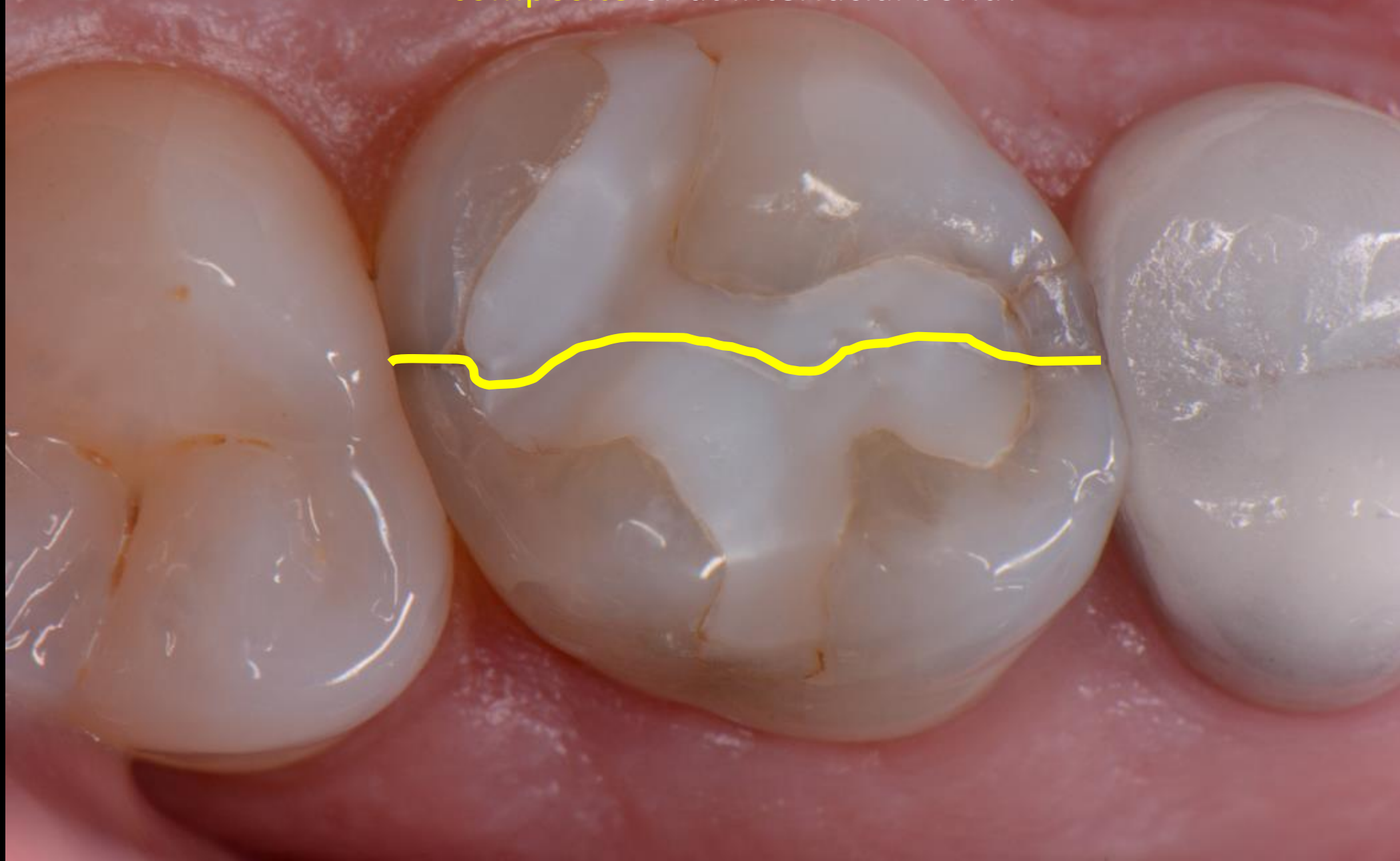
When the tooth fractures: Crack initiates at the central groove of composite or at interfacial bond.



When the tooth fractures: Crack initiates through the central groove of composite or at interfacial bond?



When tooth fractures: Crack initiates through the **central groove of composite** or at interfacial bond?



When the tooth fractures: Crack initiates through the central groove of composite or at **interfacial bond**?



When the tooth fractures: Crack initiates through the central groove of composite or at **interfacial bond**?



A close-up photograph of a human tooth showing a significant crack and a grayish discoloration on its surface. The crack runs vertically down the center of the tooth. The surrounding gum tissue is pink and appears slightly inflamed. The text is overlaid in white, bold, sans-serif font.

If the tooth is
gray, the tooth is
cracked

According to the FEA, what two things need to happen to eliminate fracturing?

- 1) No Central Groove
- 2) Horizontalize the prep to create compression (eliminate vertical walls with massive radius bevel in enamel, the prep will look like a trumpet or a calla lily)



Studies Supporting the Bioclear Method

Complete

- Comparing Conventional to Saucer-Shaped Cavity Designs

Dr. Alex Fok, BEng, PhD, MSc

Dr. Hooi Pin Chew, BDS, PhD, FDSRCS

MN Dental Research Center for Biomaterials and Biomechanics

- Comparison of Class II Adaptation and Placement Times

Dr. Richard Price, BDS, DDS, MS, FDS RCS, FRCD(C), PhD

Dept. of Clinical Dental Sciences & Biomedical Engineering Dalhousie University

- Effect of Preheating/Fatiguing/Thermocycling on Mechanical Properties

Taiseer A. Sulaiman, DDS, PhD

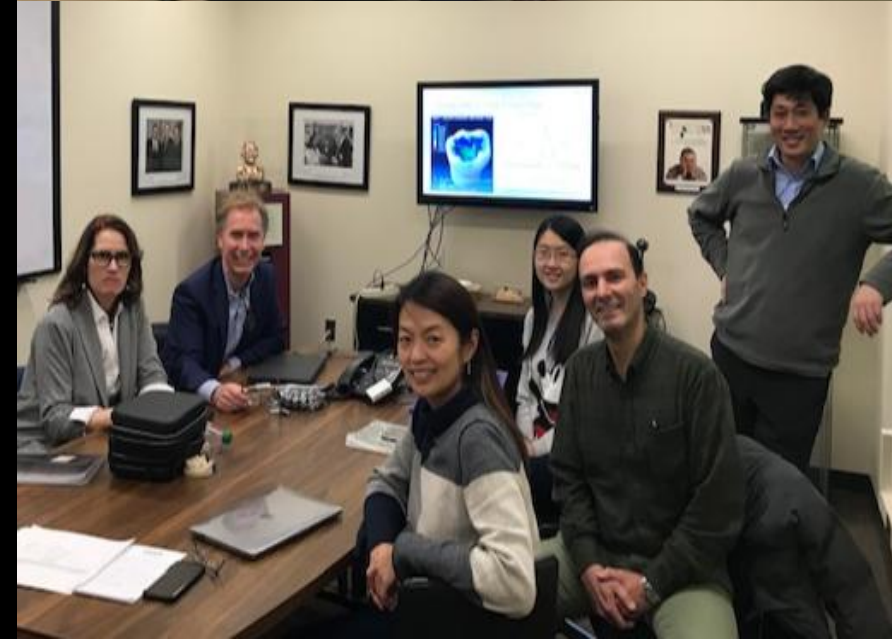
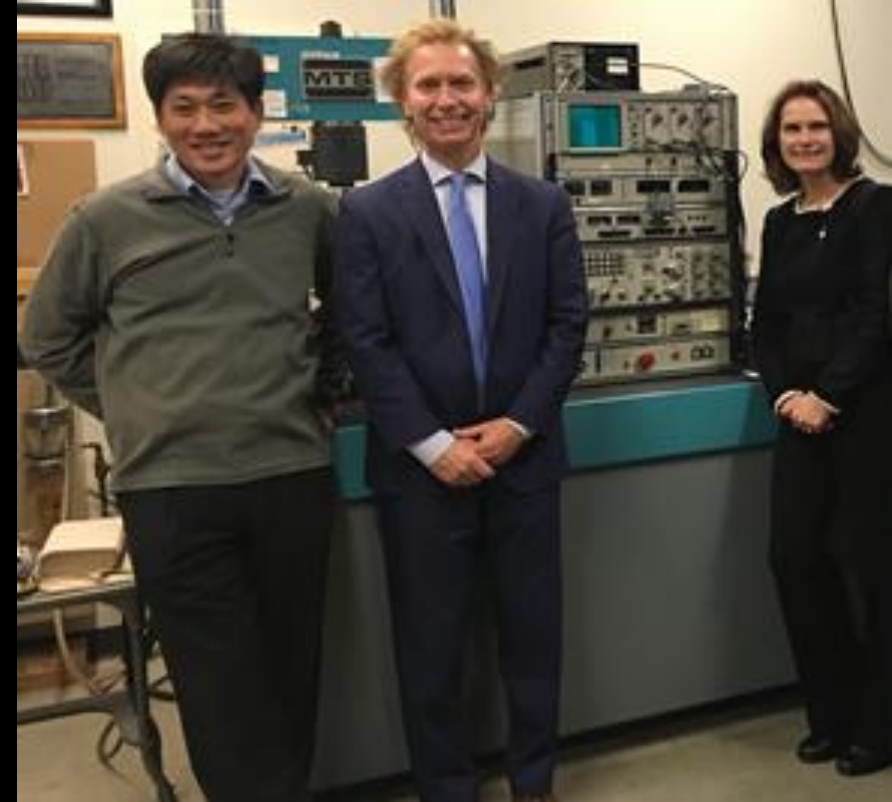
Assistant professor, Division Director of Operative Dentistry and Biomaterials, UNC School of Dentistry

- 3M Extraction and Pulp Temperature Testing

Brad Bagley, PhD, DABT Advanced Toxicology Specialist

- 3M Material Property Testing Including Injection Molding

Timothy D. Dunbar, Ph.D. Advanced Product Development Specialist



In Process

- Biofilm Adhesion Study

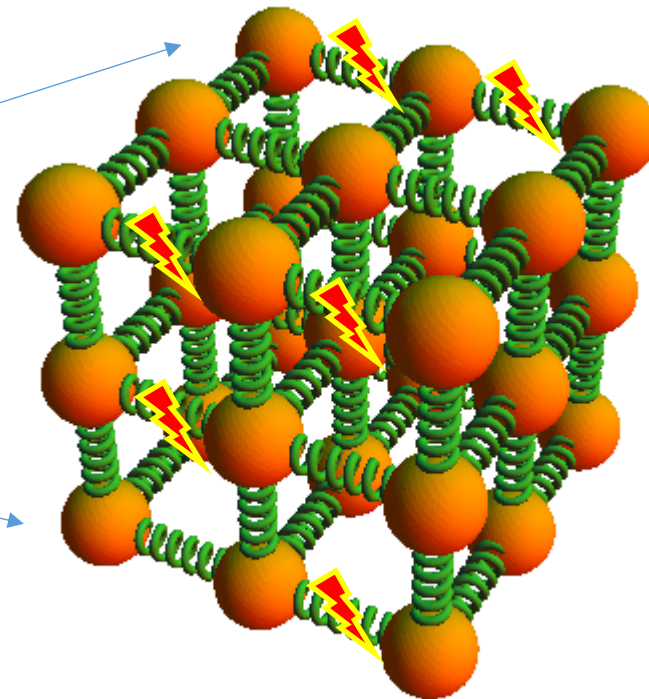
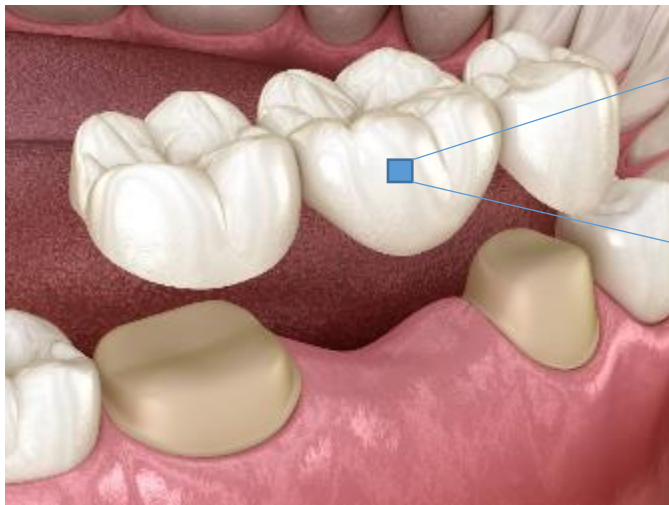
Sabrina F. Sochacki, DDS, MS, PhD

Indiana University School of Dentistry

Basics of Solid Mechanics



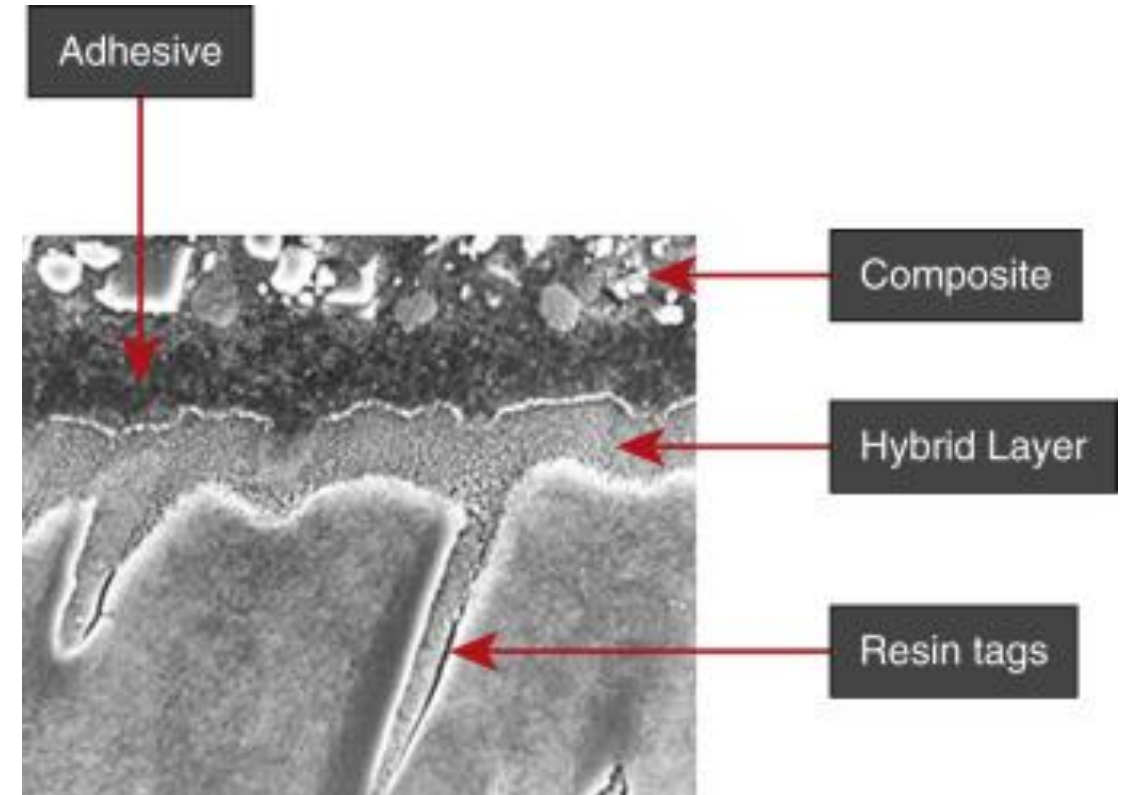
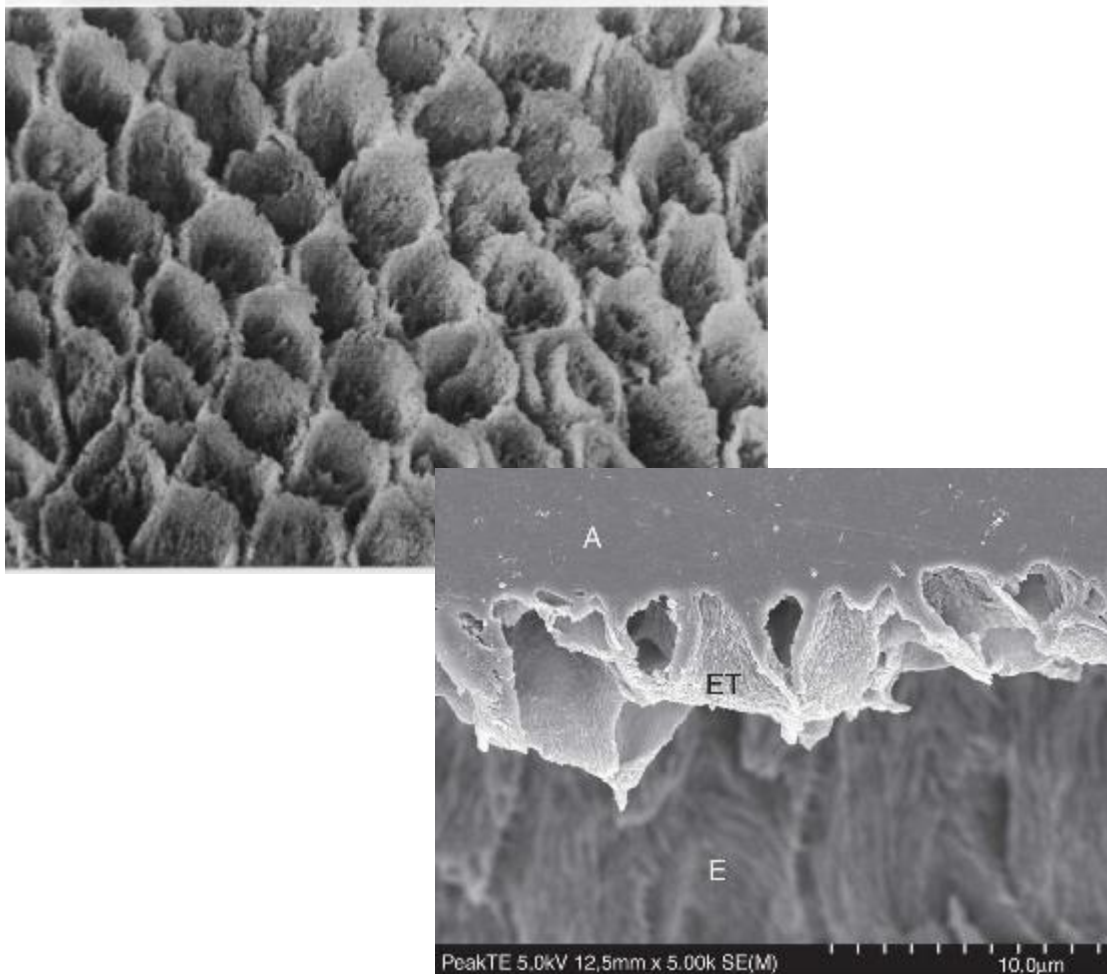
All solid structures can be considered as an assembly of many interconnected springs.





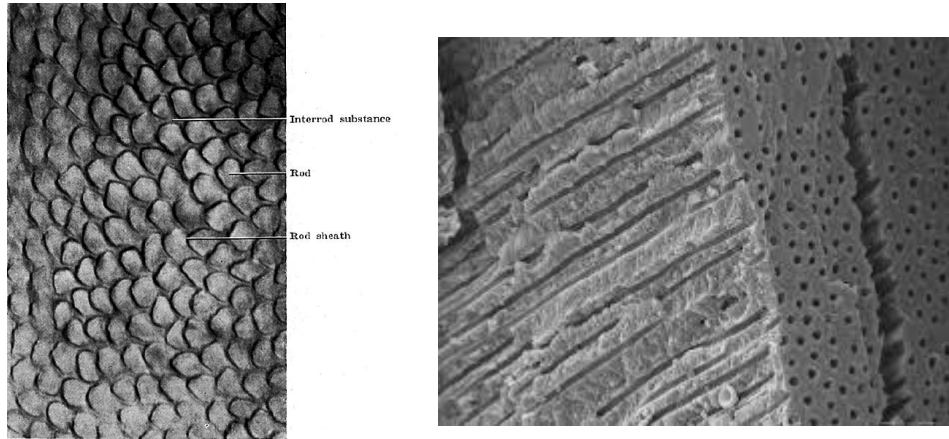
Enamel vs. Dentin Bonding

Bonding to enamel is mostly micromechanical.

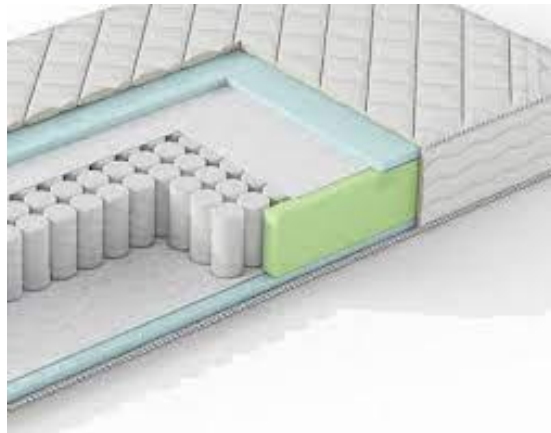


Bonding to dentin is more complicated, involving a hybrid layer and exposed collagen that are prone to enzymatic attack.

Anisotropy : tooth tissues

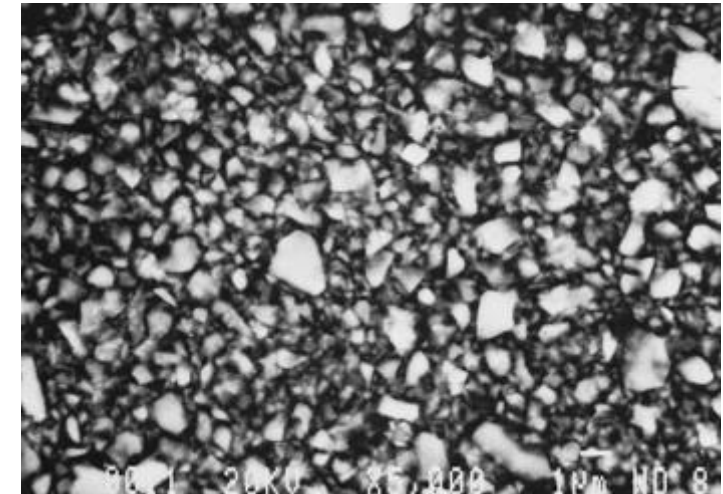


From Orban (1949) Oral Histology and Embriology, St. Louis: C.V. Mosby.



No bending stresses

Isotropy: resin composite



VS.



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and the Scandinavian Academy of Esthetic Dentistry



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Definitive Diagnosis of Early Enamel and Dentinal Cracks Based on Microscopic Evaluation

DAVID J. CLARK, DDS*
GERRYLEE G. SHEETS, DDS†
JACINTHE M. PAQUETTE, DDS‡

ABSTRACT

The diagnoses of cracked teeth and incomplete coronal fractures have historically been symptom based. The dental operating microscope at $\times 16$ magnification can fundamentally change a clinician's ability to diagnose such conditions.

Clinicians have been observing cracks under extreme magnification for nearly a decade. Patterns have become clear that can lead to appropriate treatment prior to symptoms or deterioration in tooth structure occur. Conversely, many cracks are not structural and can lead to misdiagnosis and overtreatment. Methodic microscopic examination, an understanding of crack progression, and an appreciation of the types of cracks will guide a doctor to making appropriate decisions.

Teeth can have structural cracks in various stages. To date, diagnosis and treatment are very often at end stage of crack development.

CLINICAL SIGNIFICANCE

This article gives new guidelines for recognition, visualization, classification, and treatment of cracked teeth based on the routine use of $\times 16$ magnification. The significance of enamel cracks as they relate to dentinal cracks is detailed.

(*J Esthet Restor Dent* 15:XXX-XXX, 2003)

Macroscopic and symptom-driven diagnoses have been the accepted modalities for cracked teeth. The inherent limitations of the lack of visual confirmation result in therapies that often come too late in the treatment process. One having first impression of vision through a clinical microscope is the staggering array of cracks that exist within tooth structures. Traditional visualization limited

or ocular acuity limits the clinician's ability to assess the presence or severity of the majority of these cracks (Figure 1).

At extreme magnification levels ($\times 14$ and greater), the translucent nature of enamel yields a wealth of information. Subtle color changes within the enamel may indicate early decay, microleakage, and a lack of structural integrity of dentin and

enamel. Being able to see previously invisible crazes can lead restorative dentists to more appropriate early treatment of compromised teeth before devastating fractures, pulpal involvement, and pericoronal breakdown occur. The value of early diagnosis of the structural breakdown of teeth will become even more significant with our aging population coupled with increased tooth retention in this population.

*President, Academy of Microscopic Enhanced Dentistry
†Governor's Dentist, Newport Coast Oral Facial Institute, Newport Beach, CA, clinical professor,
Restorative Dentistry, USC School of Dentistry, Los Angeles, CA, USA
‡Governor's Dentist, Newport Coast Oral Facial Institute Newport Beach, CA, associate professor,
Restorative Dentistry, USC School of Dentistry, Los Angeles, CA, USA

Nomenclature and Classification System for Enamel Cracks

Type I: Have little or no risk of underlying pathology

Type II: Have moderate risk of underlying pathology

Type III: Have high risk of underlying pathology

Type I: Have little or no risk of underlying pathology

- A) Craze lines
- B) Small vertical cracks
- C) Cracks that follow natural anatomic grooves
- D) Cracks with superficial stain penetration

Type II: Have moderate risk of underlying pathology

- E) V-shaped enamel ditching with or without an adjoining restoration often associated with a wear facet centered over an otherwise benign crack
- F) Cracks that detour from or do not follow natural anatomic grooves

Type III: Have high risk of underlying pathology

- G) Diagonal cracks branching off a vertical crack
- H) Horizontal or diagonal cracks that emanate from the corner of a restoration
- I) Cracks that house debris

Type III: Have high risk of underlying pathology

- J. Pair of cracks that outline an area (cusp or marginal ridge) of discolored enamel
- K. Crack with corresponding halo of brown, grey or white centered on crack
- **The tooth or the cusp is gray**

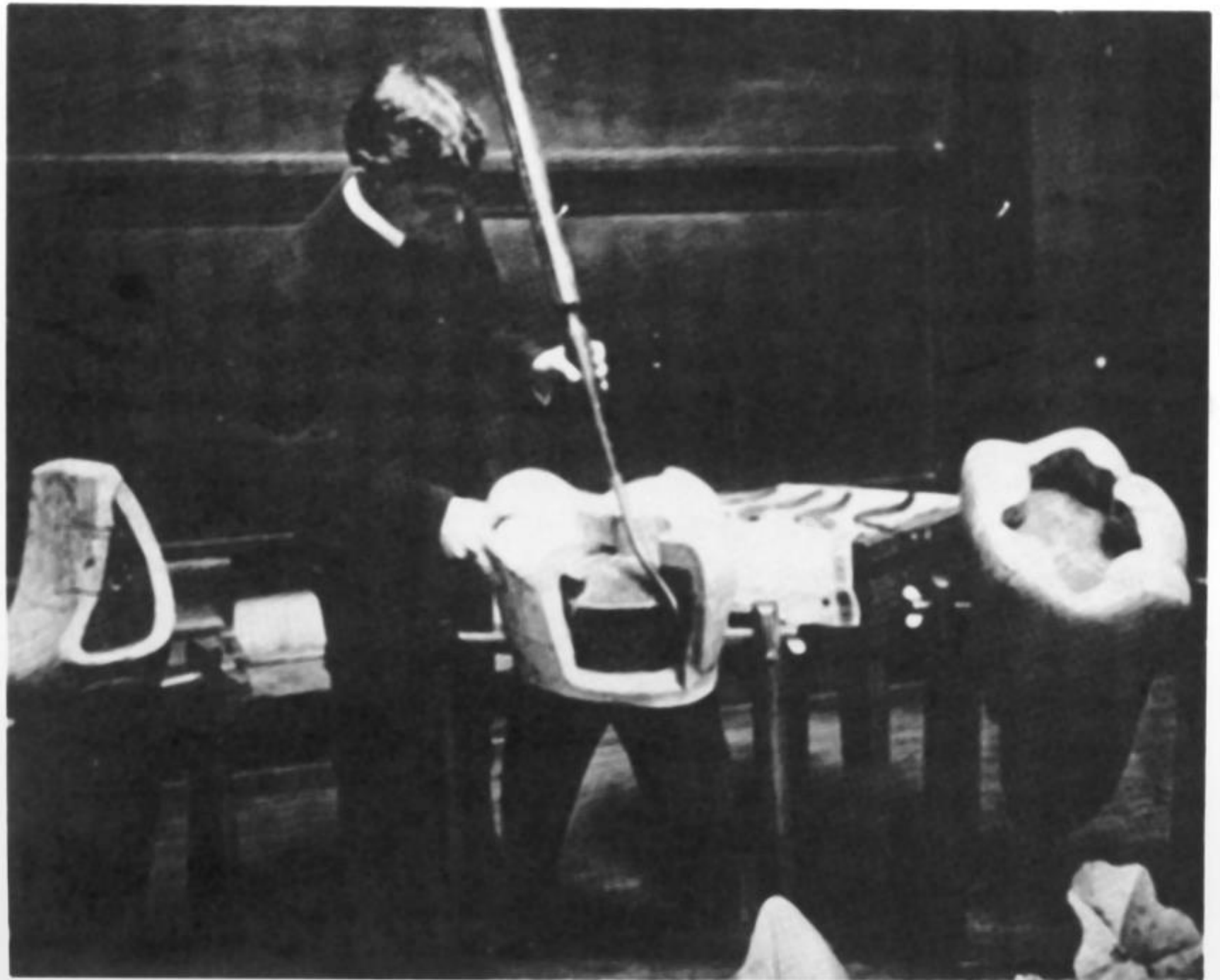
**WHERE ARE WE WITH
CAVITY SHAPES?**

1890

**G. V. BLACK,
M.D., D.D.S.,
Sc.D., LL.D.,
1836-1915**



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TENON JOINTS
NECESSARY FOR
MECHANICAL
RETENTION OF
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Decisions™ IN DENTISTRY

CONSERVATIVE APPROACH TO DEEP CARRIES LESIONS

NATHANIEL LAWSON, DMD, PhD, and
AUGUSTO ROBLES, DMD, MS

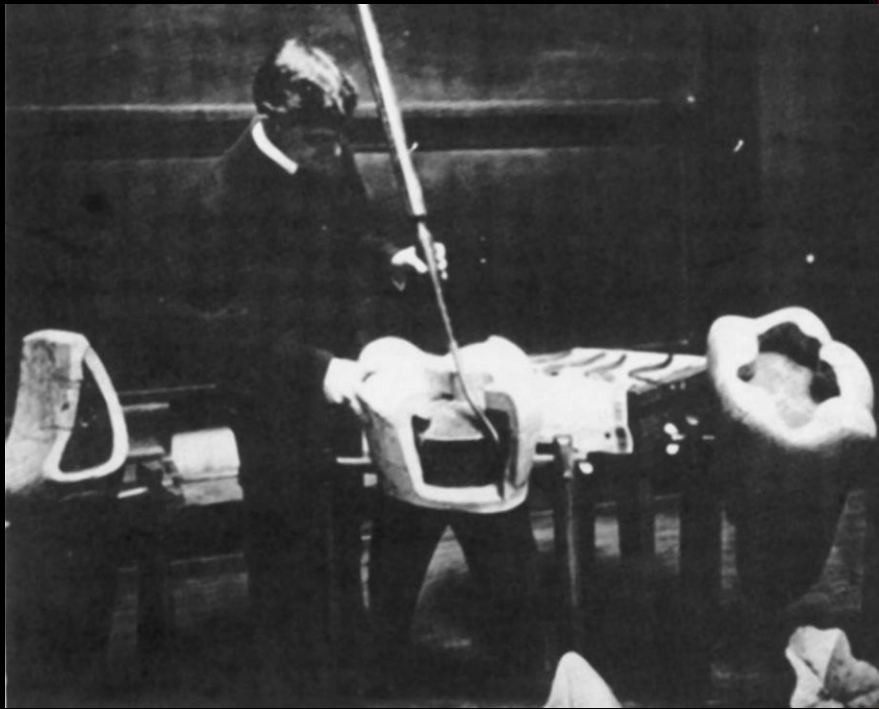
RISK FACTORS IN
ORAL CANCER
SCREENING
SARAH GLASS, DDS

HOW MANAGED
CARE WILL IMPACT
DENTAL PRACTICE
JOEL H. BERG, DDS, MS

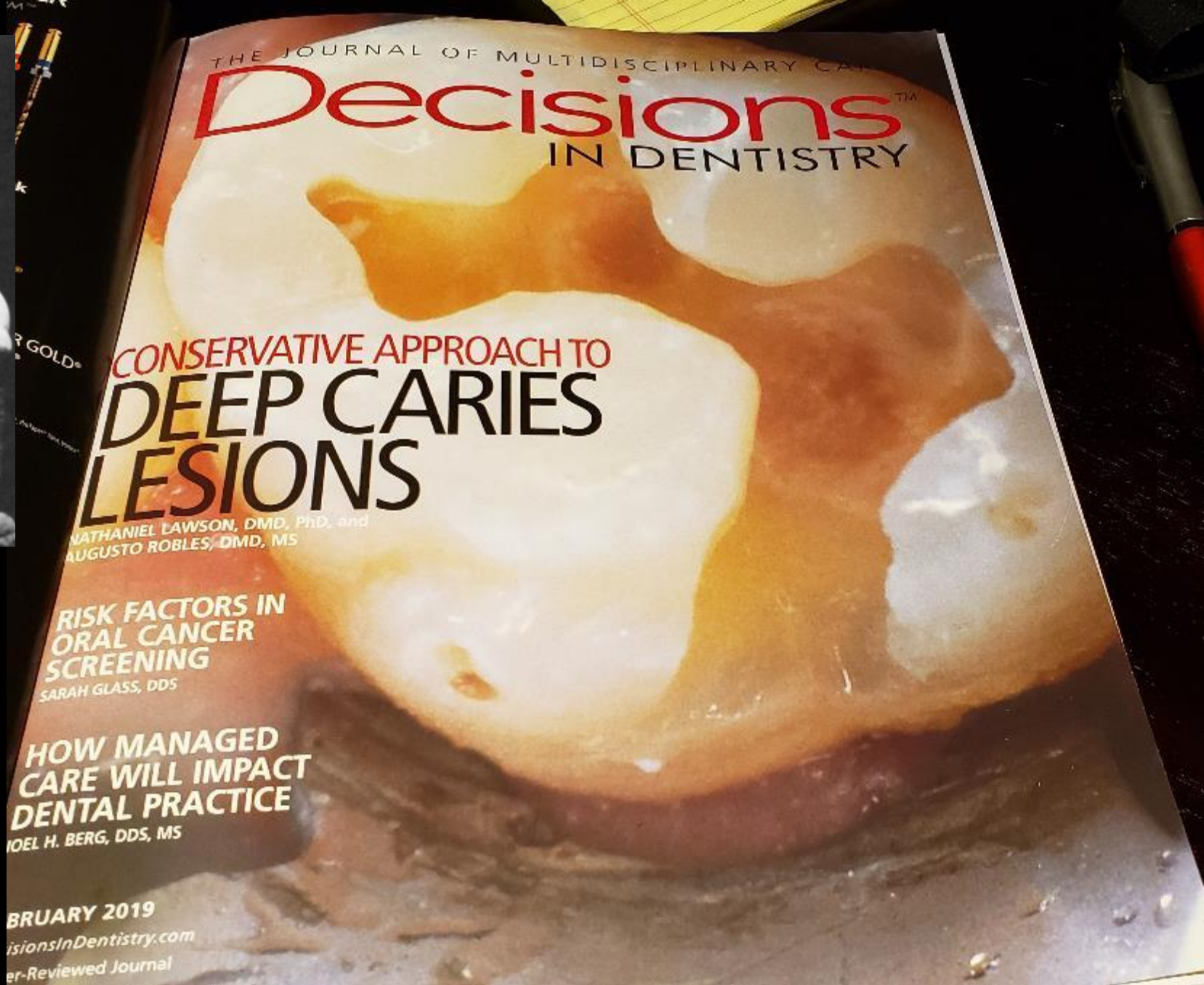
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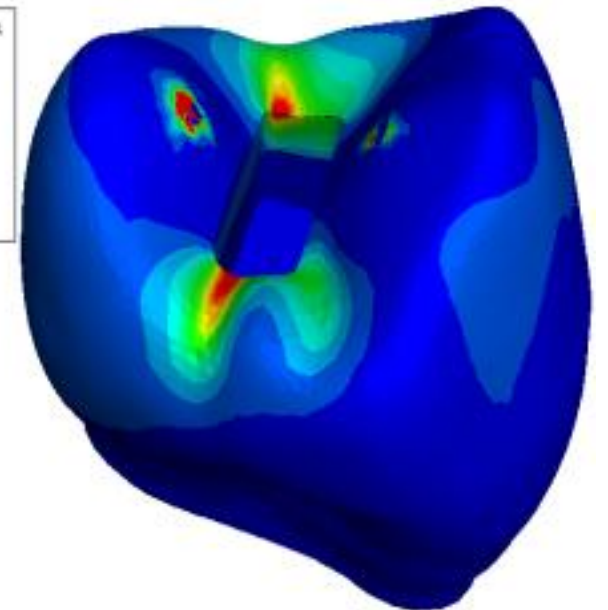
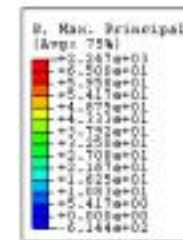
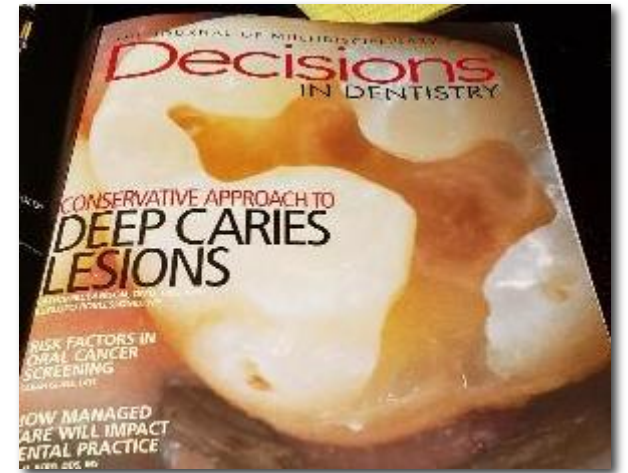


Is this the
year 2026
or 1890?



Stress/Strain Concentration

- Abrupt changes in geometry
- Mismatches in mechanical properties
- Concentrated loads

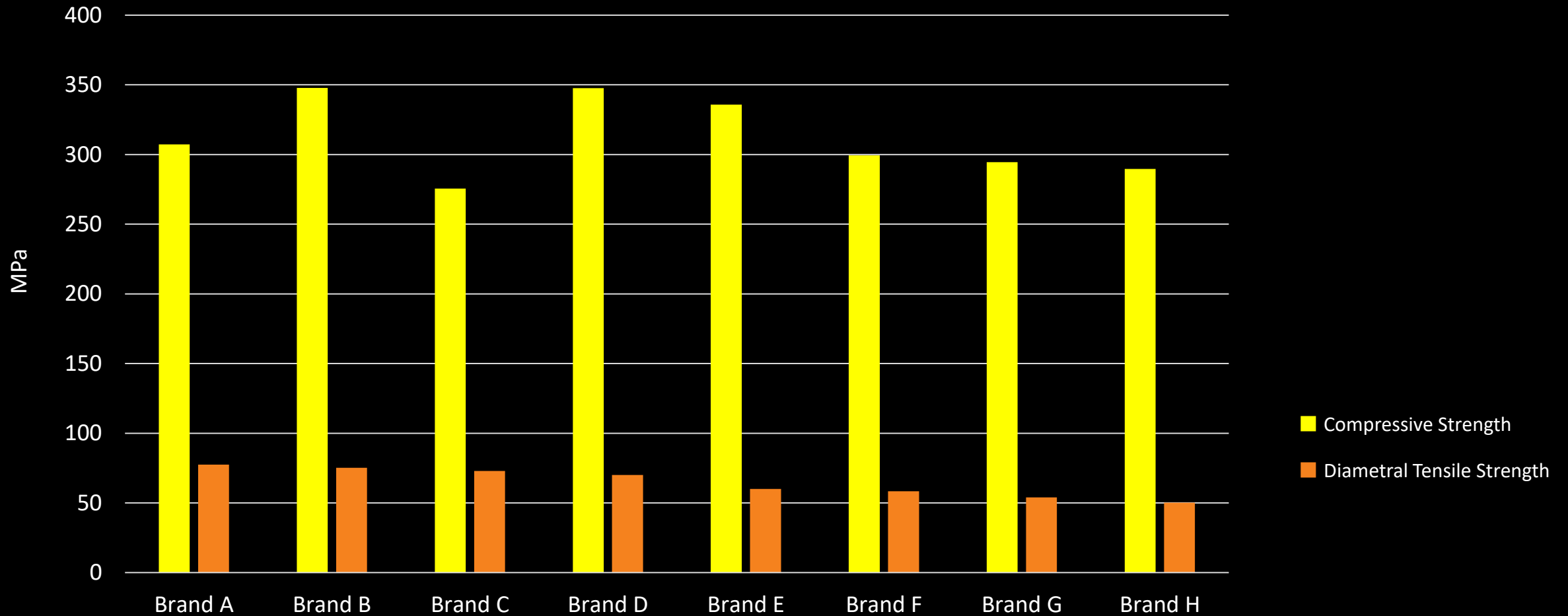


Epidemic of Cracked Teeth...Why?

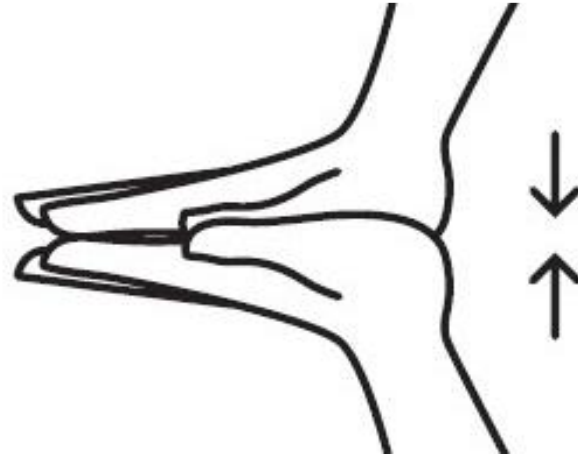
**Brittle Materials with
Tension joints**

Composite Resin Material Properties

Compressive vs Diametral Tensile Strength



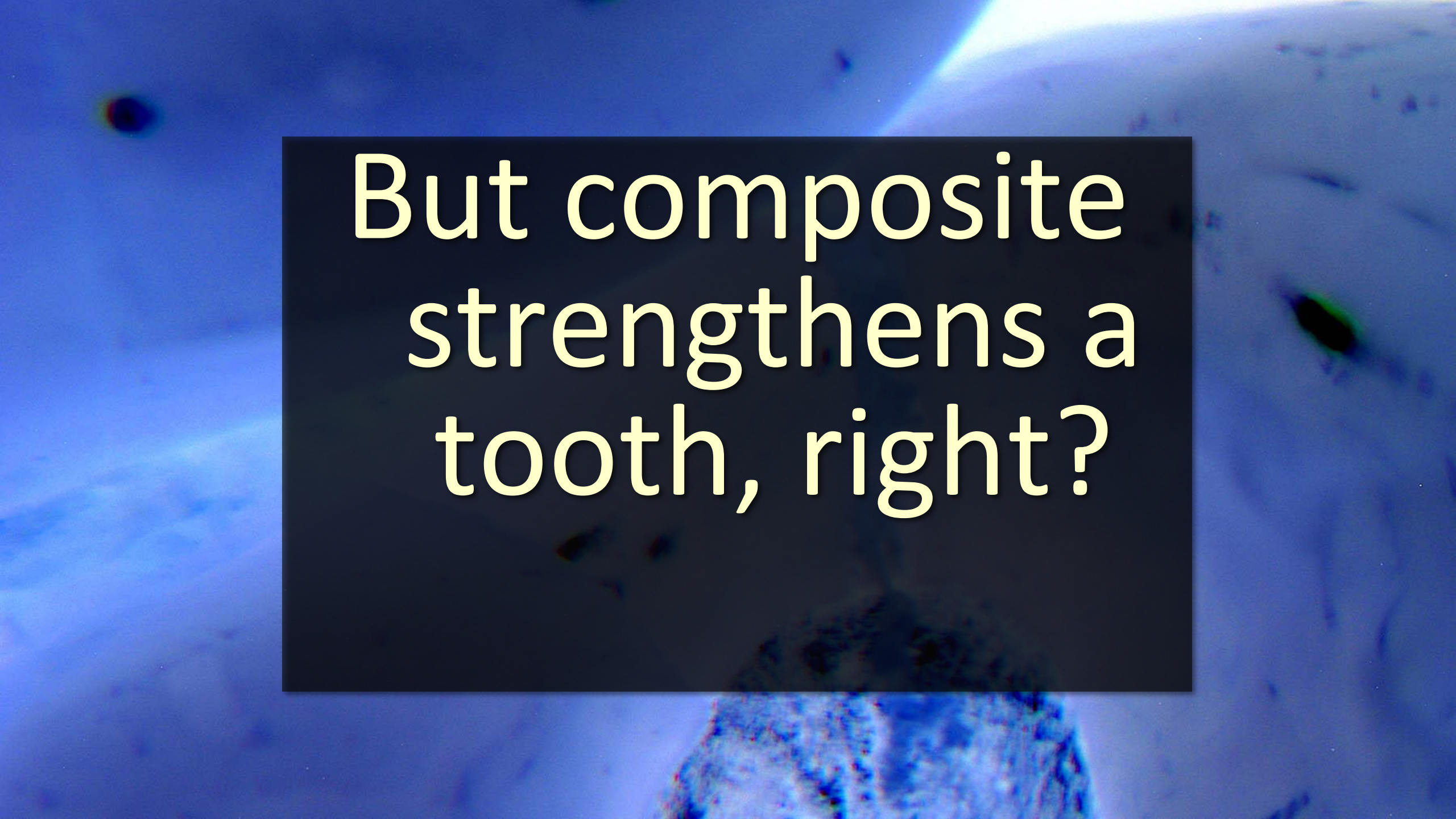
Compression vs. Tension is “Engineering 101”



compression



tension

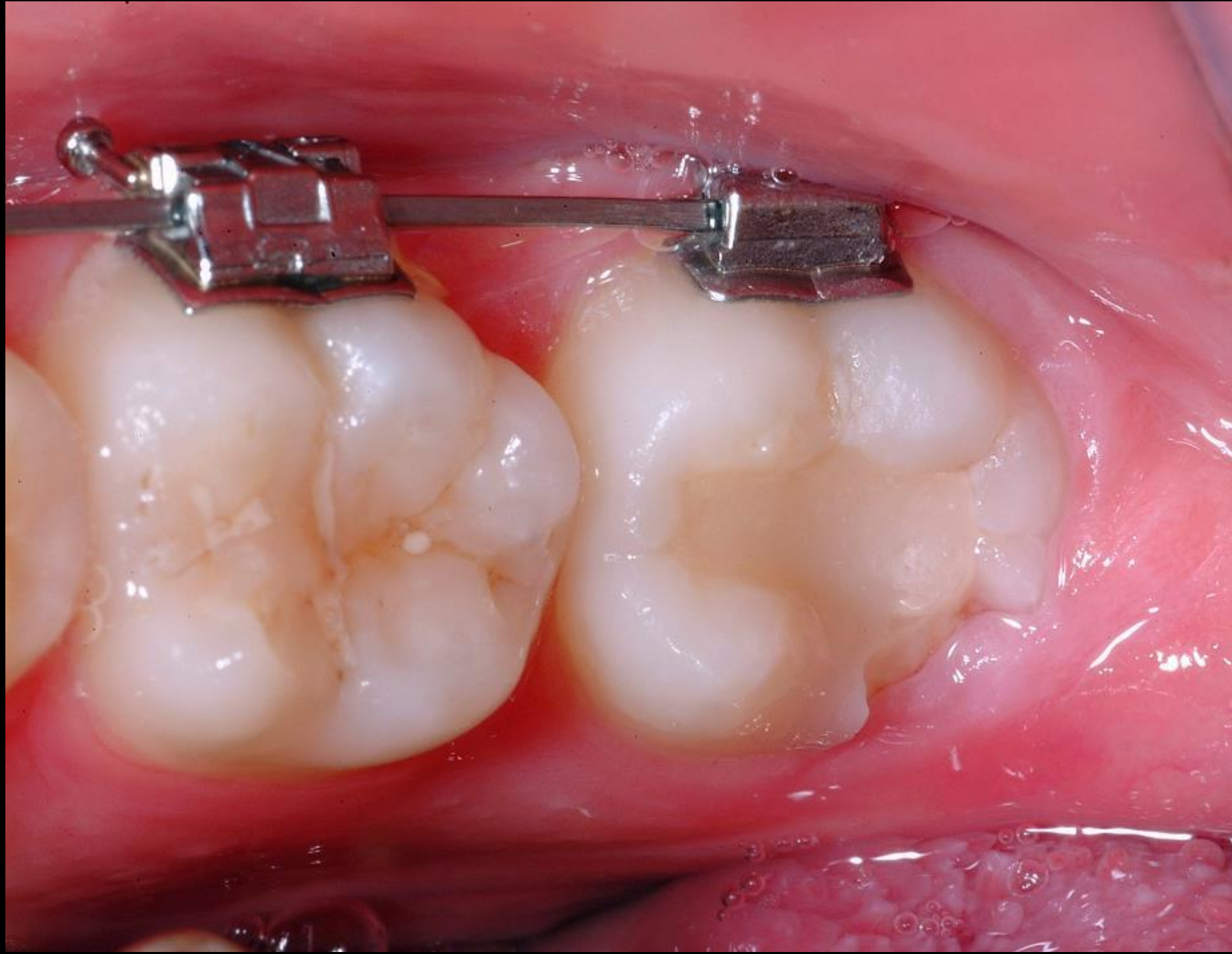
A microscopic view of a tooth with a composite filling. The background is a light blue, textured surface representing the tooth's enamel. A dark, rectangular area in the center represents the composite filling. The text is overlaid on a black rectangular background in the center of the image.

But composite
strengthens a
tooth, right?

Does composite strengthen the tooth?

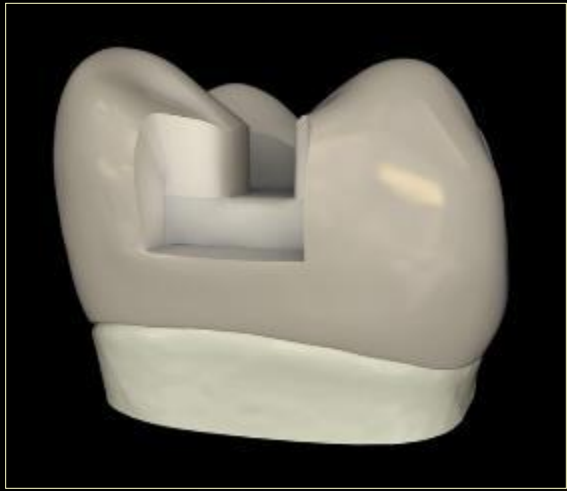
No more than does amalgam

Wahl MJ, Schmitt MM,
Overton DA, Gordon MK.
Prevalence of cusp
fractures in teeth restored
with amalgam and with
resin-based composite.
JADA 135:1127-1132
(2004)





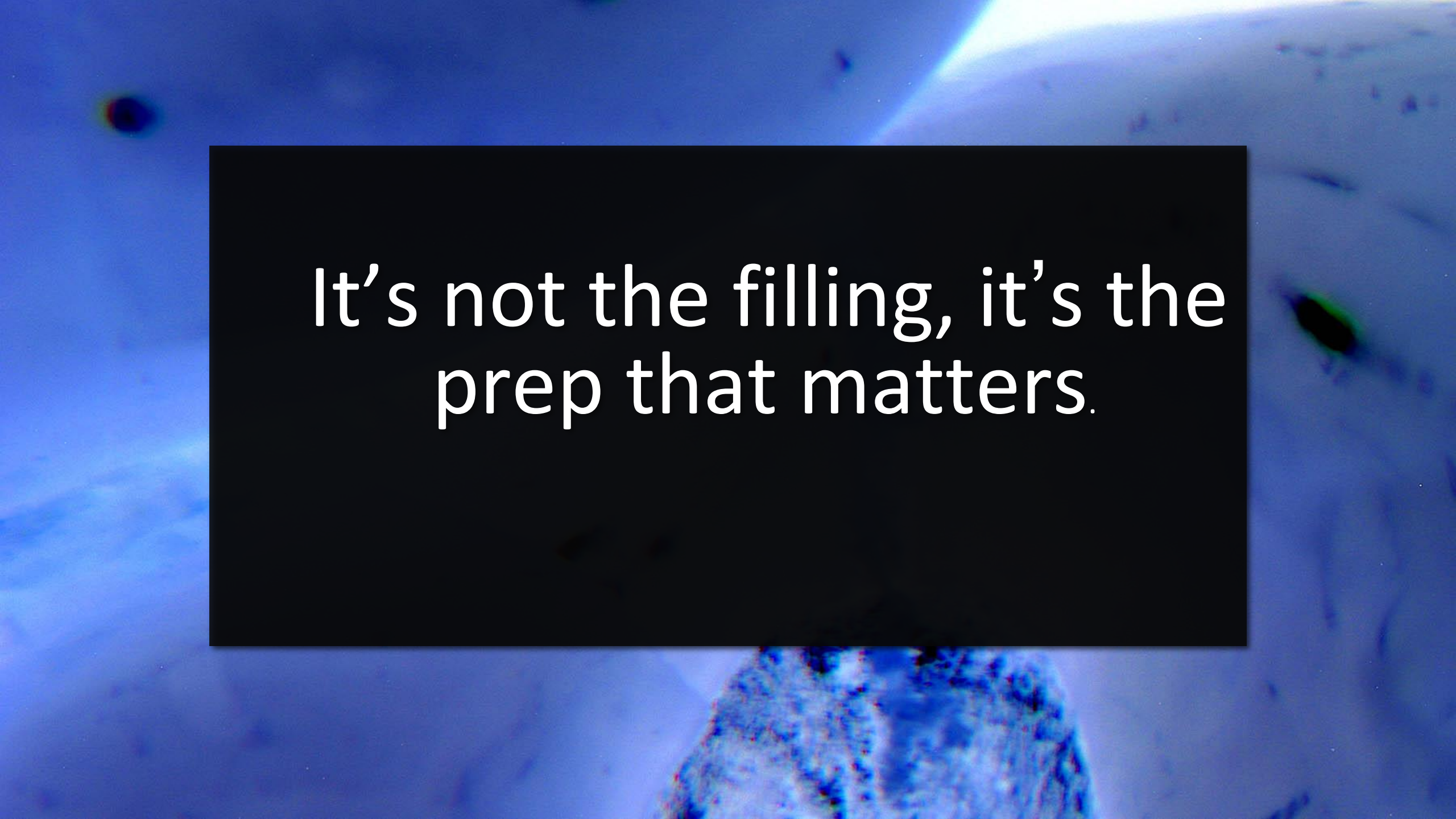




Boxes are bad.

Bevels make them less bad.

The Clark Class II replaces
beveling with radius walls.



It's not the filling, it's the
prep that matters.

Restoratively, It's Not the Size of the Hole, but the Shape of the Hole

The formula for determining stress concentration due to a cavity preparation is $(1+2\sqrt{\frac{L}{R}})$ where L is length of the cut and R is the radius of the cut. In simple terms, the longer the cut, the worse the cut. A long narrow cut, interestingly, is worse than a wide, round-bottomed cut. One reason that intracoronal composites do not protect the tooth from long-term from

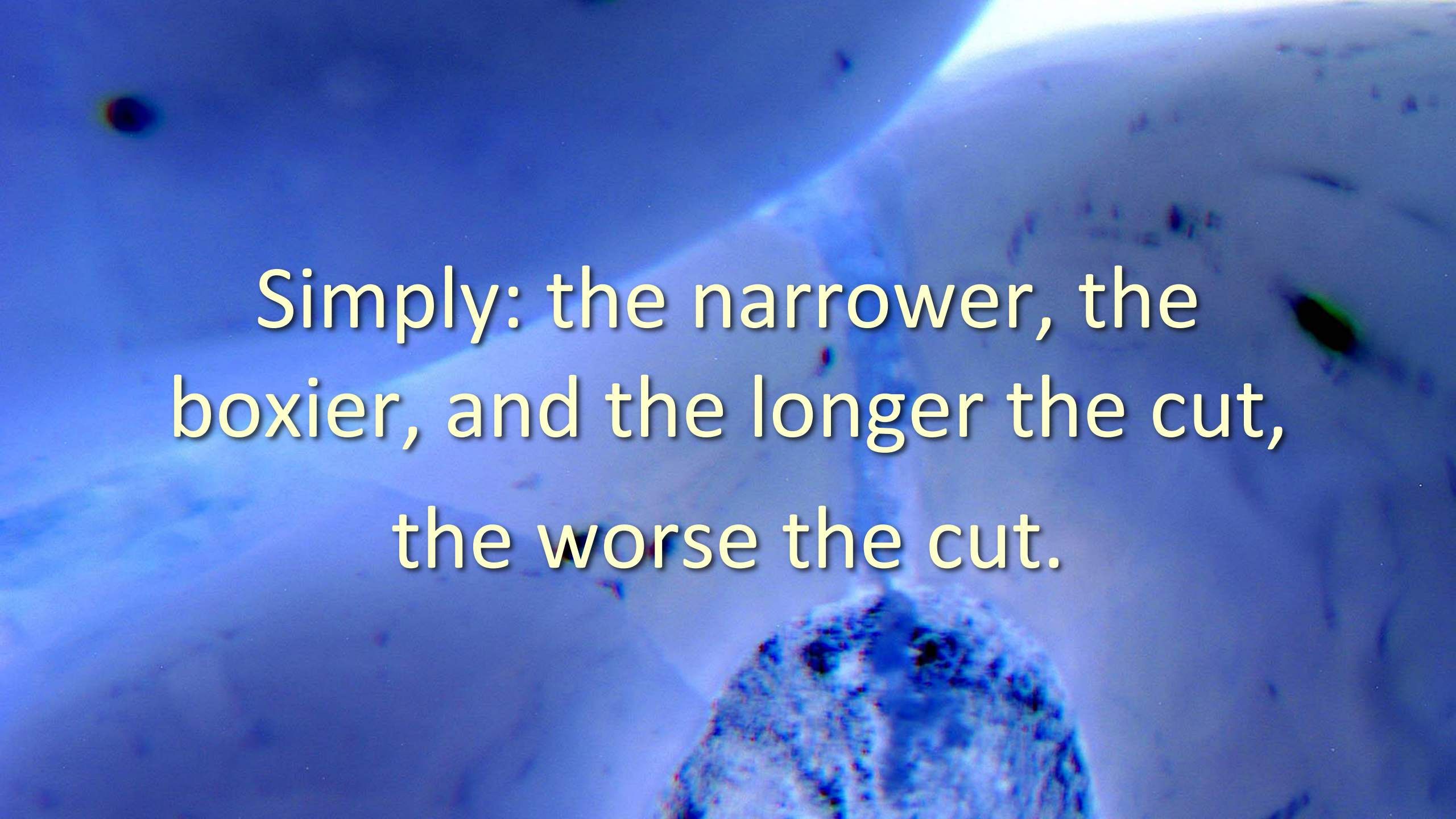
A microscopic image of a metal surface showing a sharp notch. The surface is highly reflective, and the notch is a deep, narrow cut. The background is a bright, slightly textured metal surface. The text is overlaid on the image in a white, sans-serif font.

The formula for stress concentration in a cavity is

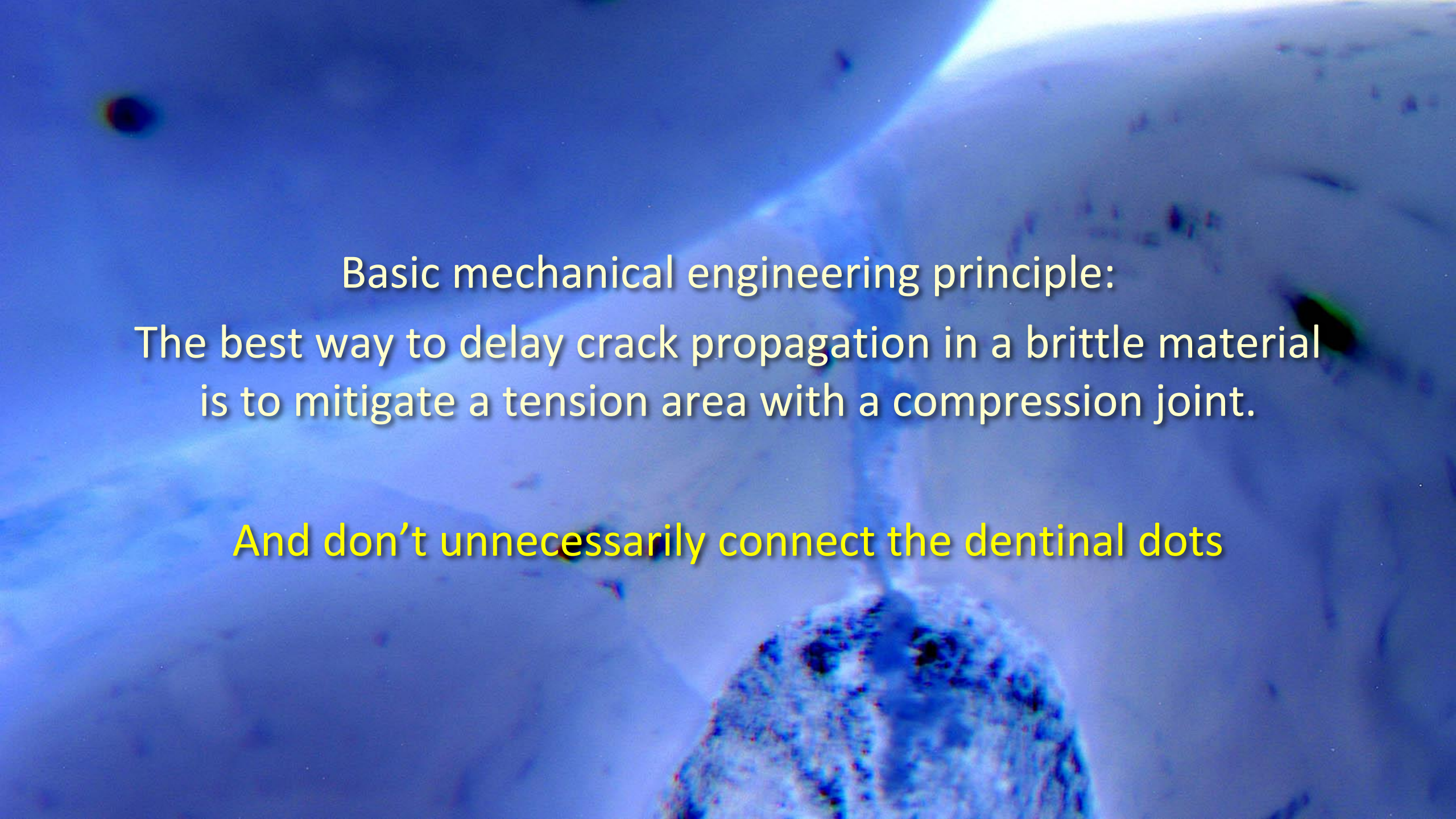
$$1 + 2 \sqrt{L/R}$$

L is the depth of the cut.

R is the radius of the cut.

A close-up photograph of a diamond being cut. The diamond is the central focus, showing its facets and the cutting process. The background is a dark, textured surface, likely the cutting table. The text is overlaid on the image in a white, sans-serif font with a slight shadow.

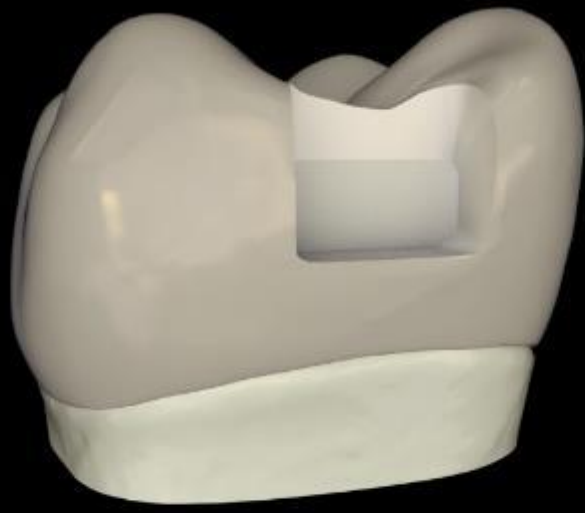
Simply: the narrower, the
boxier, and the longer the cut,
the worse the cut.

A microscopic image of a material surface, likely a metal or ceramic, showing a crack. The crack is a dark, irregular line running diagonally across the frame. The surface has a granular texture with various small features and imperfections. The lighting is bright, creating highlights and shadows that emphasize the three-dimensional nature of the crack and the surface texture.

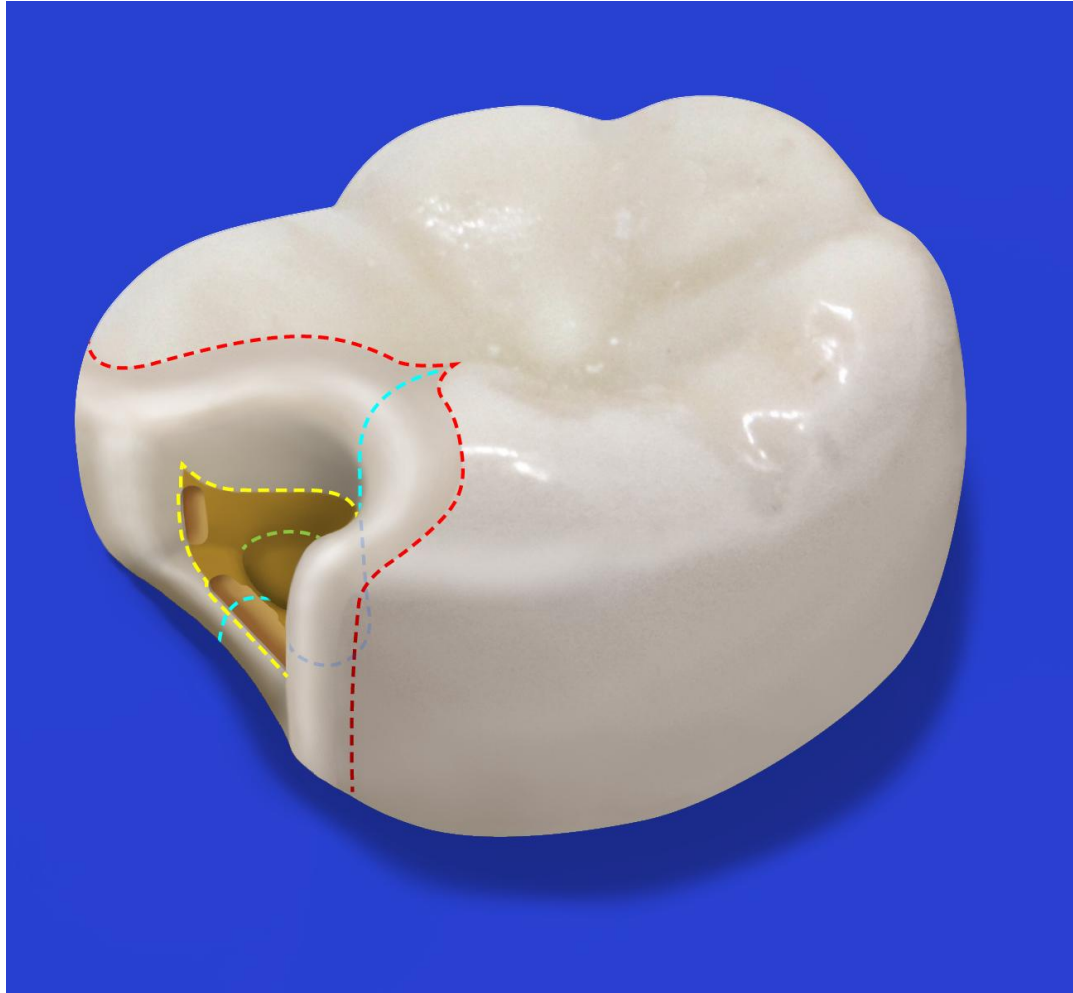
Basic mechanical engineering principle:
The best way to delay crack propagation in a brittle material
is to mitigate a tension area with a compression joint.

And don't unnecessarily connect the dentinal dots

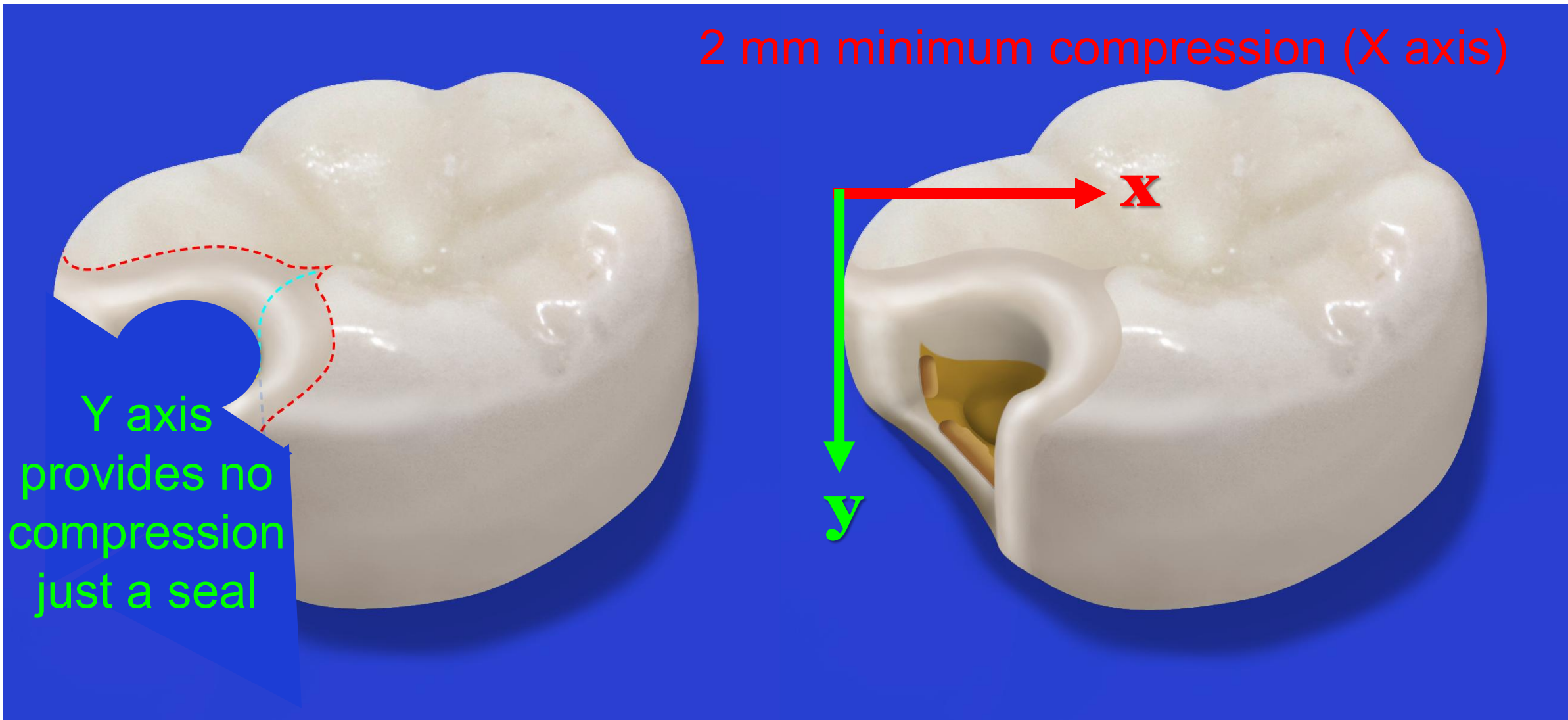
The Prep?



Final views of completed Bioclear Class II Preparation.



To eliminate mechanical retention, we need 2 mm of enamel in compression at the primary strike point of occlusion



Modern Restoration

Design=**I.C.E.**

Infinity edge

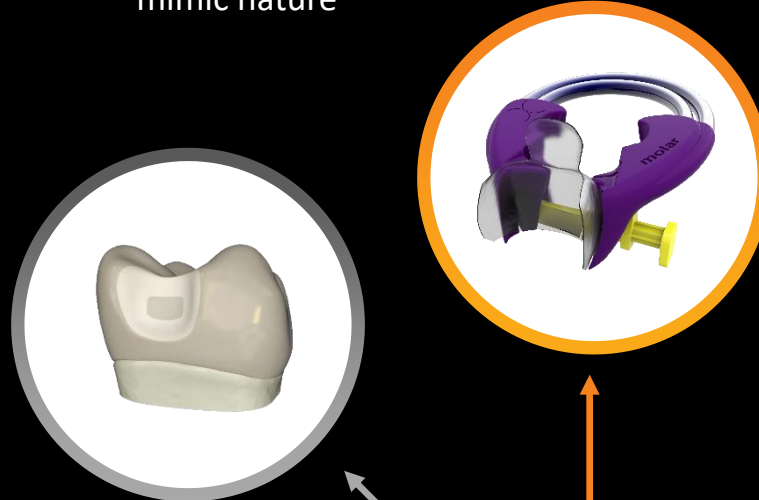
Compression based

Enamel driven

Modern Method for Composite Restorations

Clear Anatomic Matrices

- Anterior & Posterior Matrices designed to mimic nature



Injection Mold Composite

- Injection mold warmed Restorative materials
- Industry leading polish, esthetic, strength & wear



Preparation Design

- Designed for composite
- Minimizes stress concentration
- Maximizes enamel involvement



Biofilm Removal

- Remove biofilm before bonding
- Allows bonding to uncut enamel
- Allows infinity edge margins



Systematic restorative protocol for esthetic long-term clinical outcomes

Final Polish

- 3M™ Sof-Lex™ XT coarse discs for reduction
- “Rock Star” polish with Bioclear Magic Mix & RS Polisher



Clark Class II Prep Design



Unique Aspects of the Clark Class II Prep Design



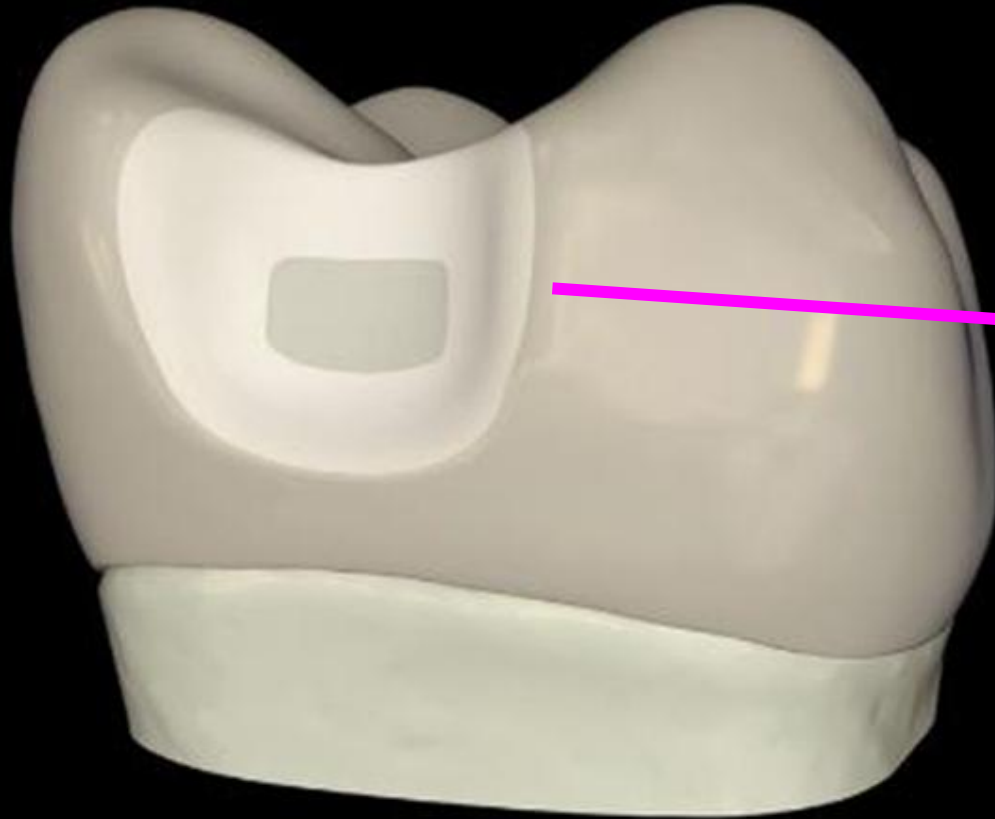
- Removal of biofilm

Unique Aspects of the Clark Class II Prep Design



- Removal of biofilm
- Rounded internal line angles

Unique Aspects of the Clark Class II Prep Design



- Removal of biofilm
- Rounded internal line angles
- Rounded external line angles via the ***Radius Bevel***

Unique Aspects of the Bioclear Prep Design



- Removal of biofilm
- Rounded line angles
- Injection mold rather than place incrementally

Unique Aspects of the Clark Class Prep Design



- Removal of biofilm
- Rounded line angles
- Rounded external line angles via the *Radius Bevel*
- Infinity Edge margins
 - Maximized enamel rod Engagement *with Large Areas of Additive Dentistry*



before

The Bioclear method





Infinity edge
of the T.R.I.

The Bioclear Injection Molding Approach



Failing composite;
traditional preparation



Re-restored using the
Bioclear approach



Step by Step Guide for Injection Molded Class II

Studies Supporting the Bioclear Method

Complete

- Comparing Conventional to Saucer-Shaped Cavity Designs

Dr. Alex Fok, BEng, PhD, MSc

Dr. Hooi Pin Chew, BDS, PhD, FDSRCS

MN Dental Research Center for Biomaterials and Biomechanics

- Comparison of Class II Adaptation and Placement Times

Dr. Richard Price, BDS, DDS, MS, FDS RCS, FRCD(C), PhD

Dept. of Clinical Dental Sciences & Biomedical Engineering Dalhousie University

- Effect of Preheating/Fatiguing/Thermocycling on Mechanical Properties

Taiseer A. Sulaiman, DDS, PhD

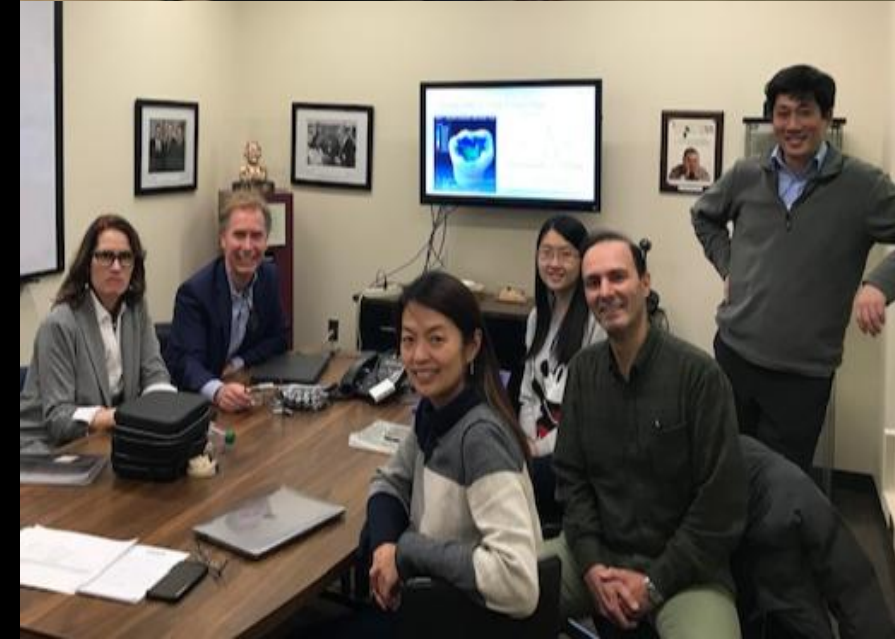
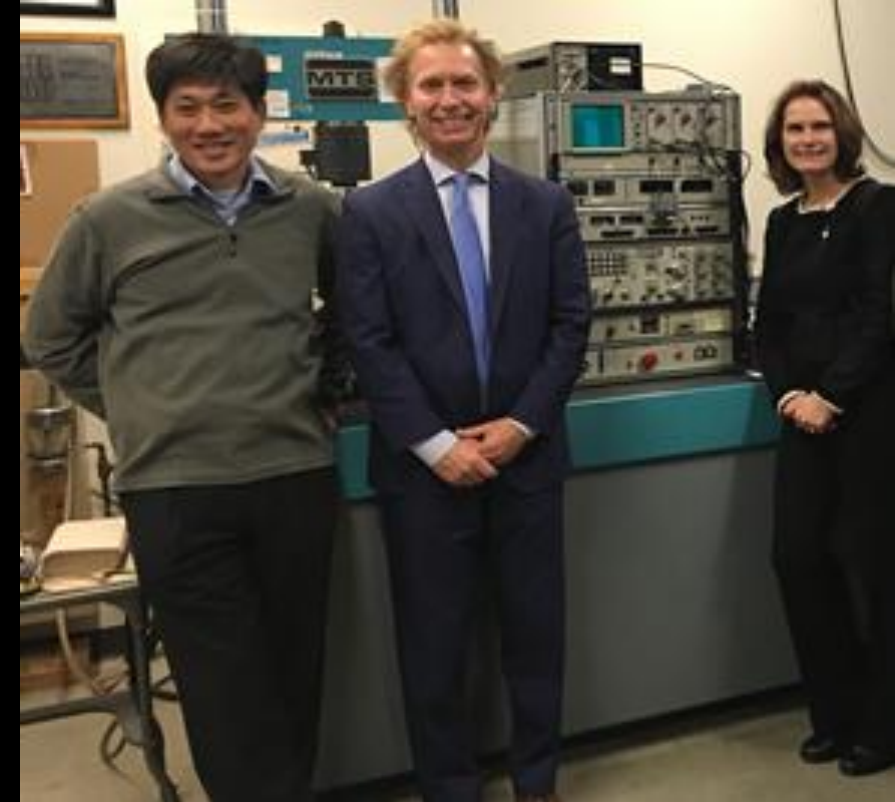
Assistant professor, Division Director of Operative Dentistry and Biomaterials, UNC School of Dentistry

- 3M Extraction and Pulp Temperature Testing

Brad Bagley, PhD, DABT Advanced Toxicology Specialist

- 3M Material Property Testing Including Injection Molding

Timothy D. Dunbar, Ph.D. Advanced Product Development Specialist



In Process

- Biofilm Adhesion Study

Sabrina F. Sochacki, DDS, MS, PhD

Indiana University School of Dentistry

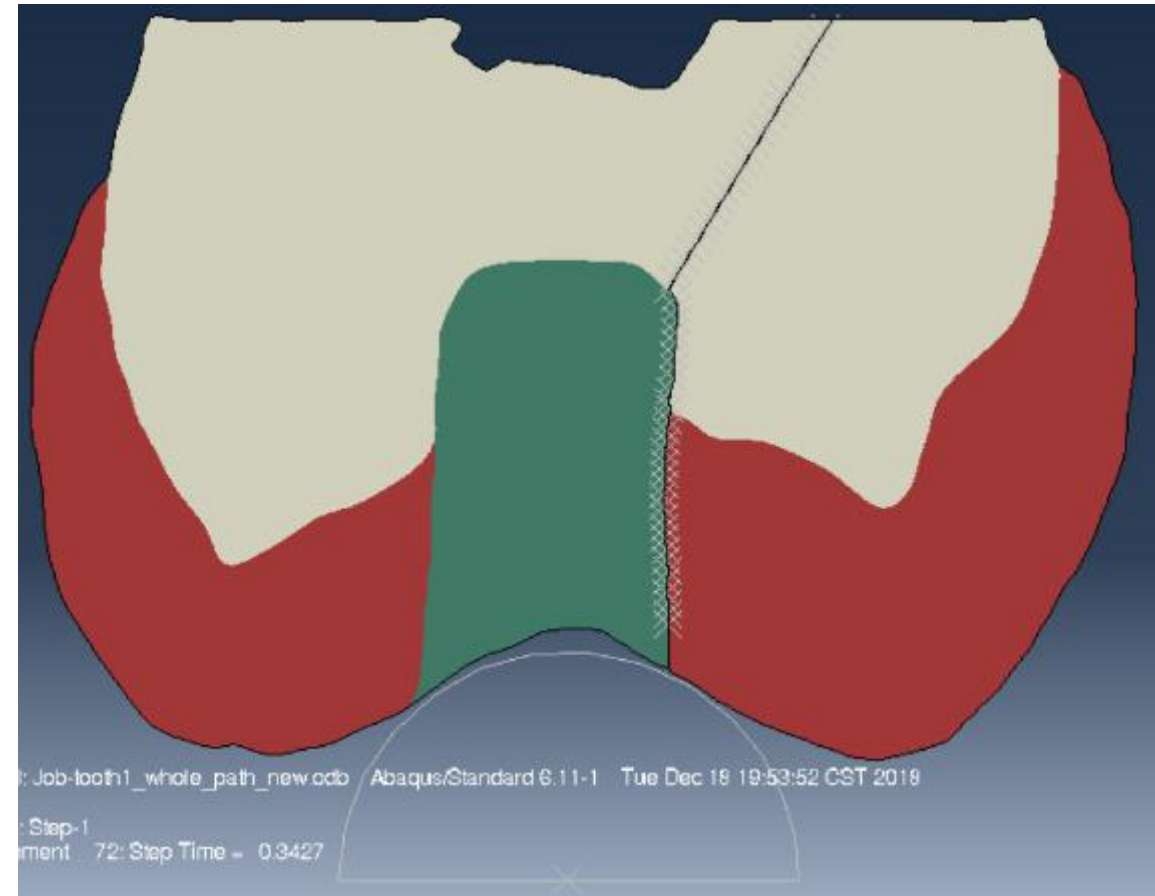
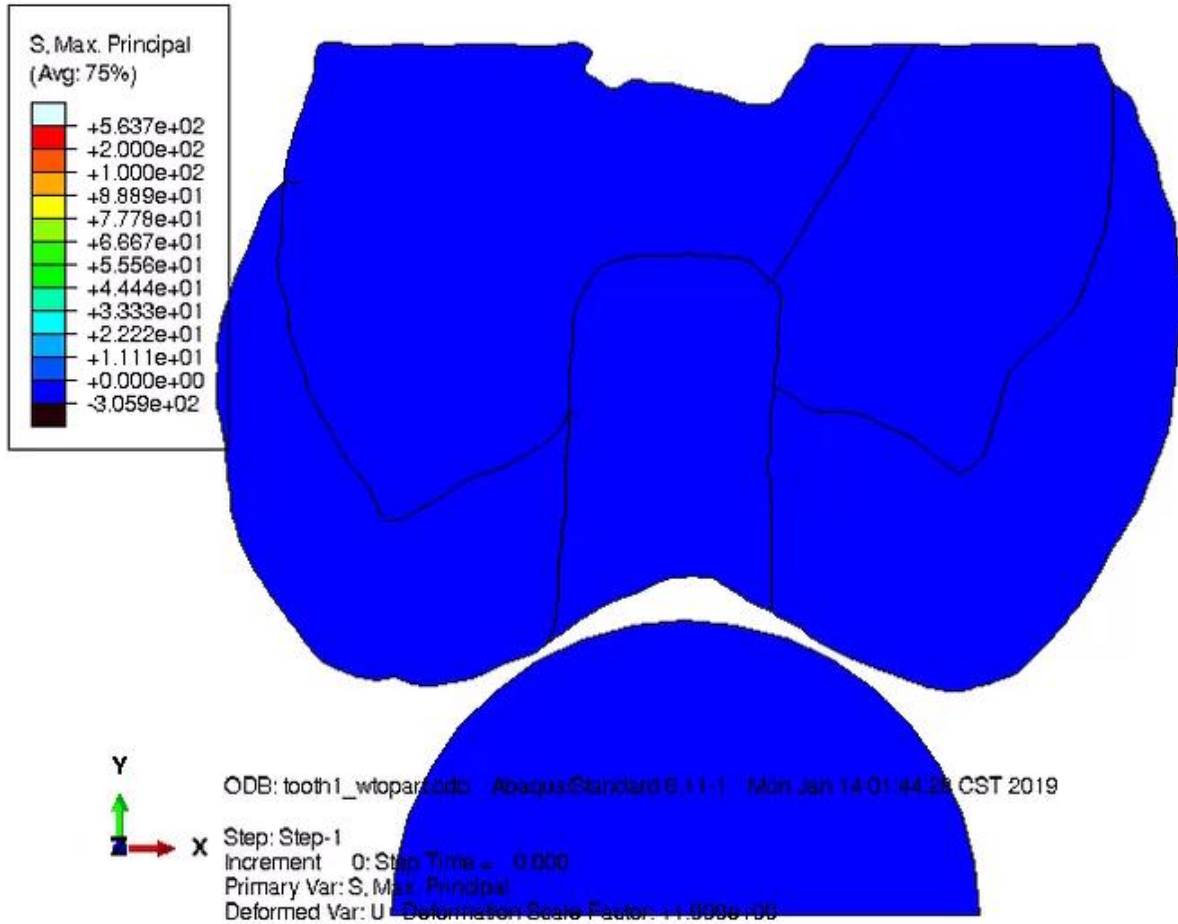
Fracture Simulation of Class-I Restorations



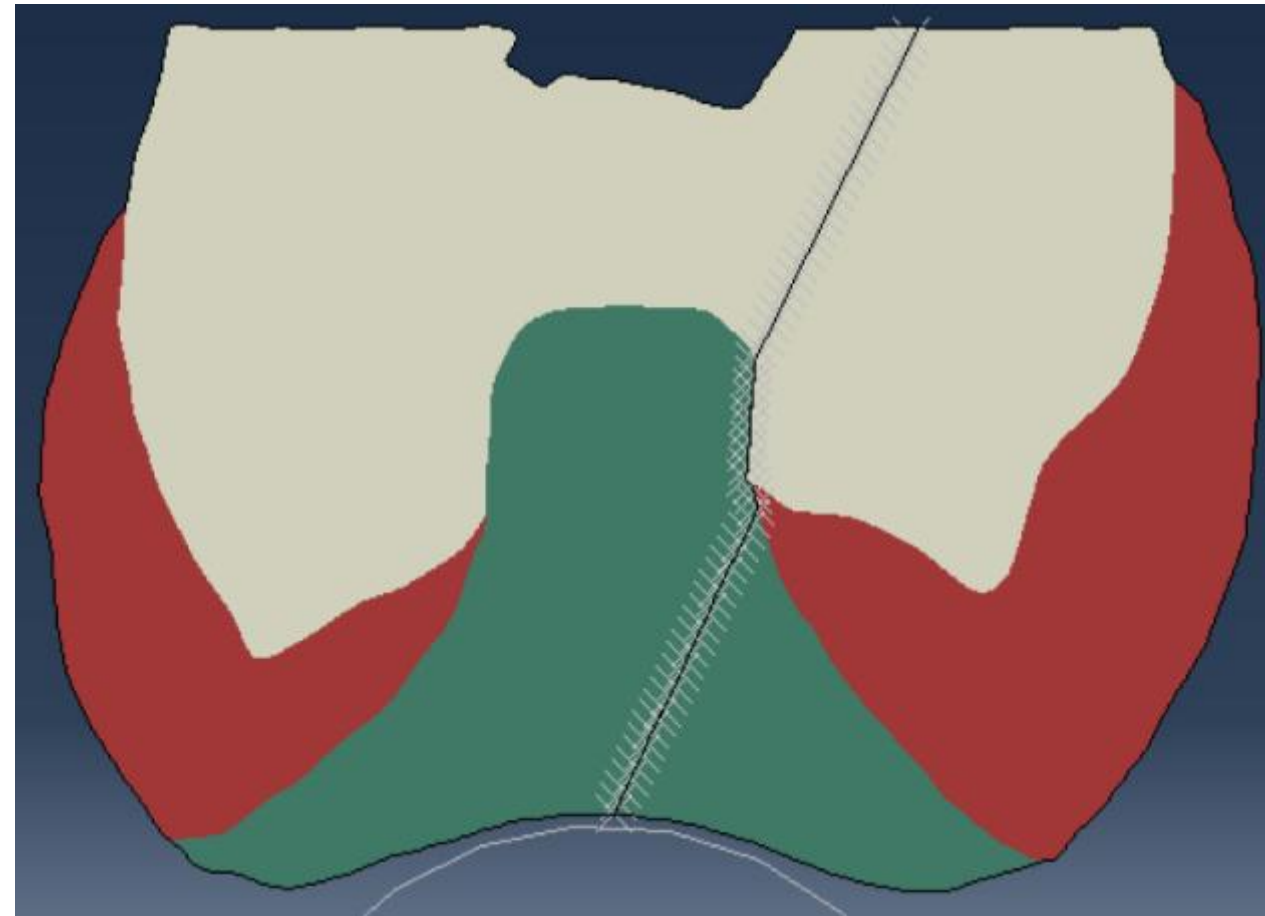
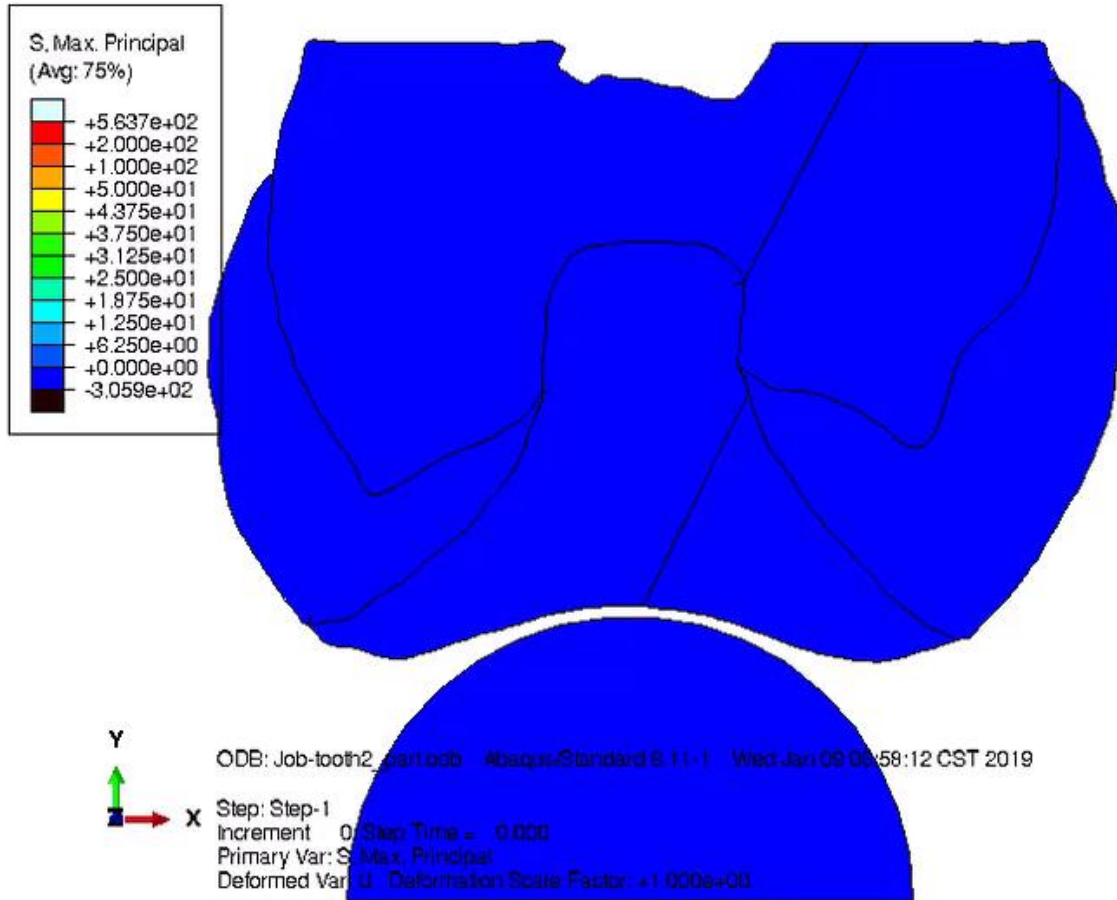
Prepared by: Ning Ye
Date: 1/11/2019

Reference no. MDRRCBB-NY-JAN11-2019

Traditional Class I Prep



Calla Lily Class I Prep



$$A_1 N_1^B = A_2 N_2^B \frac{N_1}{N_2} = \left(\frac{A_2}{A_1} \right)^{1/B}$$

...if Restoration 1 has a fast fracture strength that is **10% higher than Restoration 2**, then its fatigue life is roughly 3 times as long.

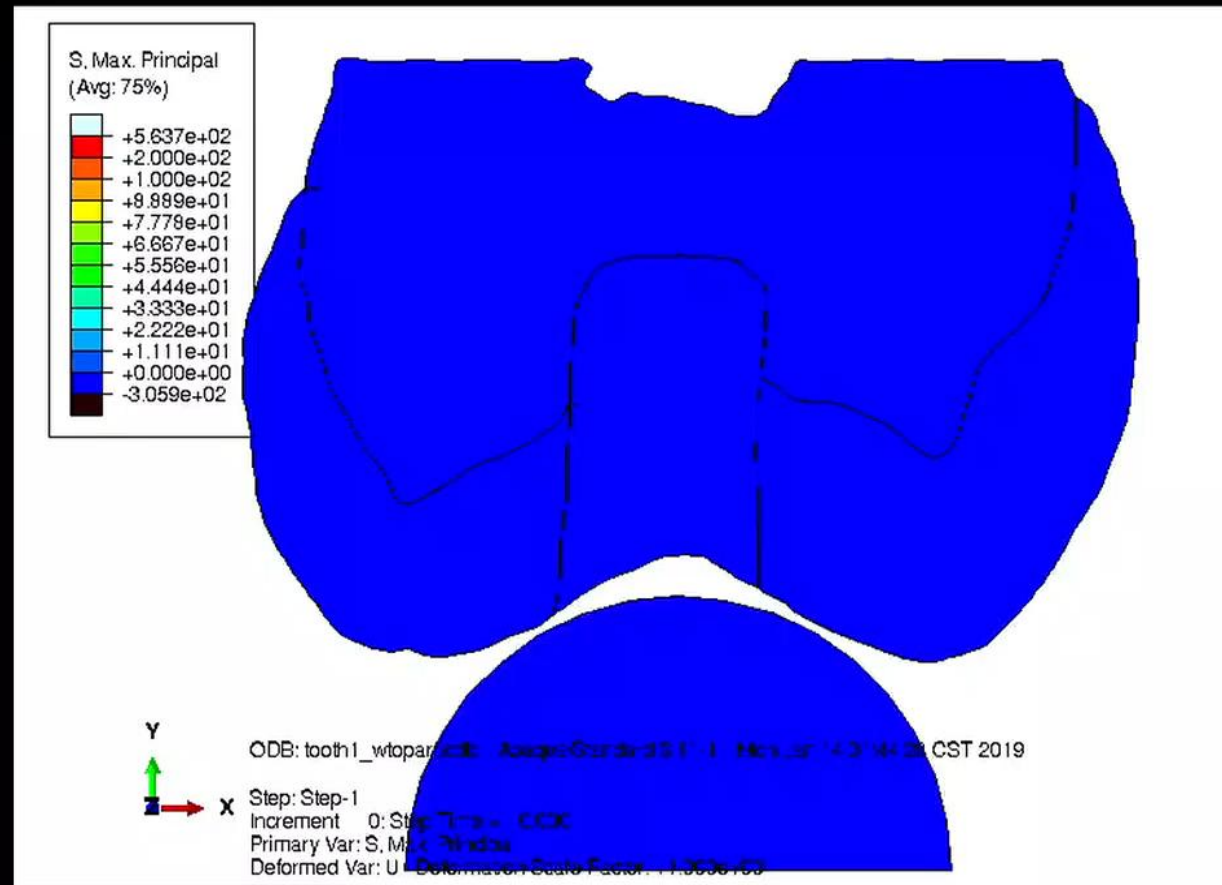
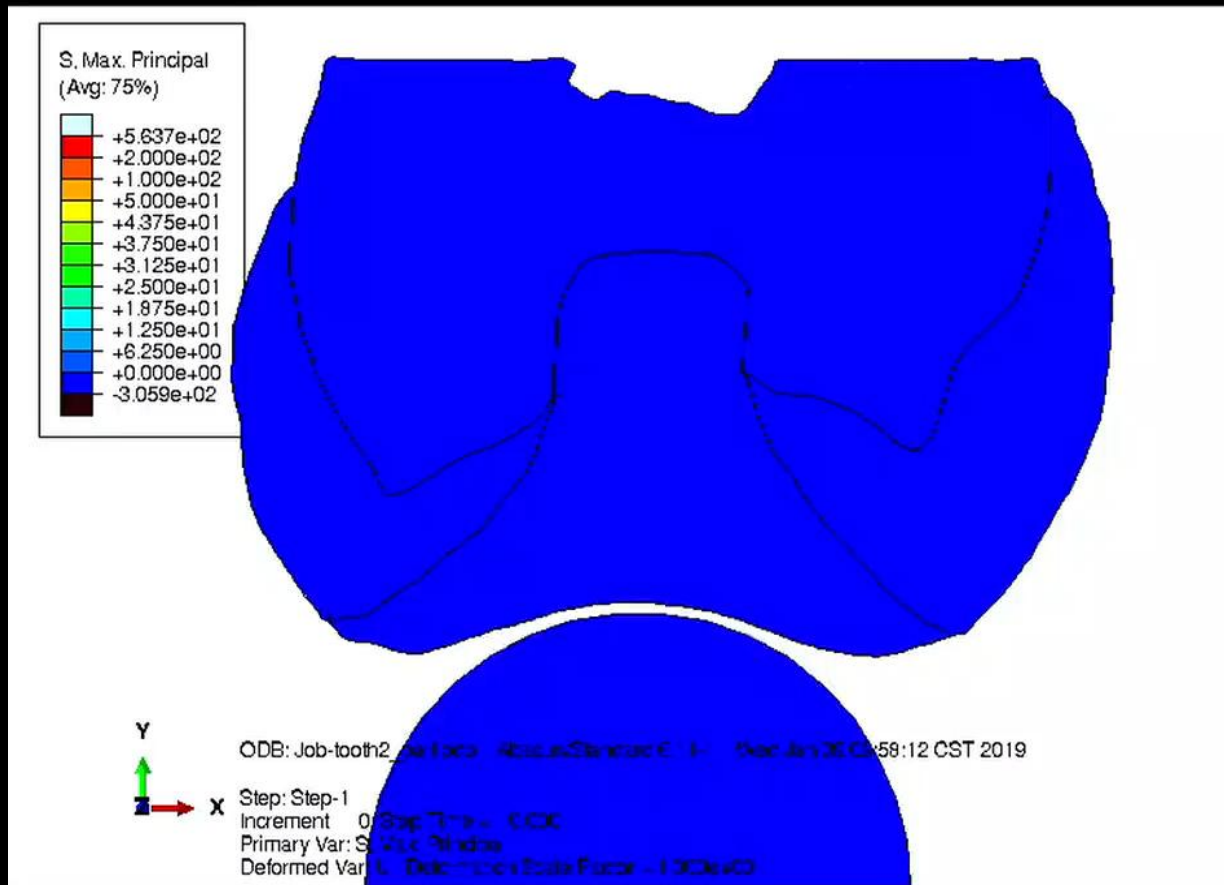
If the difference in fast fracture strength is 20%, then Restoration 1 will last roughly 8 times as long, etc.

Alex Fok

Minnesota Dental Research Center
for Biomaterials and Biomechanics

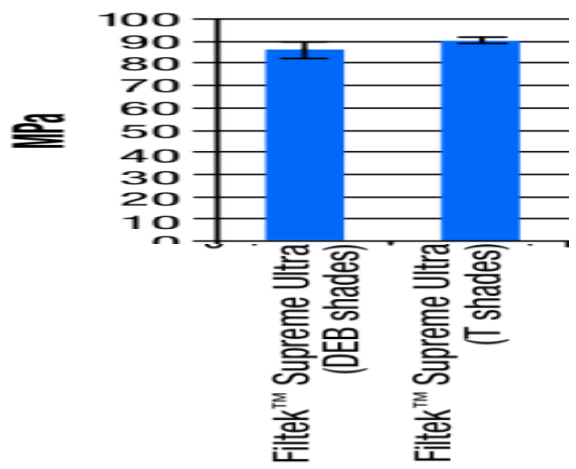
Calla Lily: moderate occlusal caries or re-treatment of Traditional prep

Traditional Class I filled with composite resin

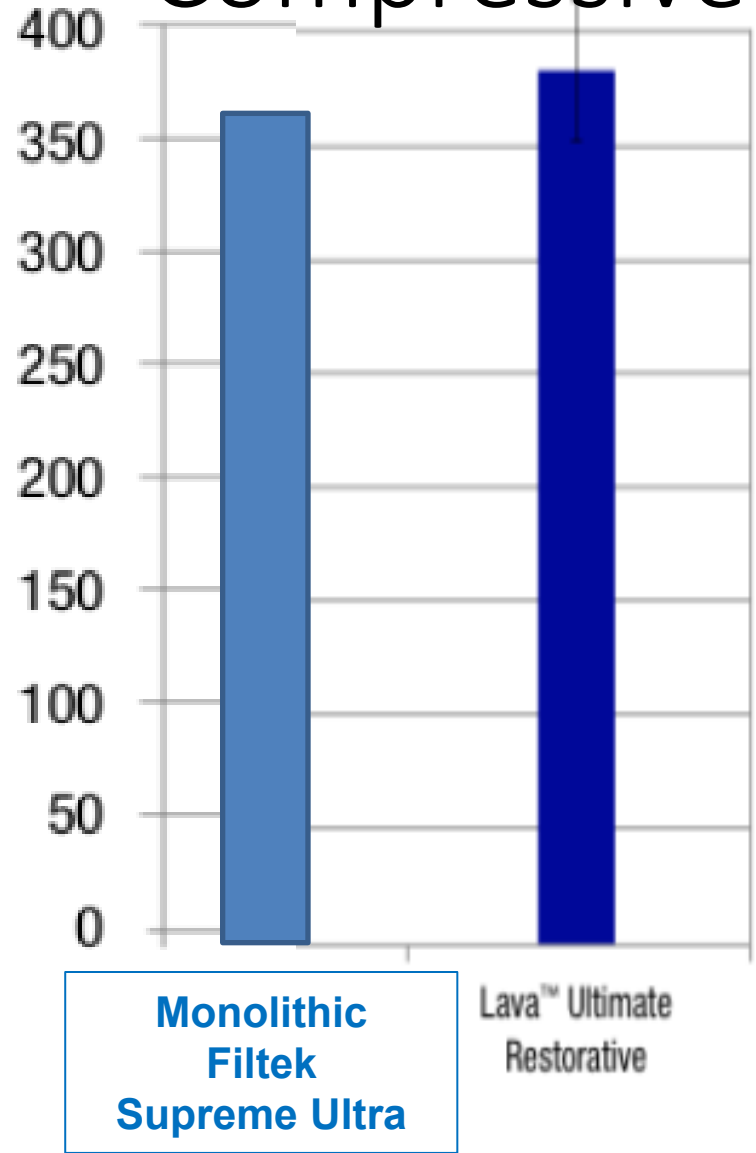


The compressive strength of composite is about 4x the diametral tensile strength.

Tensile



Compressive



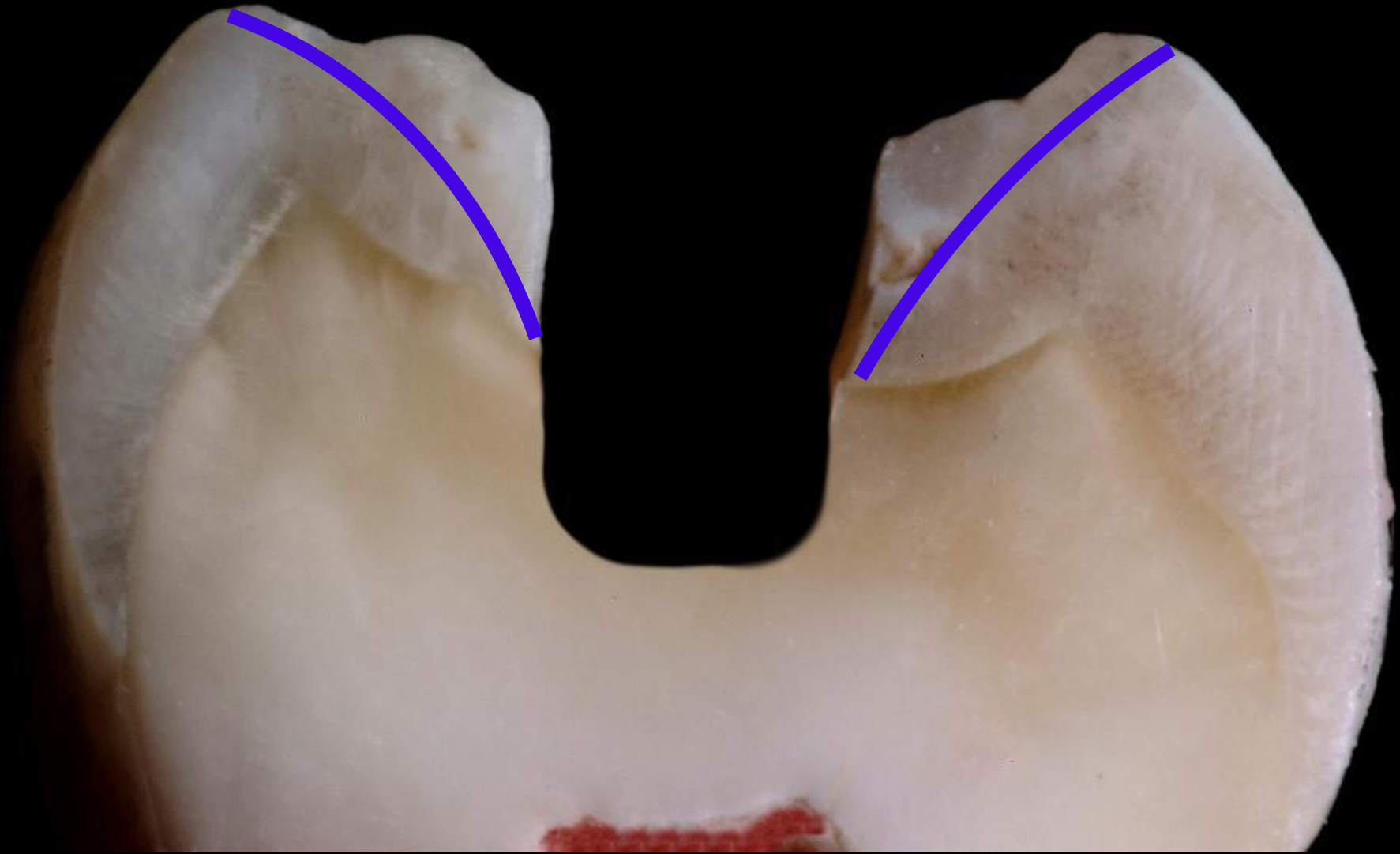
Bioclear Learning Center Guidelines:

- In compression, resin over enamel has no minimum thickness requirement
- In compression, resin over dentin needs at least 2mm thickness
- For Incisal Edges and cusp tips we need 2 mm (occluso gingivally and buccal-lingual)
- All monolithic-no seams or grooves

Calla Lily Prep

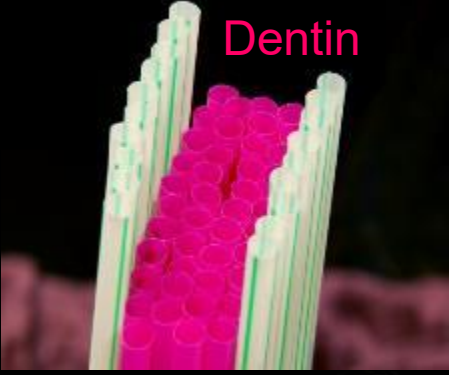
Calla Lily Prep





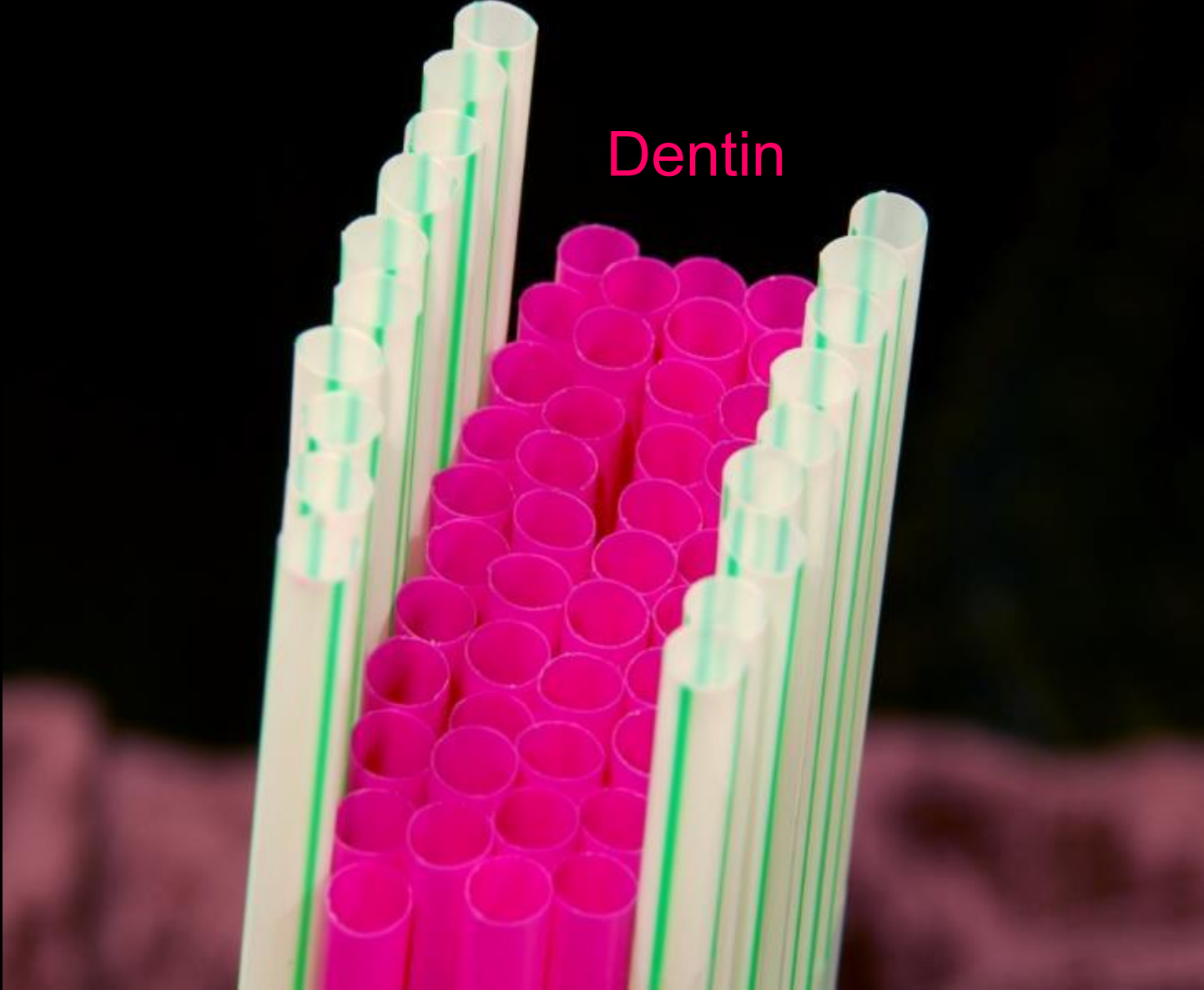
Enamel

Dentin



Enamel

Dentin

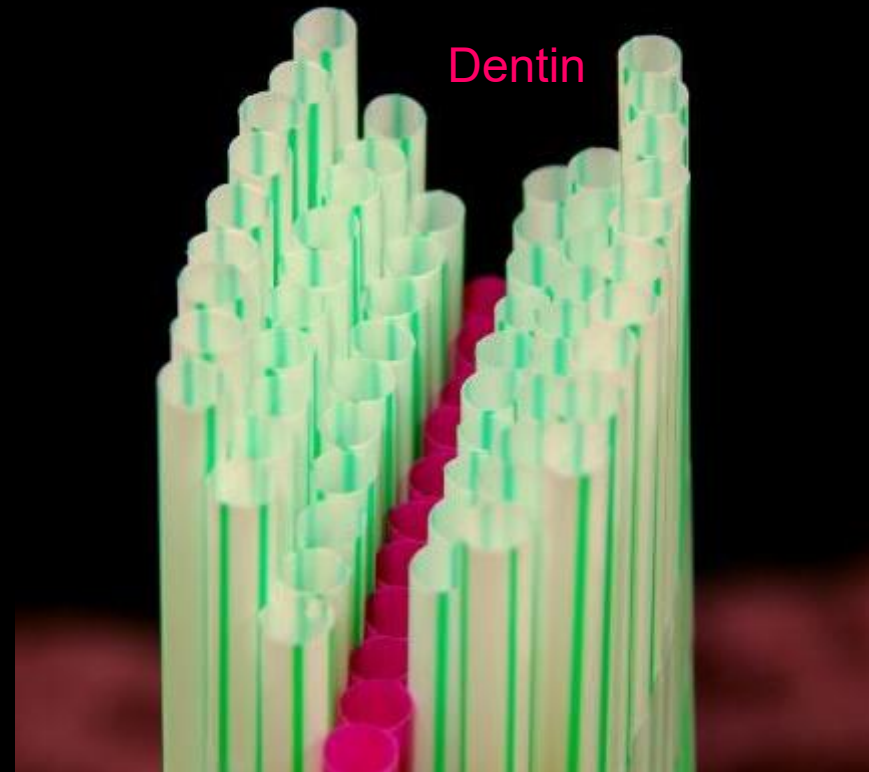


Do you trust enamel bonding or **dentin bonding**?

Enamel

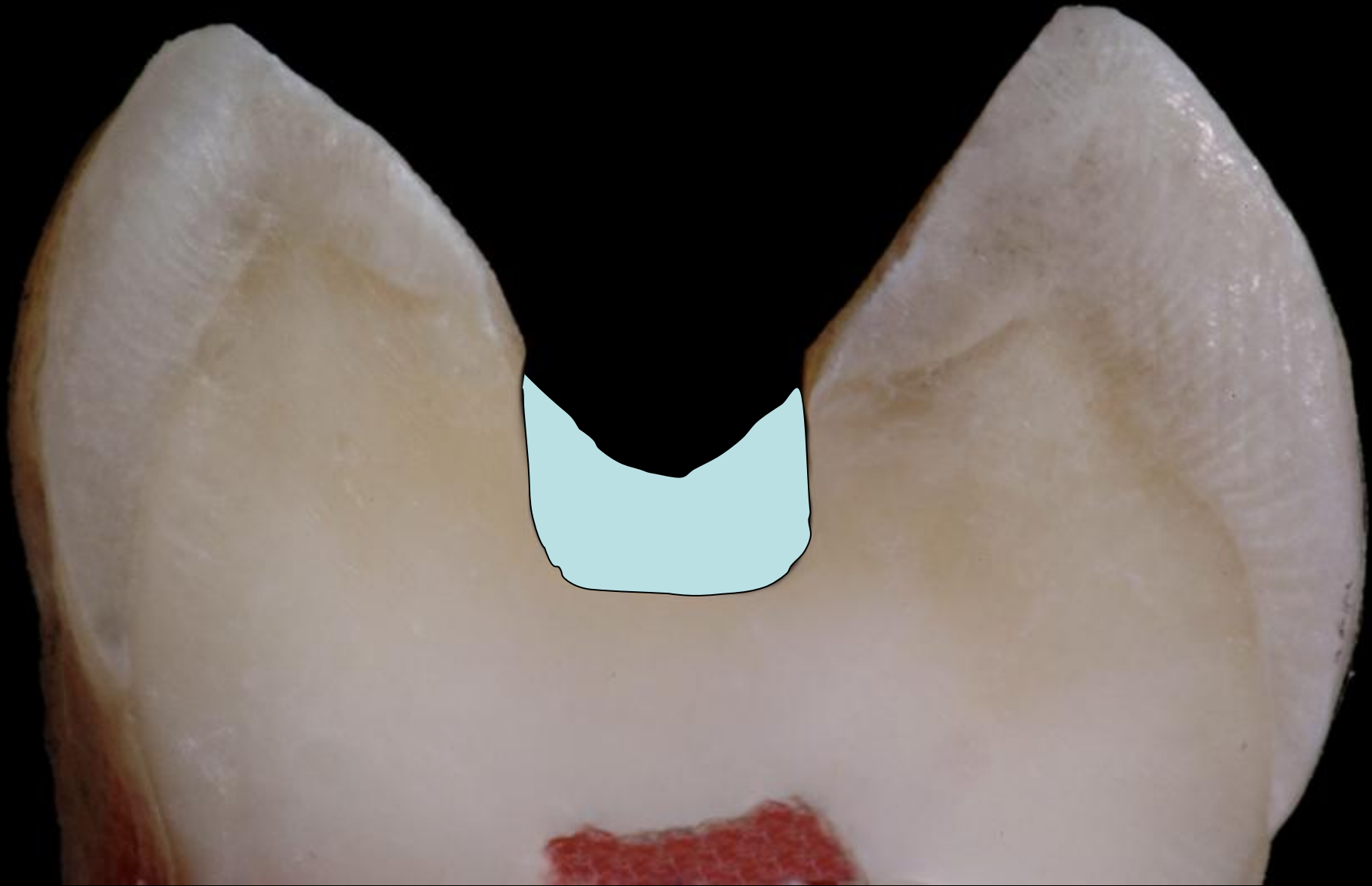


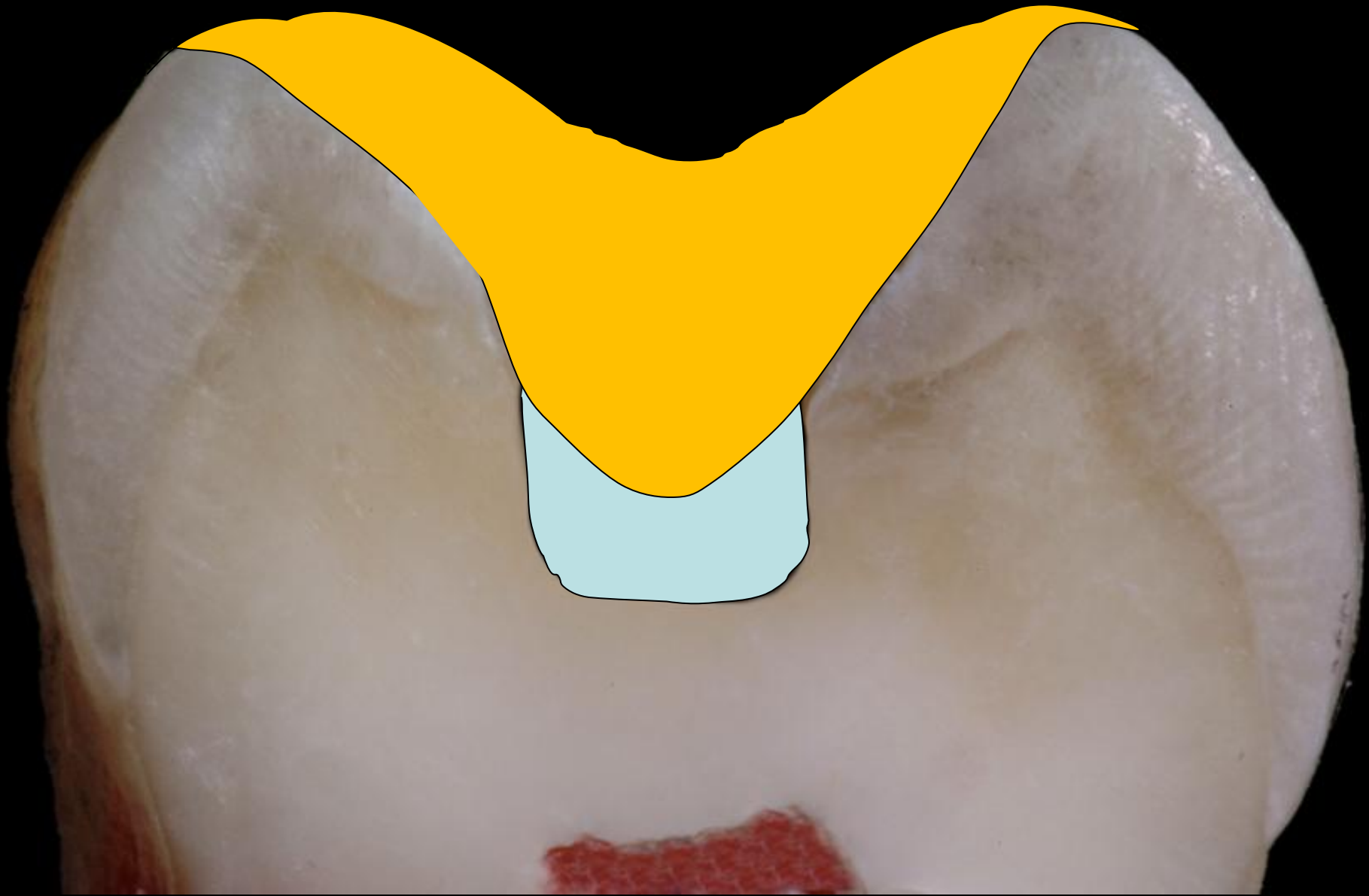
Enamel





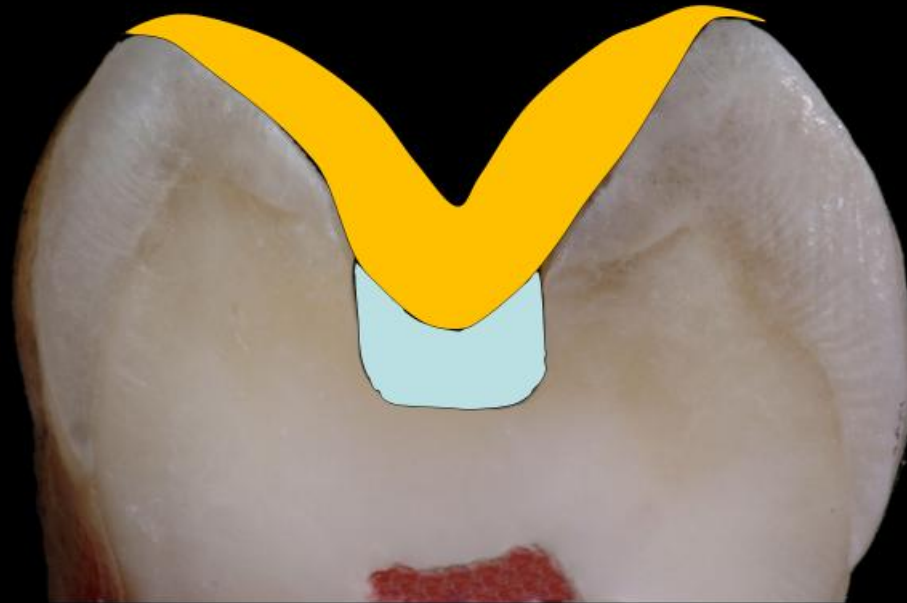








At what point will this tooth go from compression into tension, and vice versa?



Shape Optimization:
As operators we can ***flatten cusps*** or ***fill in the fossae*** (or both).



Enamel vs. resin composite

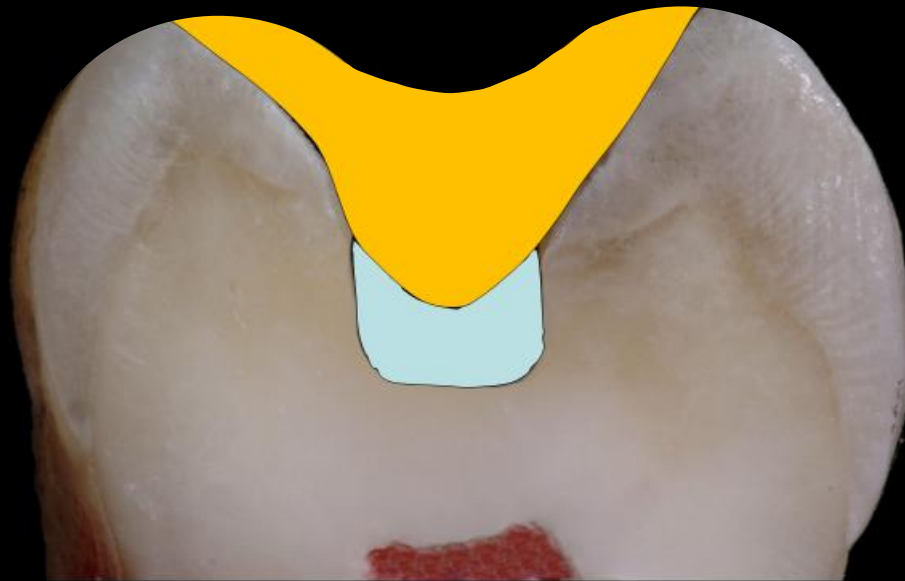


Enamel rods?

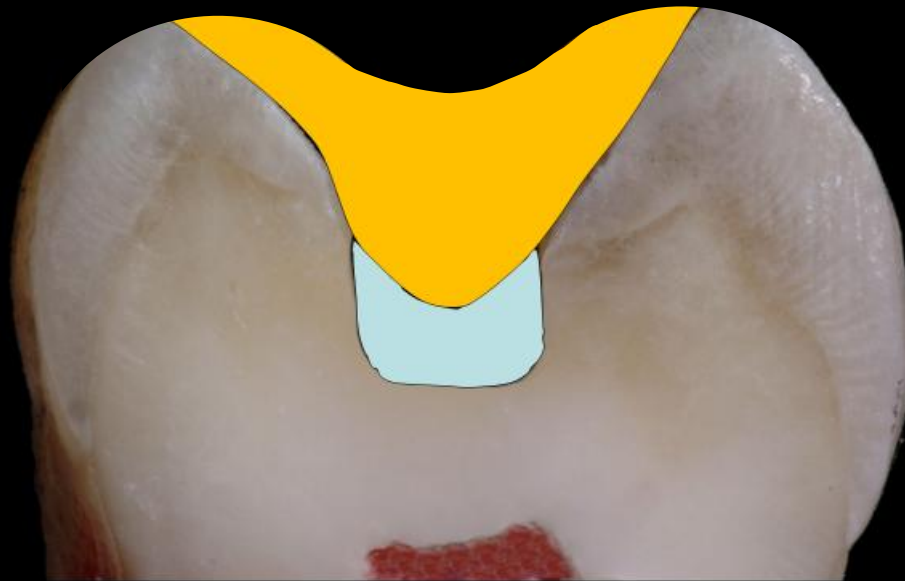
Resin composite



Shape Optimization:
Operators we can *flatten cusps* or *fill in the fossae* (or both).

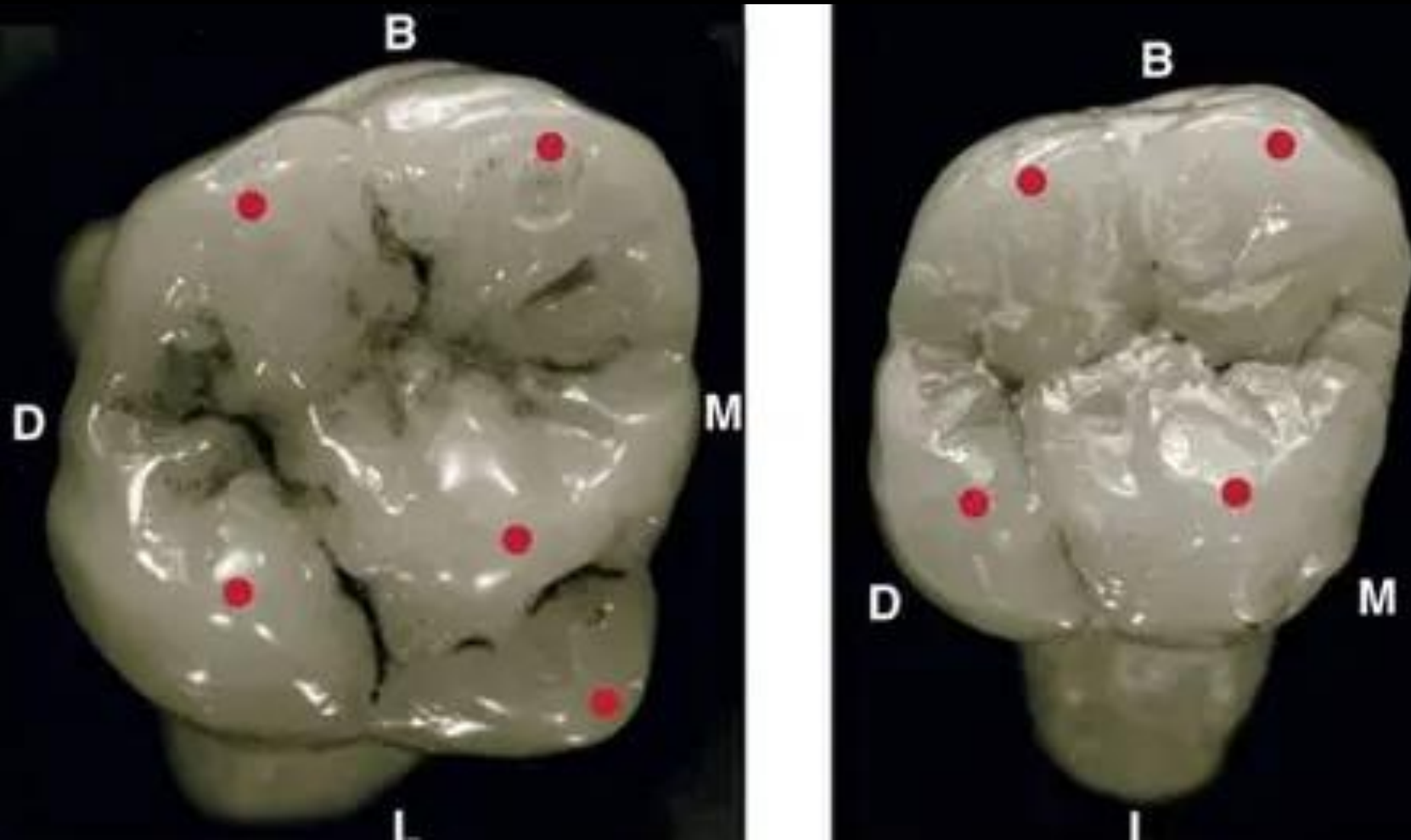


Shape Optimization:
Build a bridge from buccal to lingual

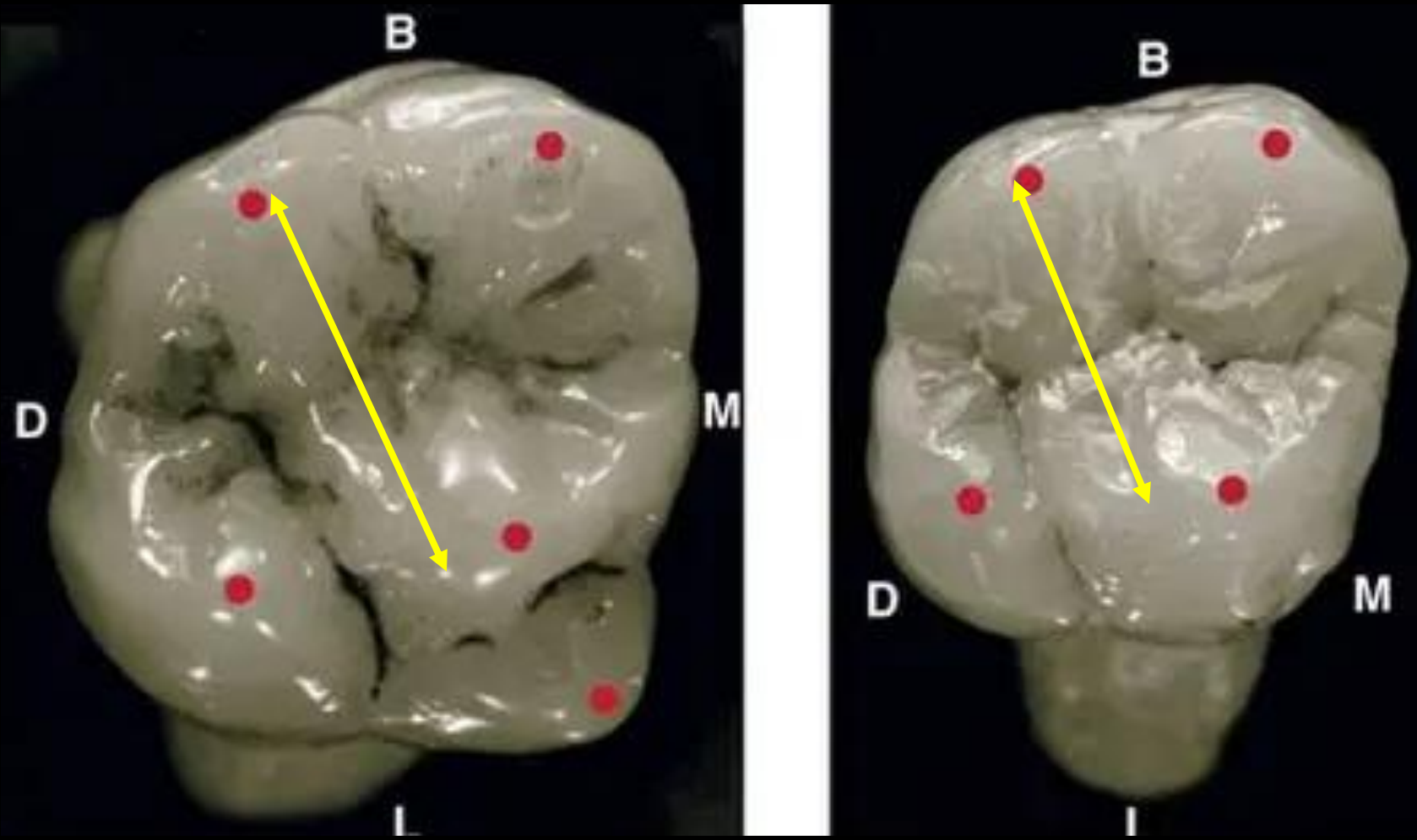


Is there anything illegal or immoral
about the anatomy of a maxillary
first molar?

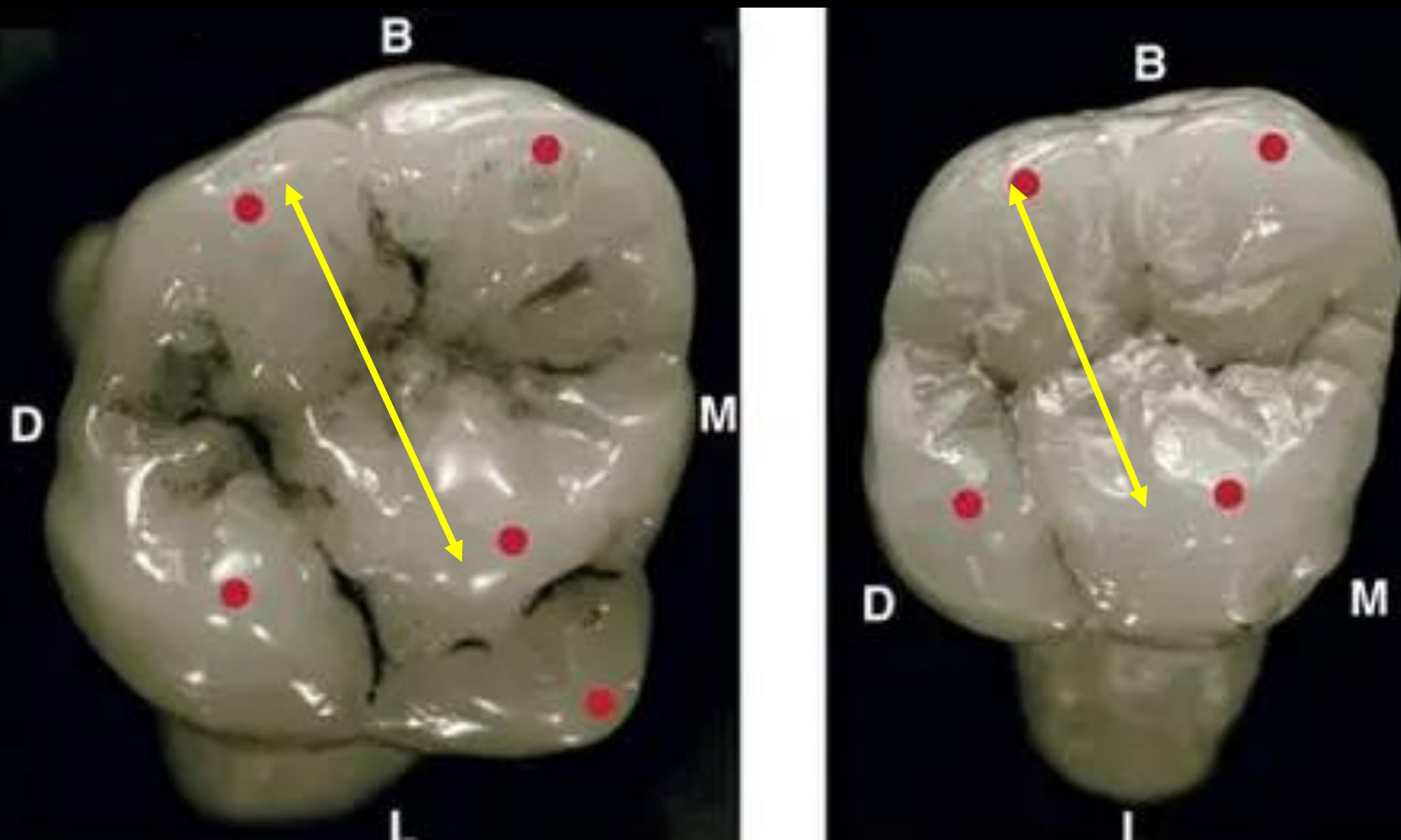
What unique trait does a maxillary first molar possess that protects it from cracking?



The oblique ridge



The oblique bridge



OUCH!!!!!!



Man Copies Nature's Mistake:

Vertical Layering and Deep Continuous Grooves in a Brittle Material (Composite or Ceramic)





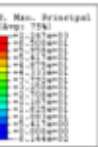




5 year post-op fracture of monolithic zirconia

Stress/Strain Concentration

- Abrupt changes in geometry
- Mismatches in mechanical properties
- Concentrated loads



Symptomatic Cracked Lower Molars: Bioclear Consult (2nd Opinion)

Julia's Seattle dentist has treatment planned her for at least one root canal and crown lower left 1st molar (#31 or 4-6)

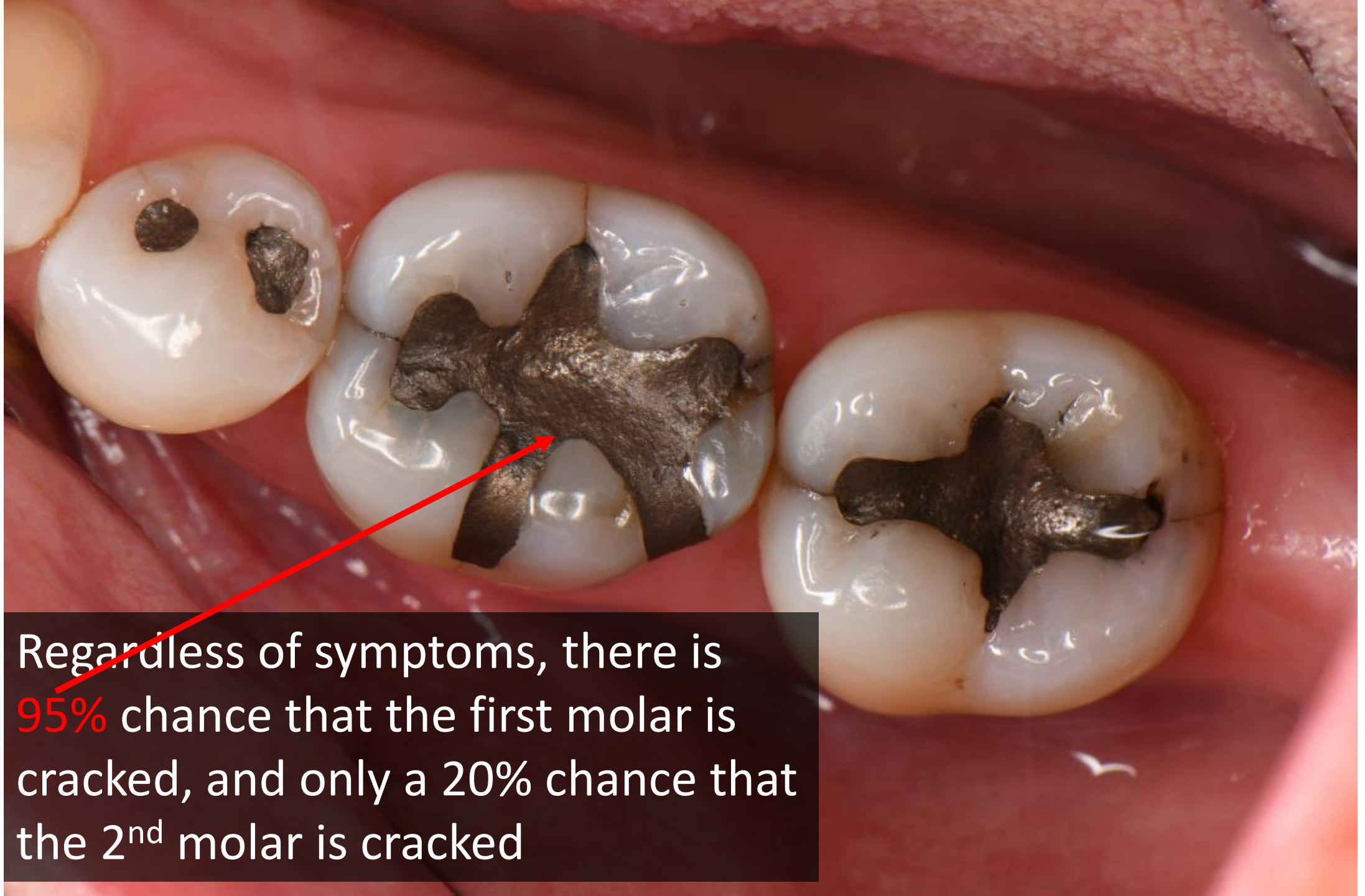
Meet Julia











Regardless of symptoms, there is **95%** chance that the first molar is cracked, and only a 20% chance that the 2nd molar is cracked



Regardless of symptoms, there is **95%** chance that the first molar is cracked, and only a **20%** chance that the 2nd molar is cracked





Julia: The wet cotton roll test **benefits:**

- **Trust:** Patient owns the diagnosis
- **Time:** Patients are often confused about which tooth is the problem, this saves time consuming and trust degrading debate
- **Efficiency and Prevention:** You may find two or more cracked teeth

Julia: The wet cotton roll test:

- For reversible pulpitis (RP) cases
- Irreversible pulpitis (IP) gets the percussion test
- Get one end of the cotton roll wet
- Patient holds on to the dry end
- Start at the canine (a negative control)
- Repeat the full test at least once

Julia: The patient driven wet
cotton roll test

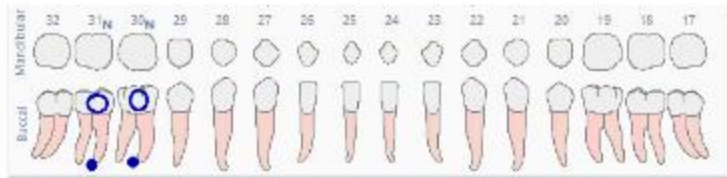


Julia: The wet cotton roll test:

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Patient Name: Julian R.
Treating Doctor: David Clark
TX Date: 10/23/2023

Lower Arch



OPTION A

Existing restorations will be removed to place the Bioclear restoration. Important step to ensure monolithic color unity and strength to the Bioclear restoration.

- **Disassembly**

- Tooth # 30 \$150
- Tooth # 31 \$150

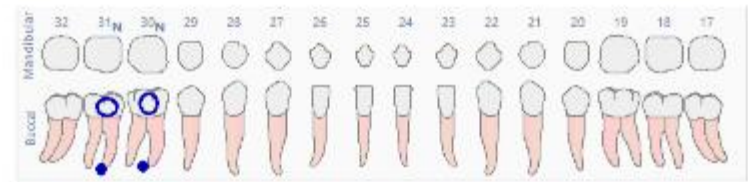
Posterior Overlay: Replace existing failing restorations, cracked tooth, rejuvenation of tooth appearance and color.

- **Bioclear Posterior Overlay**

- Tooth # 30 \$836
- Tooth # 31 \$836

Patient Name: Julian R.
Treating Doctor: David Clark
TX Date: 10/23/2023

Lower Arch



OPTION A

Existing restorations will be removed to place the Bioclear restoration. Important step to ensure monolithic color unity and strength to the Bioclear restoration.

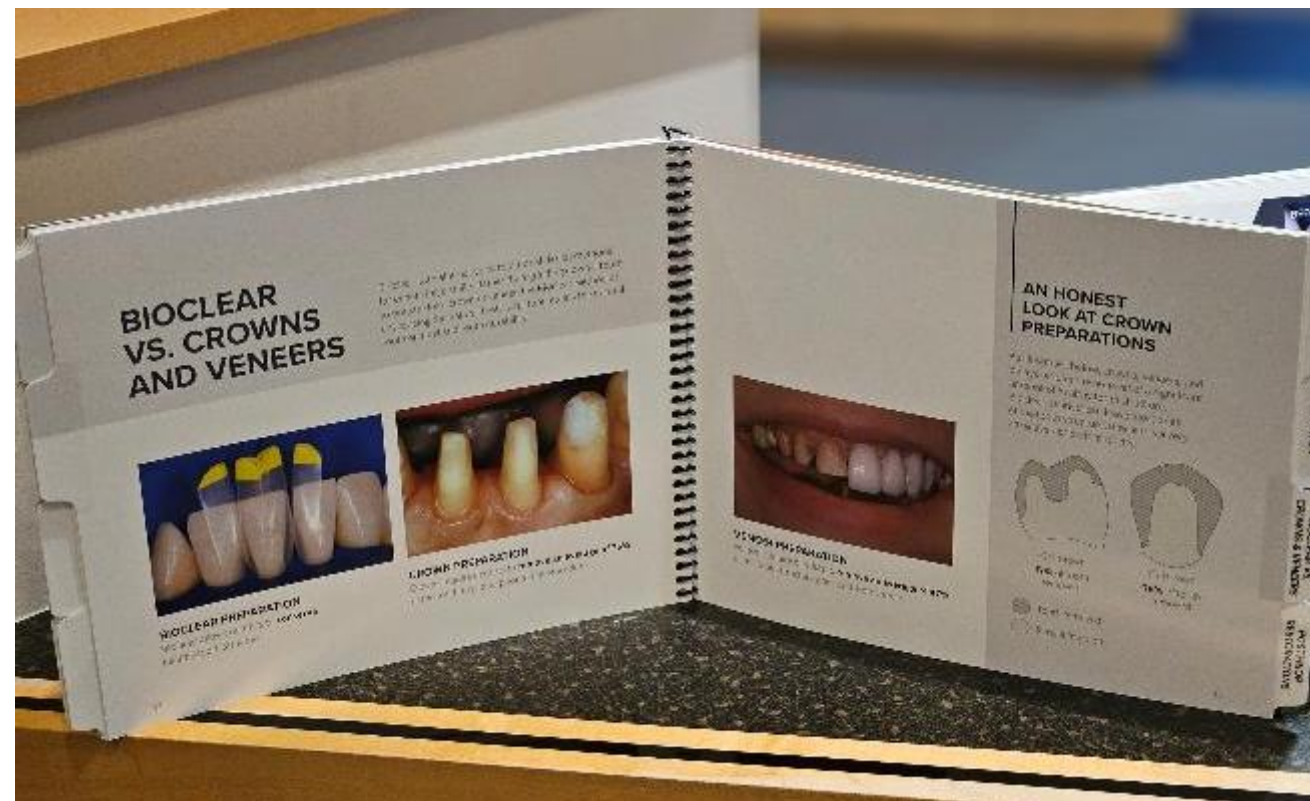
- **Disassembly**

- Tooth # 30 \$150
- Tooth # 31 \$150

Posterior Overlay: Replace existing failing restorations, cracked tooth, rejuvenation of tooth appearance and color.

- **Bioclear Complex Posterior Overlay**

- Tooth # 30 \$1,200
- Tooth # 31 \$1,200



We show her the patient book and cracked teeth pamphlet. Go straight to page 42. Then she chooses a crown or Bioclear. She will get a little insurance coverage for Bioclear. (We are PPO)

Getting paid to be conservative

BIOCLEAR VS. CROWNS AND VENEERS

Bioclear is an alternative to traditional dental methods for enhancing a smile. Rather than grinding down a tooth to prepare for a crown or veneer, the Bioclear Method of encasing the natural tooth structure retains the natural tooth enamel and tooth durability.



BIOCLEAR PREPARATION

Bioclear allows dentists to **conserve** healthy tooth structure



CROWN PREPARATION

Crowns require dentists to **remove an average of 76%** of the tooth structure prior to the procedure



AN HONEST LOOK AT CROWN PREPARATIONS

As Bioclear is a conservative method, it preserves the natural structure of the tooth. Bioclear only removes a small amount of tooth structure.

VENEER PREPARATION
Dentists use Bioclear to remove an average of 4% of the tooth structure prior to the procedure.

Preparation Method	Percentage of Tooth Structure Removed
All Crowns	76% of tooth structure
Full Crowns	76% of tooth structure

Legend:
● work crown
○ grinding tooth



Julia's overlay treatment images





































Time to *harmonize* the occlusion





Before Harmonizing

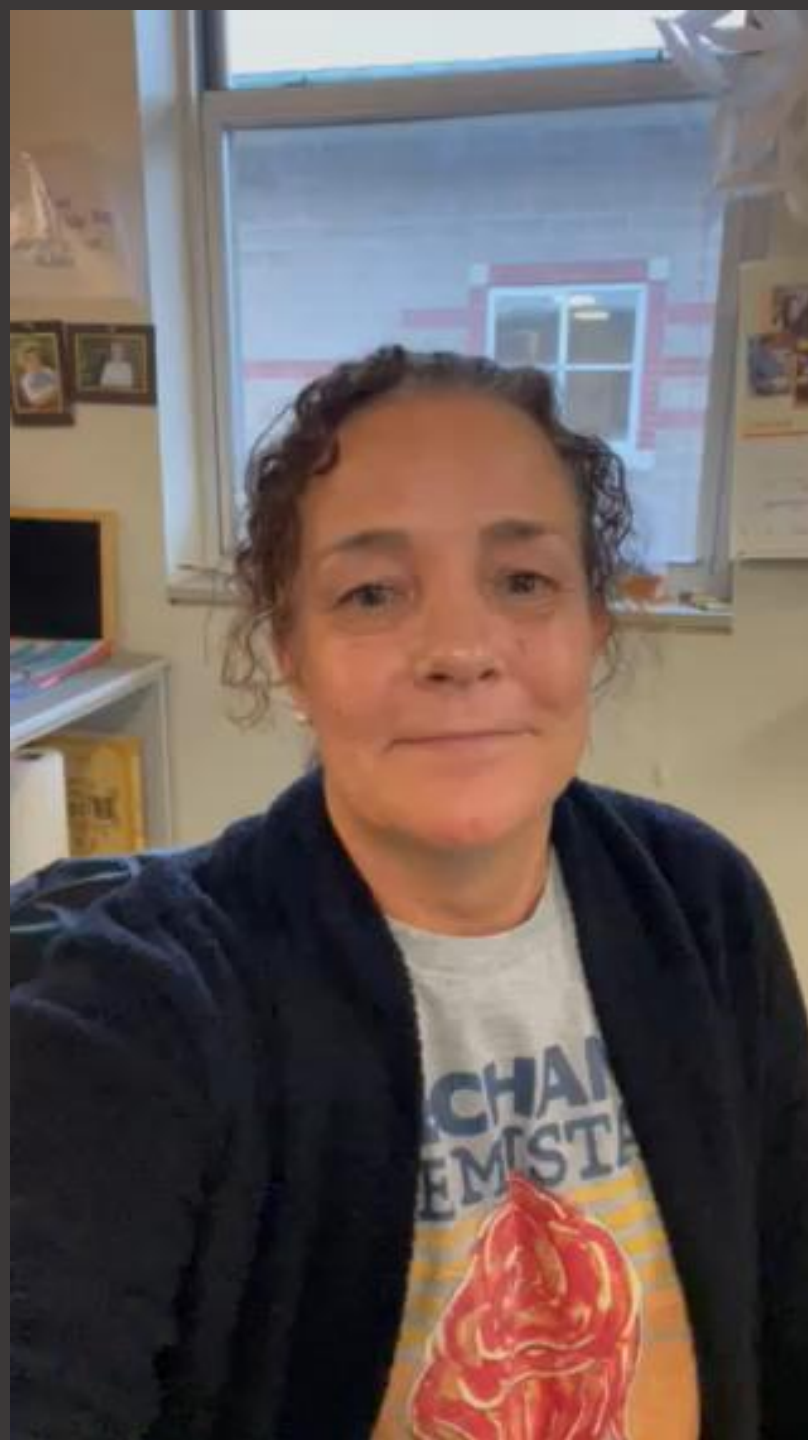


After Harmonizing

Remember that composite absorbs 1% of its volume in water in 24 hours, so you need HYPO OCCLUSION on composite



6 week
follow up



2.5 year follow up



Pre-op



What are the **modern occlusal** cavity preps?

1. Fissurotomy
2. Calla Lily
3. Flattened Calla Lily
4. Cuspal Overlay

What are the modern Interproximal cavity preps?

1. Opportunistic Class II
2. Clark Class II...double serpentine,
additive and compression based
3. Clark Class II plus Lateral Partial
Cuspal Overlay













Pre-op



1 year follow up



1 year follow up



2 year follow up



7 year follow up



9 year follow up



9 year follow up



12 year follow up



Pre-op



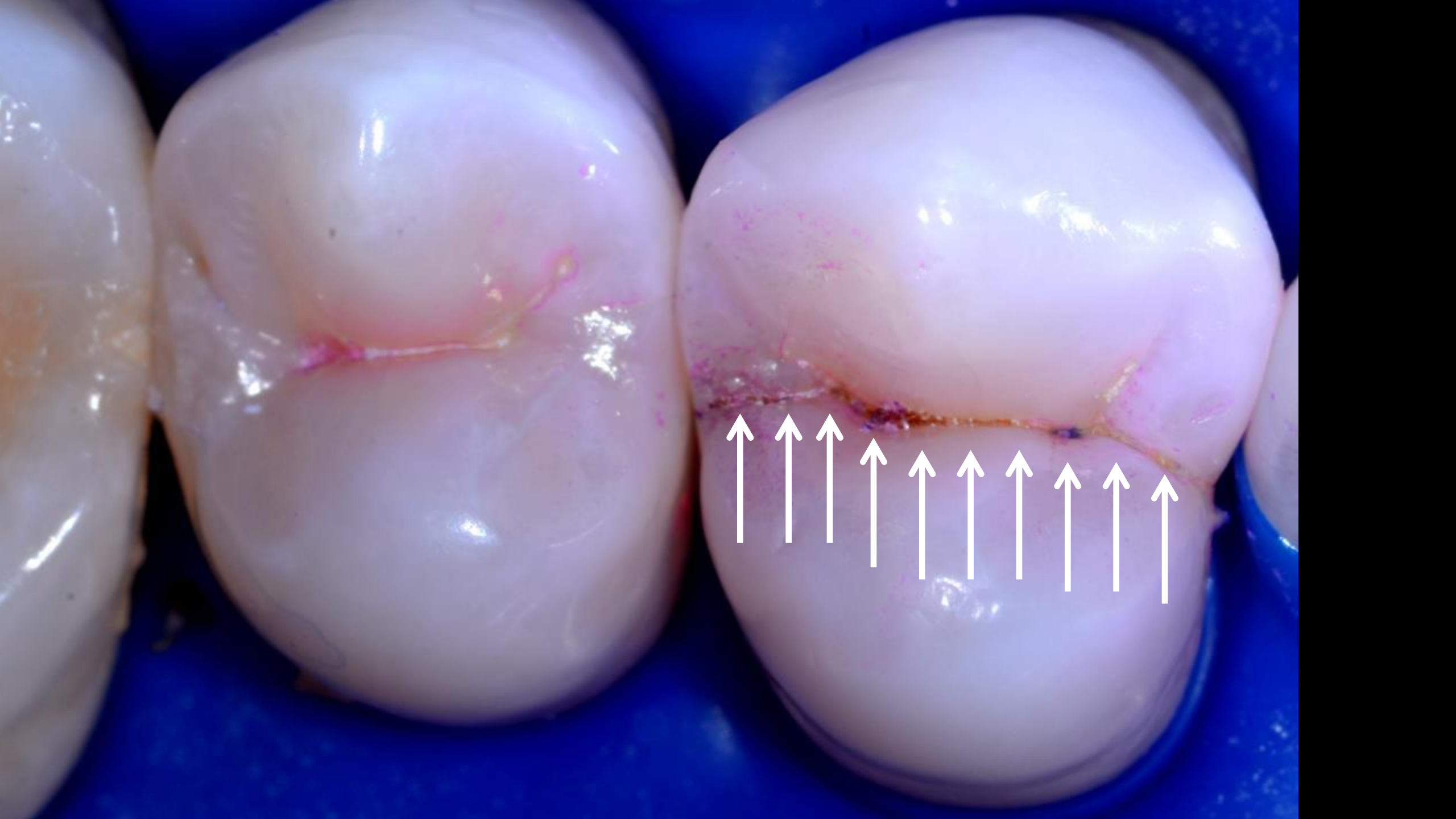
12 year follow up



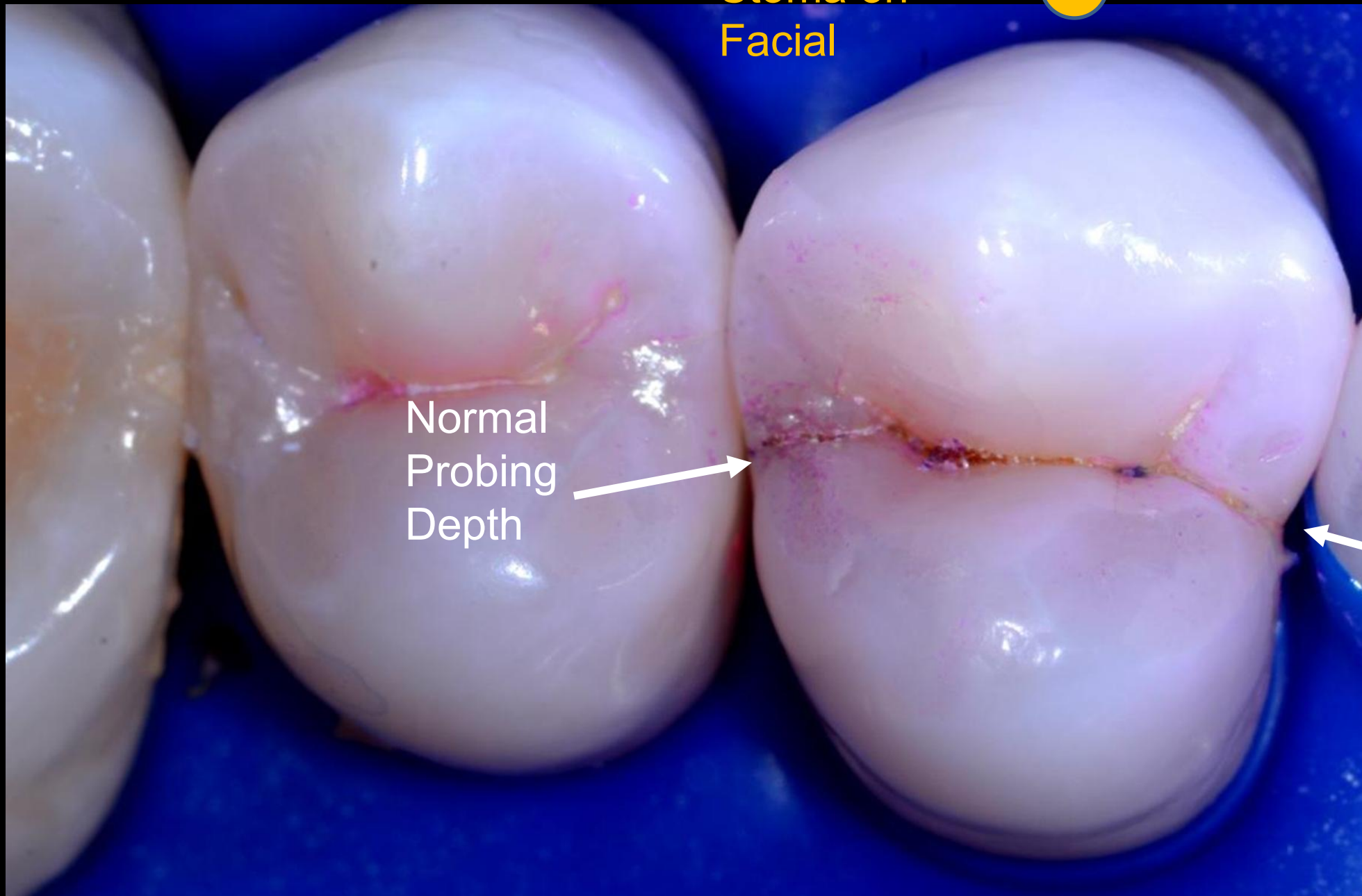
An Extreme Calla Lily Clinical Case

Patient heard a loud *snap* when he bit on a seed and now has severe cold and percussion pain





Stoma on Facial

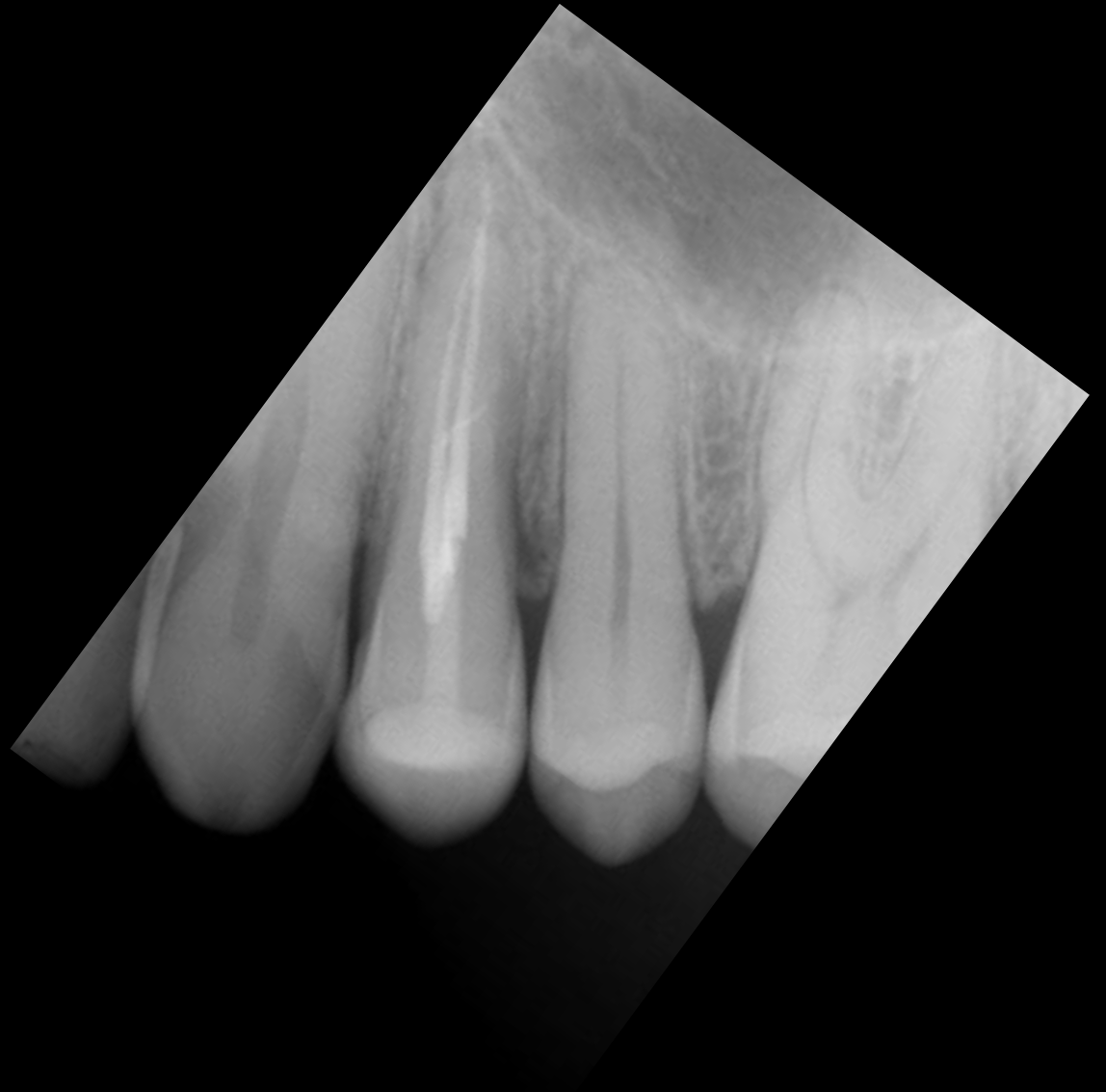


Normal Probing Depth



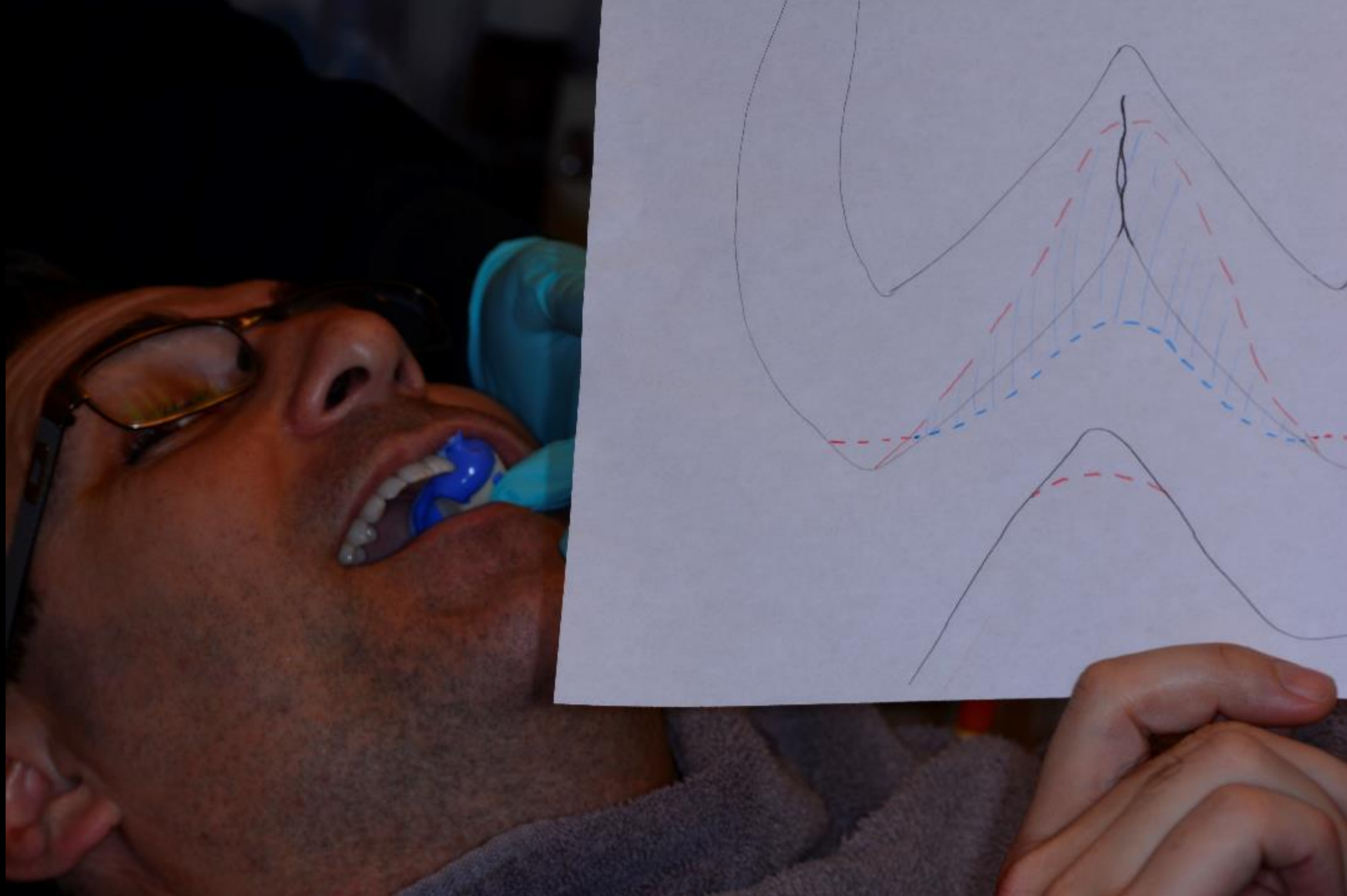
Normal Probing Depth











18 month follow up









“Build a bridge from buccal to lingual, and the crack(s) becomes dormant.”



Before



Before

“That’s it”



DR. ALEX FOK



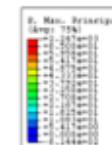
“David that’s not going to work, do a crown.”



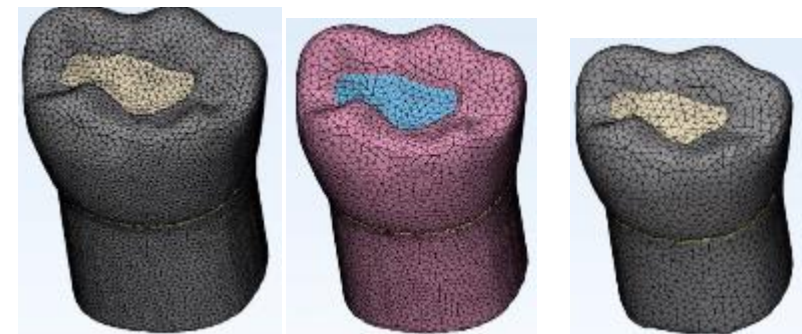
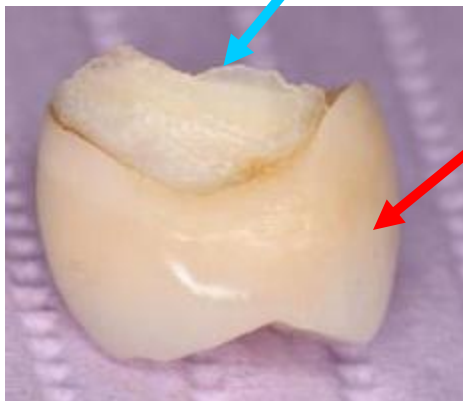
7 years post-op

Stress/Strain Concentration

- Abrupt changes in geometry
- Mismatches in mechanical properties
- Concentrated loads



	Elastic Modulus (GPa)	Poisson's Ratio	Effective Shrinkage Strain*
Composite	10	0.3	0.34%
Dentin	18	0.2	NA
Enamel	48-80	0.23	NA
Gold	79		
Zirconia	200		



[1] Alex SL Fok, Dent Mater, 2013

- Why things break...
- Modern cavity preparations
- Injection Molding of composite
- FEA of both load and shrinkage
- Long term outcomes & case studies
- The Bioclear Method as a “3rd option”

■ When to do endo, when to extract

- Why things break...
- Modern cavity preparations
- Injection Molding of composite
- FEA of both load and shrinkage
- Long term outcomes & case studies
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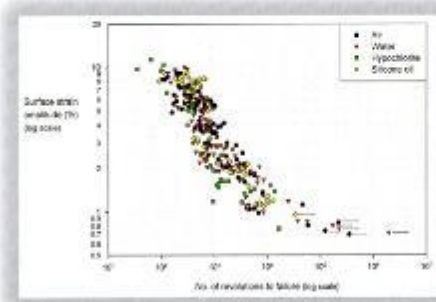
■ When to do endo, when to extract

JOE

Journal of Endodontics

December 2007 Volume 33, Number 12

Dec
2007



Effect of Environment on Cyclic Fatigue
Page 1433

Clinical page 1405

Association of Pulpitis in a Cohort of 796 Cracked Teeth

Basic page 1430

Initial Evaluation of Ceramicrete as a Potential Root End Filling Material

Case Report page 1484

Nerve Damage Associated with Overextended Obturating Material



Official Journal of the American Association of Endodontists

A Six Year Evaluation of Cracked Teeth Diagnosed with Reversible Pulpitis: Treatment and Prognosis

Keith V. Krell, DDS, MS, MA,* and Eric M. Rivera, DDS, MS†

Abstract

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Key Words

Cracked teeth, reversible pulpitis

From the *Department of Endodontics, College of Dentistry, University of Iowa, Iowa City, Iowa; and †Department of Endodontics, School of Dentistry, University of North Carolina, Chapel Hill, North Carolina.

Address requests for reprints to Keith V. Krell, DDS, MS, MA, 1450 28th St, West Des Moines, IA 50266. E-mail address: krekth@iwoi.com.

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Dec 2007



A Six Year Evaluation of Cracked Teeth Diagnosed with Reversible Pulpitis: Treatment and Prognosis

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6 year
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Address requests for reprints to Keith V. Krell, DDS, MS, MA, 1450 Hawkins Drive, Denton, TX 76205. E-mail address: krellk@uioa.edu
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127 teeth
with R.P.
were
restored
with crowns
and NO
ENDO

TABLE 1. The Number and Percentage of Cracked Teeth by Tooth Position in the Mouth

	Maxillary Second Molar	Maxillary First Molar	Maxillary Second Premolar	Maxillary First Premolar	Mandibular Second Molar	Mandibular First Molar	Mandibular Second Premolar	Mandibular First Premolar	Totals
Cracked	71	167	46	25	243	231	12	1	796
Total	835	1879	754	549	1380	2100	456	222	8175
%	8.50	8.89	6.10	4.55	17.61	11.00	2.63	0.45	9.74

Materials and Methods

There were 8175 patients included in this study from a private endodontic practice population during a 6-year period. The patients were recorded consecutively as they were referred to the endodontist for evaluation and appropriate treatment during the 6-year period. Besides the standard medical history and subjective history, the endodontist was responsible for the diagnosis of all teeth and recorded the following information for all teeth:

- (1) Pulpal response to cold or hot.
- (2) Periapical response to pressure, palpation, and percussion.
- (3) Buccal and lingual periodontal probeings were recorded in the mesial and distal interproximal spaces and furca. These interproximal probeings would be directed precisely where marginal ridge cracks were identified to indicate the deepest probing of the crack. A total of 6 probing points were recorded for each tooth.
- (4) Identification of a crack(s) with direct transillumination and visualization with and without magnification. The identified crack had to block light transmission and show a definite shadow with both the buccal and lingual coronal light placement. Teeth not exhibiting a shadow were considered to have "crazings" and were not included in this study.
- (5) Responses to biting on various cusps of the diagnosed tooth, with at least 1 cusp exhibiting pain to biting on either a burlew wheel or Tooth Slooth (Professional Results, Inc, Laguna Hills, Calif).

Teeth were diagnosed with RP if (1) there was no history of spontaneous pain; (2) the response to cold went away in less than 3–5 seconds; (3) there was no radiographic pathology.

No teeth were included in this part of the study that could not be confirmed by visualization as having an identifiable crack even if biting sensitivity was present. Restorations were removed only for patients with pulpal diagnoses that required root canal treatment. Teeth diagnosed as cusp fractures, split teeth, and vertical root fractures were also excluded from this study (6). All patients were recalled at 1 year unless root canal treatment was needed before the anniversary, then recall was 1 year later after treatment. The recall therefore extended into a seventh year of the data collection.

All cases were treatment planned according to the pulpal and periapical diagnosis. Cases with RP were treatment planned for crowns only, regardless of periapical diagnosis.

TABLE 2. The Number and Percentage of Cracked Teeth by Tooth Position with RP Eventually Requiring Root Canal Treatment

	Maxillary Second Molar	Maxillary First Molar	Maxillary Second Premolar	Maxillary First Premolar	Mandibular Second Molar	Mandibular First Molar	Mandibular Second Premolar	Mandibular First Premolar	Totals
Cracked	12	33	8	4	29	41	0	0	127
REV. > IP or NEC.	3	9	0	0	8	7	0	0	27
%	25	27	0	0	28	17	0	0	21

REV, reversible pulpitis; IP, irreversible pulpitis; NEC, necrosis.

Results

Of the 8175 cases seen during the 6-year period, 796 cases were diagnosed as cracked teeth (9.7%). Mandibular second molars (243/796, 30%) had the largest incidence followed by mandibular first molars (231/796, 29%) and maxillary first molars (167/796, 21%). All teeth are included in Table 1.

Cases with RP had the following distribution: mandibular first molars (41/127, 32%), maxillary first molars (33/127, 25%), and mandibular second molars (29/127, 23%). All teeth are included in Table 2.

Of 127 patients specifically diagnosed with RP, 27 converted to irreversible pulpitis (N = 21) in 58 days or to necrotic pulp (N = 6) in 149 days. The distribution of teeth requiring root canal therapy was as follows: maxillary first molars (9/27, 33%), mandibular second molars (8/27, 29%), mandibular first molars (7/27, 26%), and maxillary second molars (3/27, 11%).

All teeth had initial interproximal probeings less than 3 mm in the space associated with the identified crack. Increased interproximal probeings were associated with the fractured marginal ridge for only 5 of the 27 teeth requiring root canal treatment. The greatest increase in probing depth was 2 mm for 2 of 5 teeth.

The teeth requiring root canal treatment had the crack located on the distal marginal ridge in 15 of the 27 cases (56%). The distribution was mandibular second molars (6/27, 27%), mandibular first molars (3/27, 11%), maxillary first molars (3/27, 11%), maxillary second premolars (2/27, 7%), and maxillary second molars (1/27, 4%). The crack was located only on the mesial marginal ridge in 4 of the 27 cases (15%). The distribution was the maxillary first molars (3/27, 11%) and maxillary first premolars (1/27, 4%). Both marginal ridges were involved in 8 of the 27 cases (29%). The distribution was mandibular first molars (5/27, 19%), maxillary first molars (2/27, 7%), and maxillary second molars (1/27, 4%). None of the teeth had fractures that extended into the floor of the chamber or rendered them "non-restorable".

None of the original remaining 100 cases of RP required root canal treatment.

Discussion

The patients who composed this database were all patients referred to a private practice endodontist. Our incidence data are in agreement with the findings of Weine et al (5), which were also derived from an endodontist's practice. The difference in percentages from

What are the 5 questions you ask to distinguish R.P. ?



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871	Editorial
873	Editorial
875	Editorial
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993	Editorial
995	Editorial
997	Editorial
999	Editorial



1) Is the pain spontaneous?

Discussion

Table 1. Mean values of the variables measured in the study.

Variable	Mean	SD	Min	Max
Age (years)	23.5	2.1	18	28
Gender (male/female)	12/10			
Height (cm)	175.2	6.5	165	185
Weight (kg)	68.5	12.3	55	85
Temperature (°C)	36.5	0.2	36.1	36.9
Heart rate (b/min)	72	10	60	85
Respiration rate (b/min)	14	3	10	18
SpO ₂ (%)	98	1	97	99
ECG (normal/abnormal)	15/0			
ECG (sinus/other)	15/0			
ECG (normal/abnormal)	15/0			
ECG (sinus/other)	15/0			



2) Does the pain to cold and biting linger? (past 5 seconds)

3) Has the pain ever woken
you?

4) Lingering pain to heat?

Table 1 (continued) **Table 1** (continued)

Year	Volume	Issue	Pages	Articles	Reviews	Notes	Index
1998	36	1	1-100	10	10	10	10
1998	36	2	101-200	10	10	10	10
1998	36	3	201-300	10	10	10	10
1998	36	4	301-400	10	10	10	10
1998	36	5	401-500	10	10	10	10
1998	36	6	501-600	10	10	10	10
1998	36	7	601-700	10	10	10	10
1998	36	8	701-800	10	10	10	10
1998	36	9	801-900	10	10	10	10
1998	36	10	901-1000	10	10	10	10



5) Is there “radiographic pathosis”? (Krell’s lexicon)

TABLE 1. The Number and Percentage of Cracked Teeth by Tooth Position in the Mouth

	Maxillary Second Molar	Maxillary First Molar	Maxillary Second Premolar	Maxillary First Premolar	Mandibular Second Molar	Mandibular First Molar	Mandibular Second Premolar	Mandibular First Premolar	Totals
Cracked	71	167	46	25	243	231	12	1	796
Total	835	1879	754	549	1380	2100	456	222	8175
%	8.50	8.89	6.10	4.55	17.61	11.00	2.63	0.45	9.74

Materials and Methods

There were 8175 patients included in this study from a private endodontic practice population during a 6-year period. The patients were recorded consecutively as they were referred to the endodontist for evaluation and appropriate treatment during the 6-year period. Besides the standard medical history and subjective history, the endodontist was responsible for the diagnosis of all teeth and recorded the following information for all teeth:

- (1) Pulpal response to cold or hot.
- (2) Periapical response to pressure, palpation, and percussion.
- (3) Buccal and lingual periodontal probing were recorded in the mesial and distal interproximal spaces and furca. These interproximal probing would be directed precisely where marginal ridge cracks were identified to indicate the deepest probing of the crack. A total of 6 probing points were recorded for each tooth.
- (4) Identification of a crack(s) with direct transillumination and visualization with and without magnification. The identified crack had to block light transmission and show a definite shadow with both the buccal and lingual coronal light placement. Teeth not exhibiting a shadow were considered to have "crazings" and were not included in this study.
- (5) Responses to biting on various cusps of the diagnosed tooth, with at least 1 cusp exhibiting pain to biting on either a burlew wheel or Tooth Slooth (Professional Results, Inc, Laguna Niguel, CA).

Teeth were diagnosed with RP if (1) there was no history of spontaneous pain; (2) the response to cold went away in less than 3–5 seconds; (3) there was no radiographic pathology.

No teeth were included in this part of the study that could not be confirmed by visualization as having an identifiable crack even if biting sensitivity was present. Restorations were removed only for patients with pulpal diagnoses that required root canal treatment. Teeth diagnosed as cusp fractures, split teeth, and vertical root fractures were also excluded from this study (6). All patients were recalled at 1 year unless root canal treatment was needed before the anniversary, then recall was 1 year later after treatment. The recall therefore extended into a seventh year of the data collection.

All cases were treatment planned according to the pulpal and periapical diagnosis. Cases with RP were treatment planned for crowns only, regardless of periapical diagnosis.

TABLE 2. The Number and Percentage of Cracked Teeth by Tooth Position with RP Eventually Requiring Root Canal Treatment

	Maxillary Second Molar	Maxillary First Molar	Maxillary Second Premolar	Maxillary First Premolar	Mandibular Second Molar	Mandibular First Molar	Mandibular Second Premolar	Mandibular First Premolar	Totals
Cracked	12	33	8	4	29	41	0	0	127
REV. >IP or NEC.	3	9	0	0	8	7	0	0	27
%	25	27	0	0	28	17	0	0	21

REV, reversible pulpitis; IP, irreversible pulpitis; NEC, necrosis.

Results

Of the 8175 cases seen during the 6-year period, 796 cases were diagnosed as cracked teeth (9.7%). Mandibular second molars (243/796, 30%) had the largest incidence followed by mandibular first molars (231/796, 29%) and maxillary first molars (167/796, 21%). All teeth are included in Table 1.

Cases with RP had the following distribution: mandibular first molars (41/127, 32%), maxillary first molars (33/127, 25%), and mandibular second molars (29/127, 23%). All teeth are included in Table 2.

Of 127 patients specifically diagnosed with RP, 27 converted to irreversible pulpitis (N = 21) in 58 days or to necrotic pulp (N = 6) in 149 days. The distribution of teeth requiring root canal therapy was as follows: maxillary first molars (9/27, 33%), mandibular second molars (8/27, 29%), mandibular first molars (7/27, 26%), and maxillary second molars (3/27, 11%).

All teeth had initial interproximal probing less than 3 mm in the space associated with the identified crack. Increased interproximal probing were associated with the fractured marginal ridge for only 5 of the 27 teeth requiring root canal treatment. The greatest increase in probing depth was 2 mm for 2 of 5 teeth.

The teeth requiring root canal treatment had the crack located on the distal marginal ridge in 15 of the 27 cases (56%). The distribution was mandibular second molars (6/27, 27%), mandibular first molars (3/27, 11%), maxillary first molars (3/27, 11%), maxillary second premolars (2/27, 7%), and maxillary second molars (1/27, 4%). The crack was located only on the mesial marginal ridge in 4 of the 27 cases (15%). The distribution was the maxillary first molars (3/27, 11%) and maxillary first premolars (1/27, 4%). Both marginal ridges were involved in 8 of the 27 cases (29%). The distribution was mandibular first molars (5/27, 19%), maxillary first molars (2/27, 7%), and maxillary second molars (1/27, 4%). None of the teeth had fractures that extended into the floor of the chamber or rendered them "non-restorable".

None of the original remaining 100 cases of RP required root canal treatment.

Discussion

The patients who composed this database were all patients referred to a private practice endodontist. Our incidence data are in agreement with the findings of Weine et al (5), which were also derived from an endodontist's practice. The difference in percentages from

How many pulps eventually died?



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The patients who composed this database were all patients referred to a private practice endodontist. Our incidence data are in agreement with the findings of Weine et al (5), which were also derived from an endodontist's practice. The difference in percentages from

How many pulps eventually died? 20%



other studies might be largely due to the nature of general dental populations versus an endodontic specialty population. Hiat (5) and Cameron (4) reported maxillary premolars having the second highest incidence of cracks, which represents a periodontist and general dental practice. Therefore, this study's population might be under-represented with respect to premolars and the actual incidence of cracked teeth in the population at large.

This study found that 21% of the cases diagnosed with RP and a crack eventually required root canal treatment. Although no other studies have reported this finding, there have been studies examining the necessity for root canal treatment on teeth restored with crowns. Saunders and Saunders (7) reported that 19% of crowned teeth in a Scottish dental school population had root canal treatment after crown placement. This study was unable to report whether cracks were present before the crown was placed.

Cheung et al (8) found that 15% (19/122) of teeth restored with a ceramo-metallic crown required root canal treatment after crown placement in a population in Asia. They also found that of those serving as an abutment of a fixed-fixed bridge (25/77), 32% required root canal treatment after final cementation of the bridge.

Although the populations in these 2 studies are quite diverse, the similar percentages for teeth requiring root canal treatment after crown placement suggest that 15%–19% of their patients are to be expected for all crowns. The 21% of the cases in this study with RP and cracks that were crowned and subsequently required root canal treatment is only slightly higher than the 15%–19% and suggests similar incidence data.

When examining a tooth with both mesial and distal marginal ridge fractures, the natural assumption would be that more of these teeth

would eventually require root canal treatment. Our data showed more teeth with a single marginal ridge crack, either mesial or distal, eventually required root canal treatment. This underlines the difficulty in predicting the eventual need for root canal treatment in teeth with RP and a cracked marginal ridge.

Conclusions

The outcomes of this study suggest that if a crack is identified early enough in cases with a diagnosis of RP and a crown is placed, root canal treatment will be necessary in about 20% of these cases within a 6-month period. Progression of interproximal periodontal defects associated with the crack(s) will occur in a very small percentage of the cases (5/127, 4%).

References

1. Cracking the cracked tooth code. *Endodontics: Colleagues for Excellence* 1997 (Fall/Winter):1–15.
2. Aizer JJ Jr. Margging incomplete tooth fractures. *J Am Dent Assoc* 2000;131:1168–74.
3. Hiat NH. Incomplete crown root fracture in pulpal periodontal disease. *J Periodontol* 1973;44:369–79.
4. Cameron GE. The cracked tooth syndrome: additional findings. *J Am Dent Assoc* 1976;93:971–5.
5. Wene FS, Detharry Jr, James A. Cracked tooth syndrome: vertical fractures of posterior teeth. In: Wene FS, ed. *Endodontic therapy*, 3rd ed. St Louis: Mosby, 1982:8–15.
6. Rivera EM, Walton BE. Longitudinal fractures. In: Torabinejad M, Walton BE, eds. *Principles and practice of endodontics*, 4th ed. Philadelphia: Saunders, in press.
7. Saunders WP, Saunders EM. Prevalence of periradicular periodontitis associated with crowned teeth in an adult Scottish subpopulation. *Br Dent J* 1998;185:137–40.
8. Cheung GS, Lee SC, Ng RP. Fate of vital pulps beneath a metal-ceramic crown or a bridge retainer. *Int Endod J* 2005;38:521–30.

What is the
pulpal death
rate for any
tooth w/ a
crown? 15-
19%



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8. Cheong GS, Lee BC, Ng RP. Fate of vital pulps beneath a metal-ceramic crown on a bridge abutment. Int Endod J 2005;38:521–30.

What is the pulpal death rate for bridge abutments? 32%



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7. Saunders GP, Saunders EM. Prevalence of periodontal periodontitis associated with crowned teeth in an adult Scottish subpopulation. Br Dent J 1998;185:137–40.
8. Cheung GS, Lai SK, Ng RP. Rate of vital pulps beneath a metal-ceramic crown on a bridge abutment. Int J Endod J 2005;38:521–30.

Big picture:
Cracked teeth
with R.P. don't
necessarily
need endo.



Big picture:

Bioclear

Composite

Overlays have
shown immediate
elimination of
symptoms*



Big picture: If you *give up* and do a crown, prepare, impress and temporize normally but wait 6-8 weeks to seat crown



Big picture:

PROBE!

PROBE!

PROBE!



What is our most
reliable clinical test for
irreversible pulpitis?

**PERCUSSION TEST,
and REPEAT**



Which tooth is cracked?



Which tooth is cracked?



Which tooth is cracked?

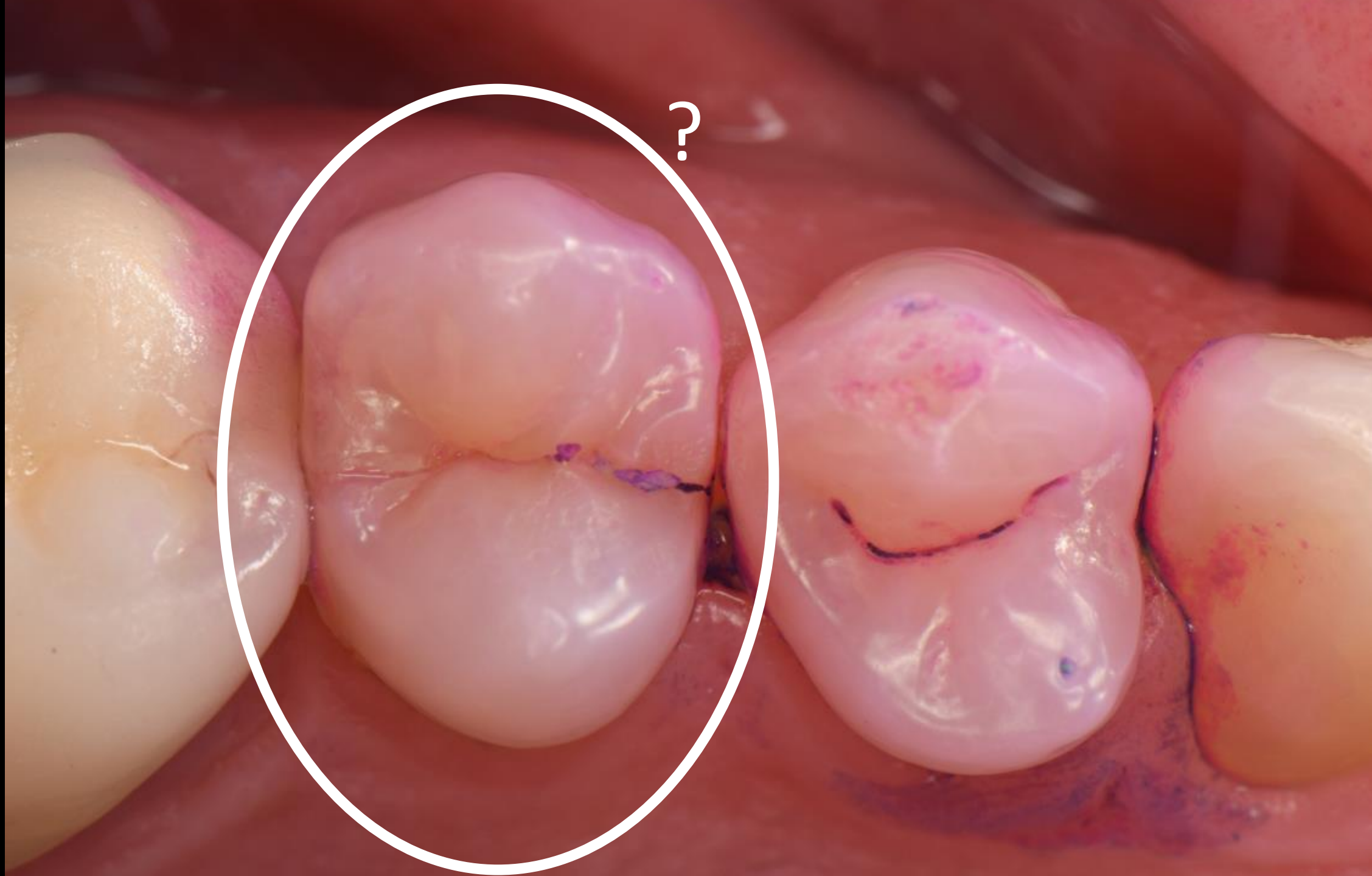


Which tooth is cracked?



?

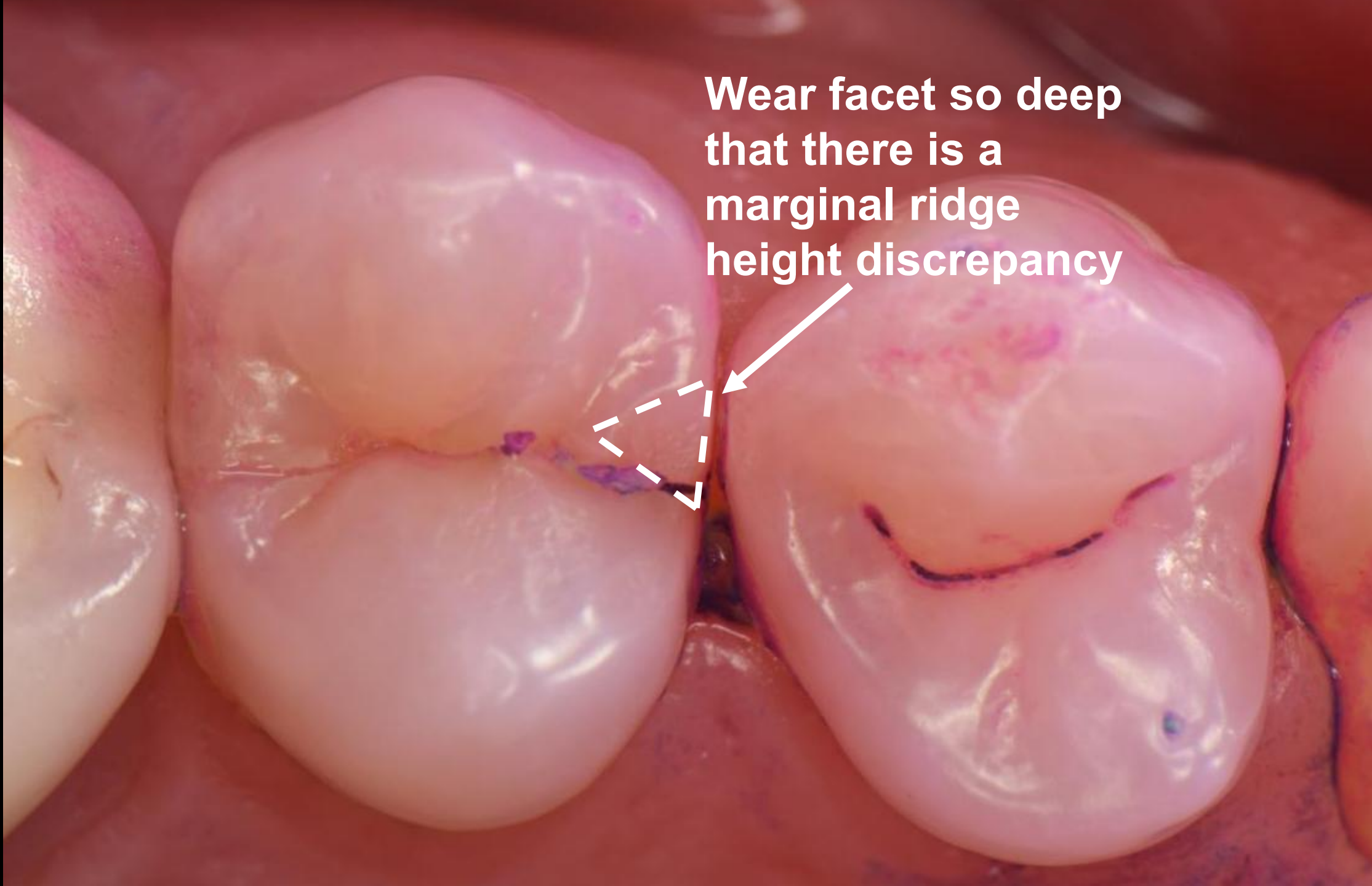


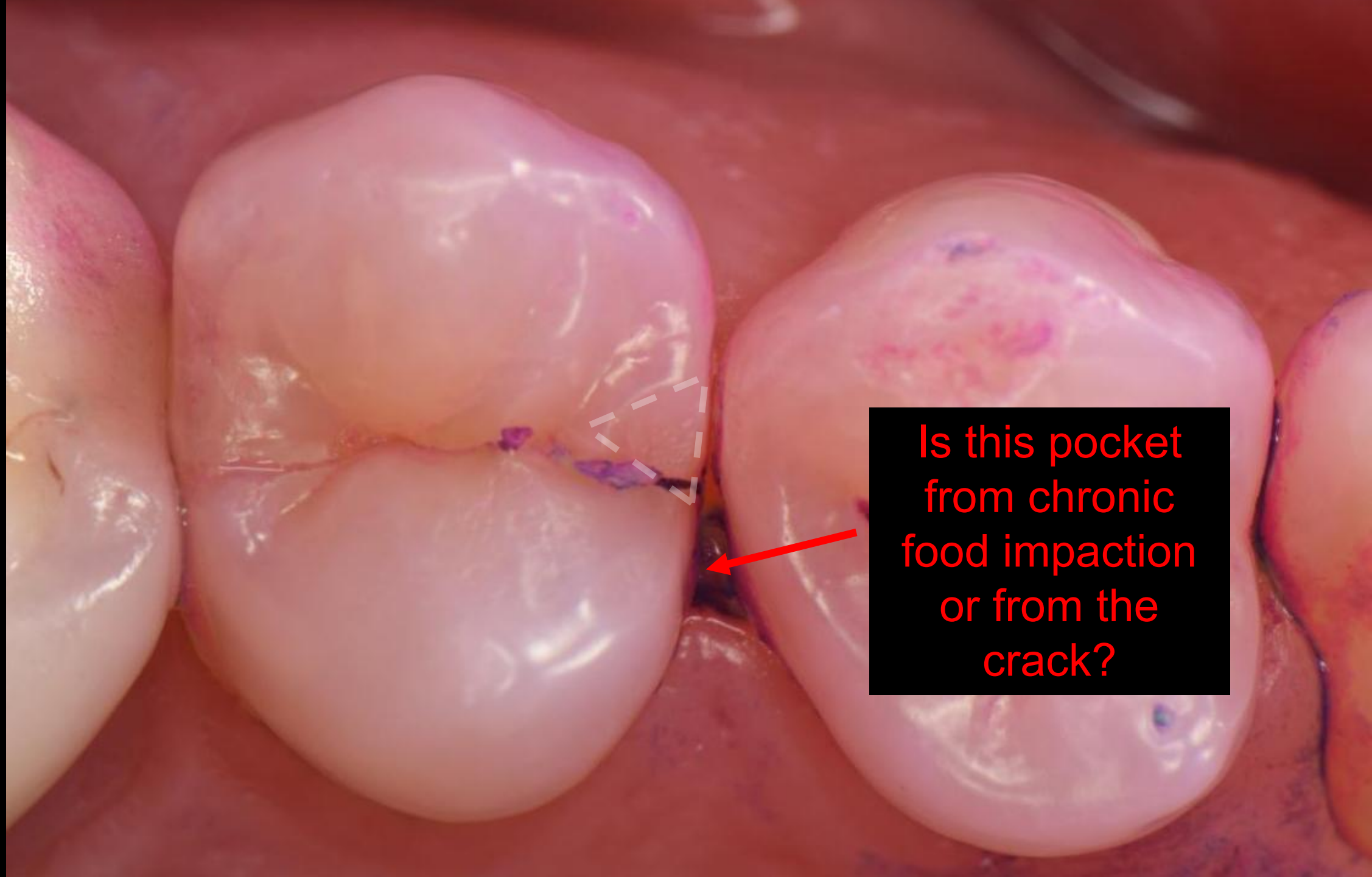






**Wear facet so deep
that there is a
marginal ridge
height discrepancy**





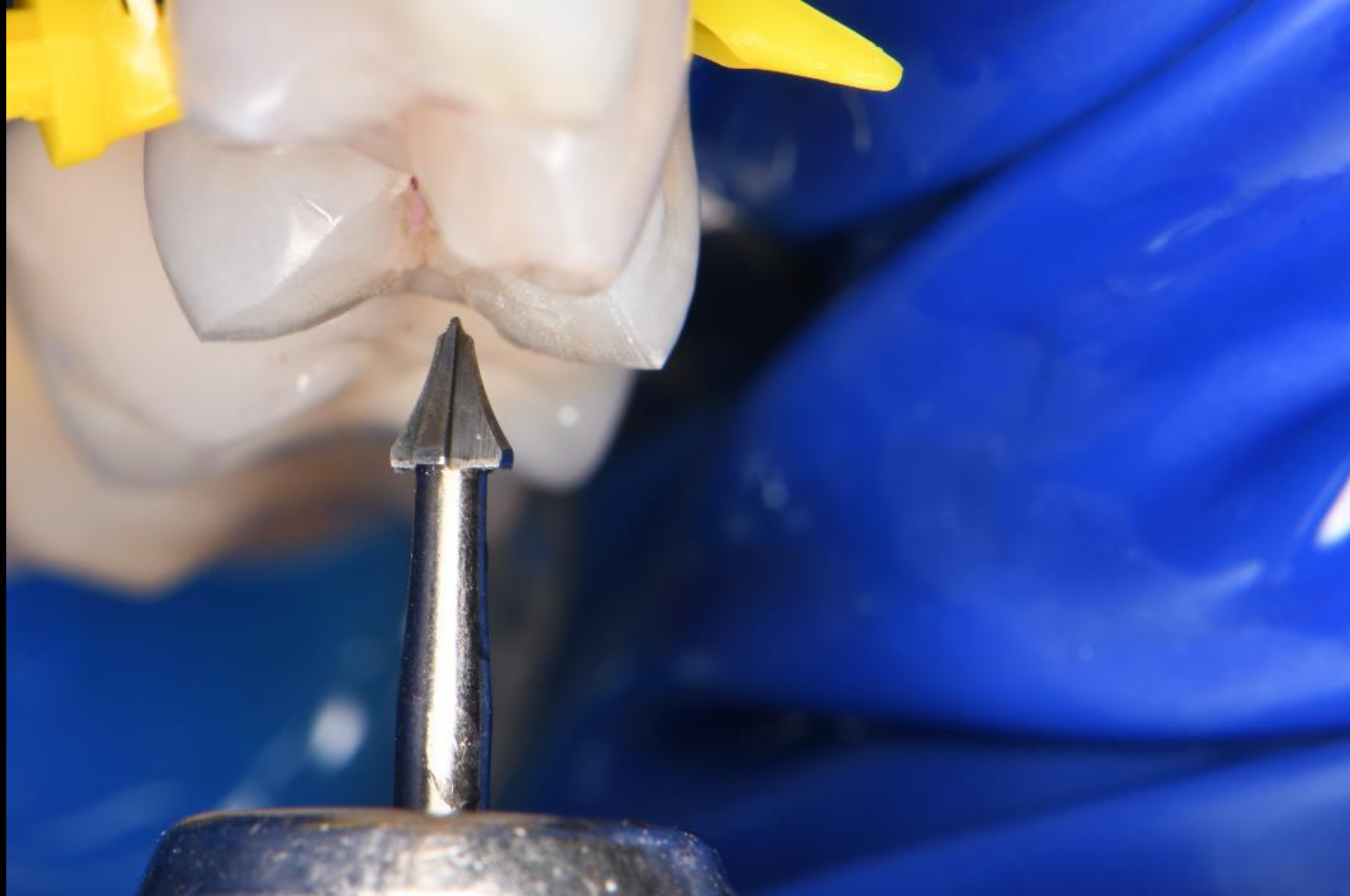
Is this pocket from chronic food impaction or from the crack?

































Learning Objectives from the Case:

- Don't sweep the contacts*
- 3 mm thickness over the crack
- Build a bridge from buccal to lingual
- The crack becomes dormant
- “Harmonize” the opposing w/ consent
- If food impaction continues, so will pain and pocketing
- Contact technique works for other problems**
- We need a powerful separator



Pre-op, post op, and 3 year follow up

∞ BIOCLEAR



Are all
Separators
Equal?

NO!



Stretched to 20mm ONCE!!!





And now most of
the power is
permanently lost

Once the yield of the metal/shape is reached, the metal undergoes plastic deformation

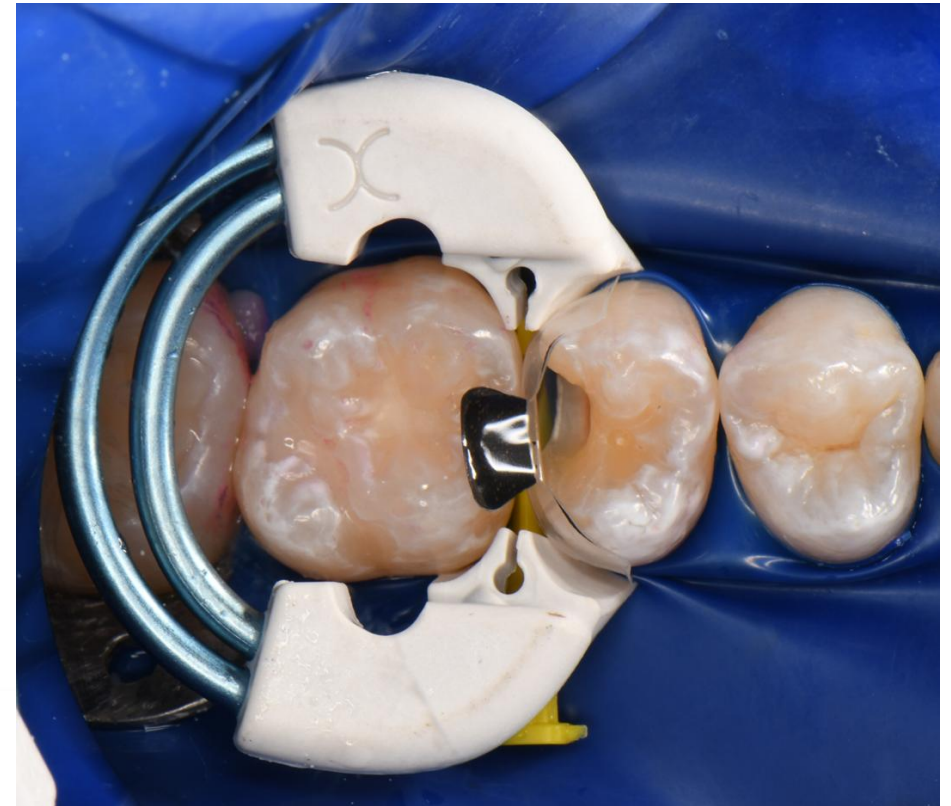
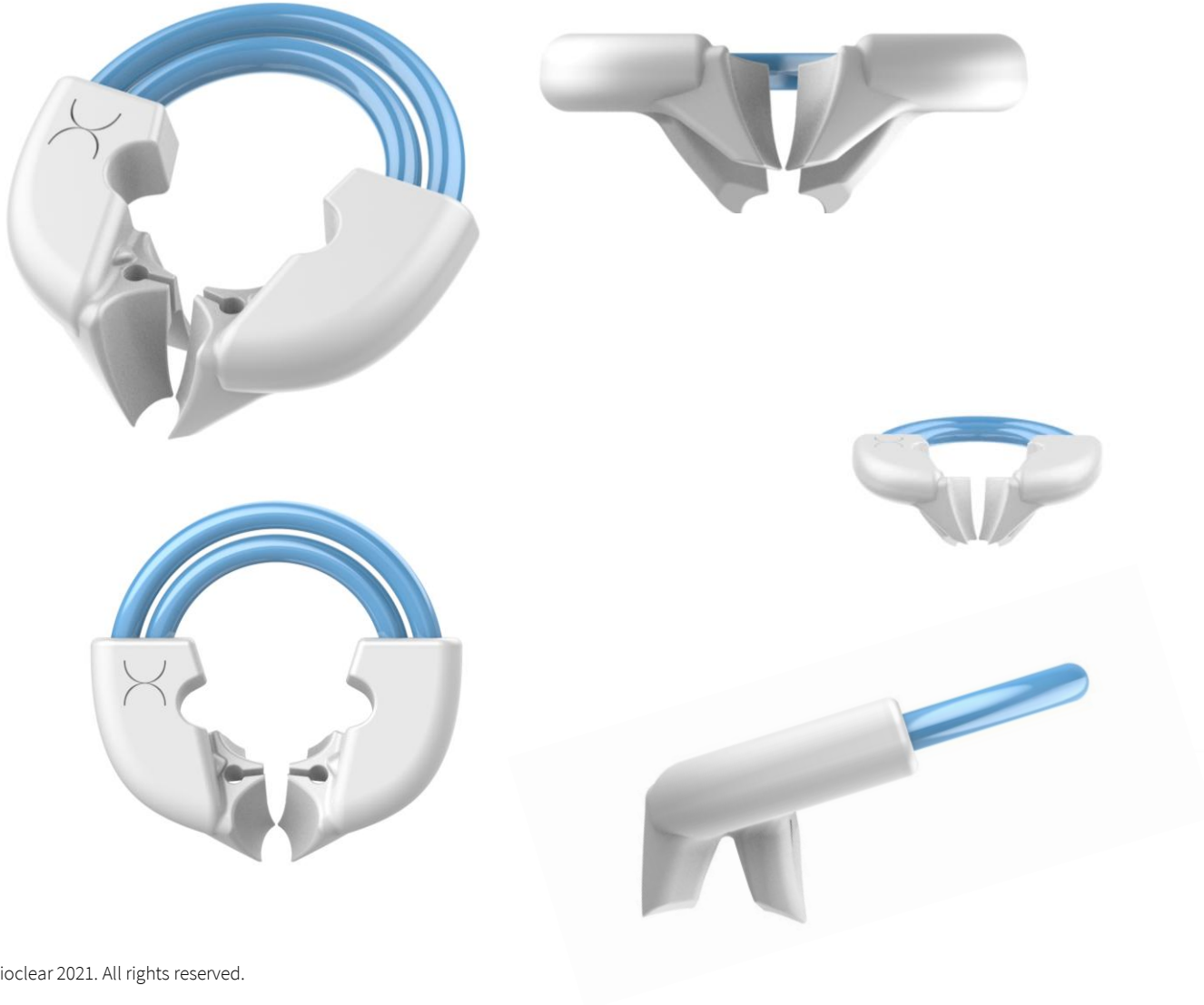
Stretched to 20mm Twenty Times

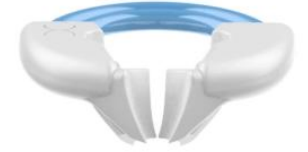


Stretched to 20mm Twenty Times



TwinRing Universal





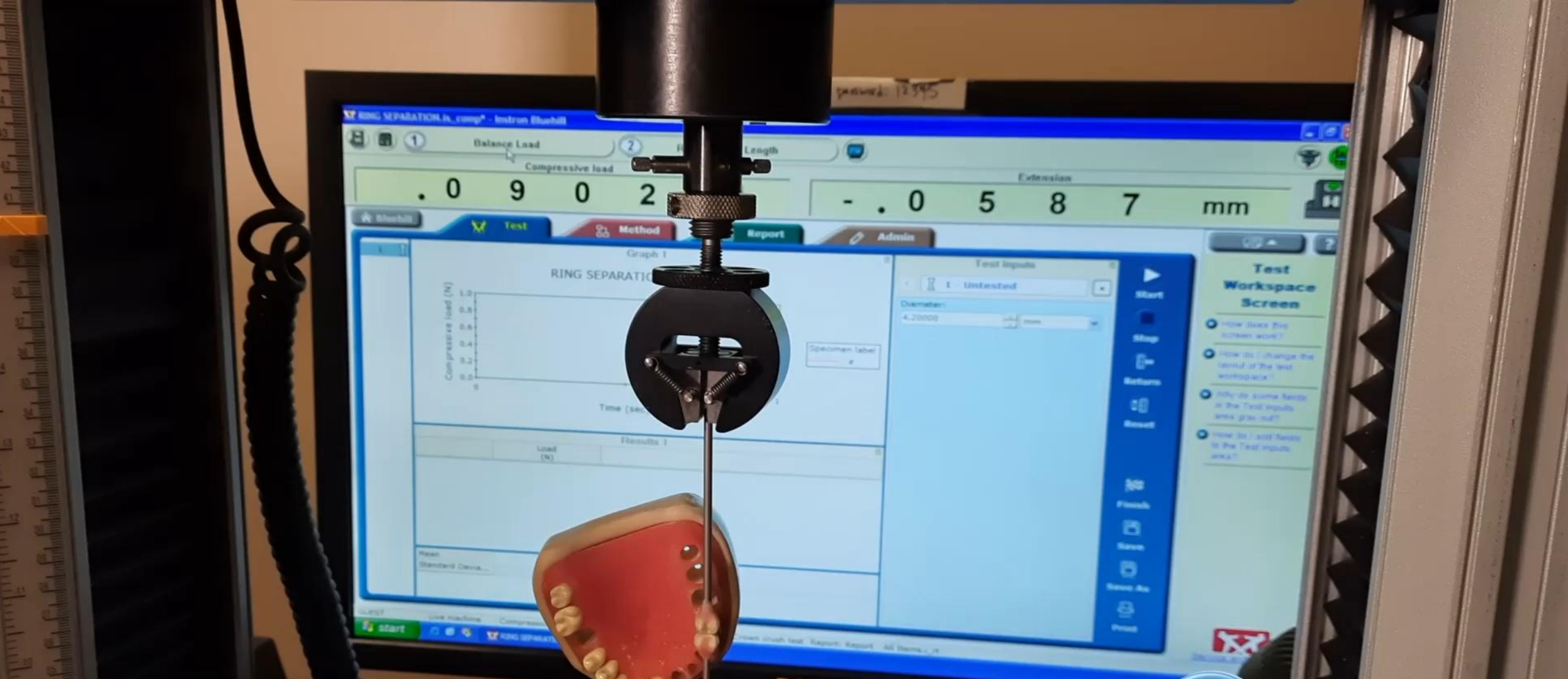
How do we win the *Snug Contact Game?*

- Power
- Strategy
- Technique



How do we win the *Snug Contact Game?*

- Power
- Strategy
- Technique



Nate Lawson DMD PhD

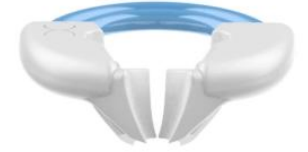
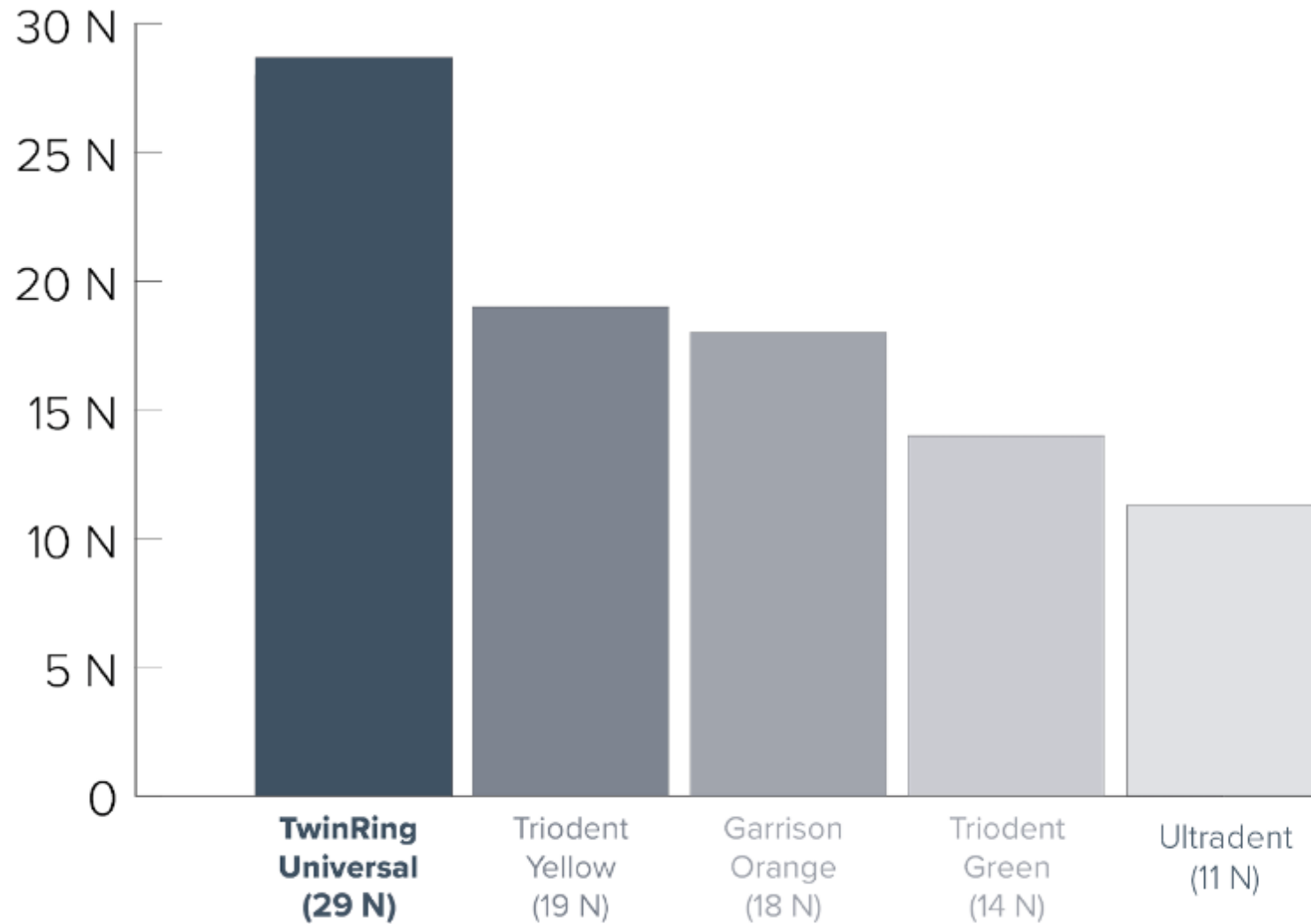
Director of the Division of Biomaterials and Pranit Bora. BDS, MDS.

Resident, Division of Biomaterials UAB School of Dentistry



TwinRing Universal
28 N

TwinRing Universal Instron Comparison



Note: Rings tested are not new and some rings stretch out quickly and lose up to half of their power after multiple uses. 1N = 1kg (m/s/s)

The slip-off test



 BIOCLEAR

Bioclear Matrices - Posterior





EVOLVE --- MATRIX

Premolar



Molar

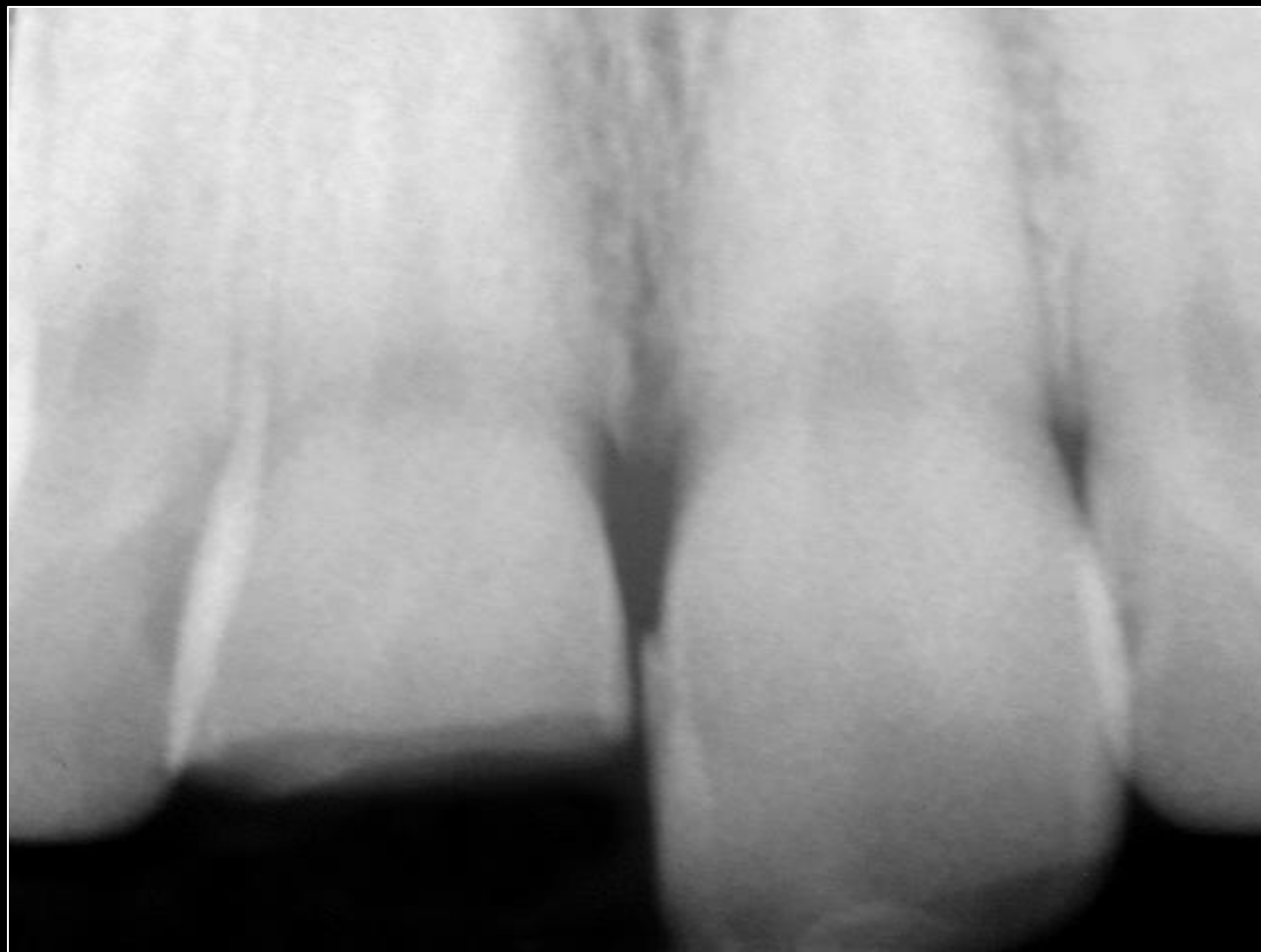


EVOLVE
MATRIX

In this case based lecture today we explore:

- Coronal (vertical and cuspal) Fracturing
- Snap-Off Fracturing





What Would You Do?

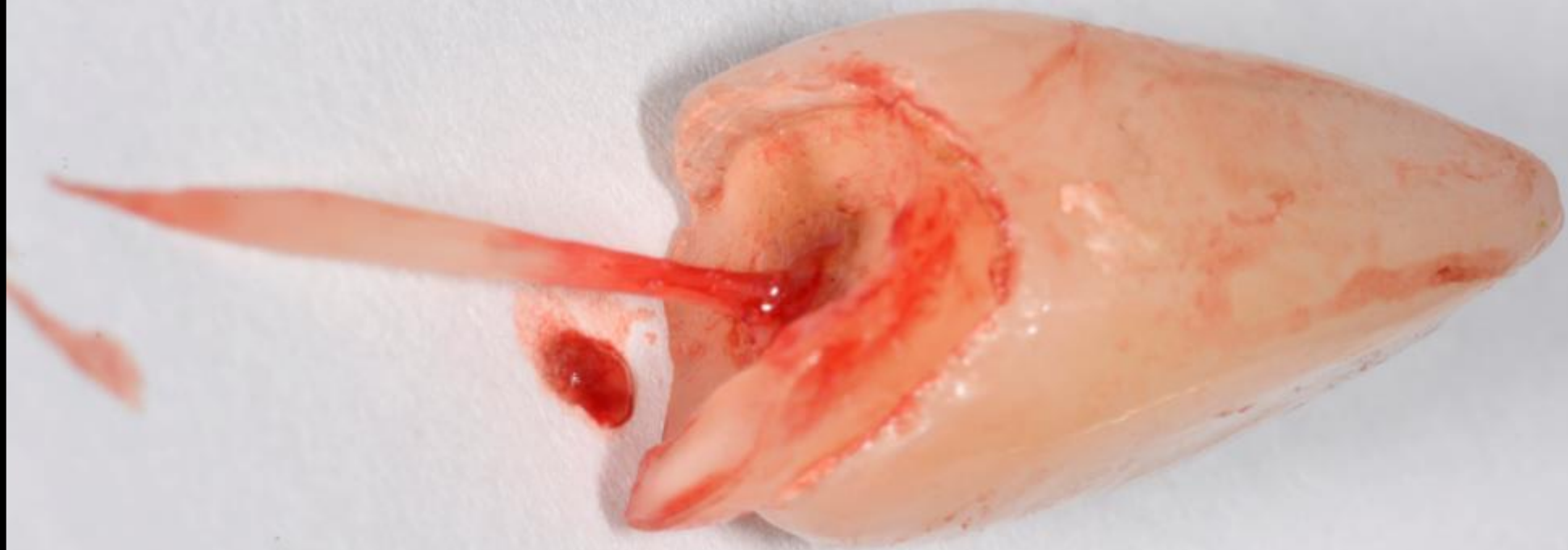


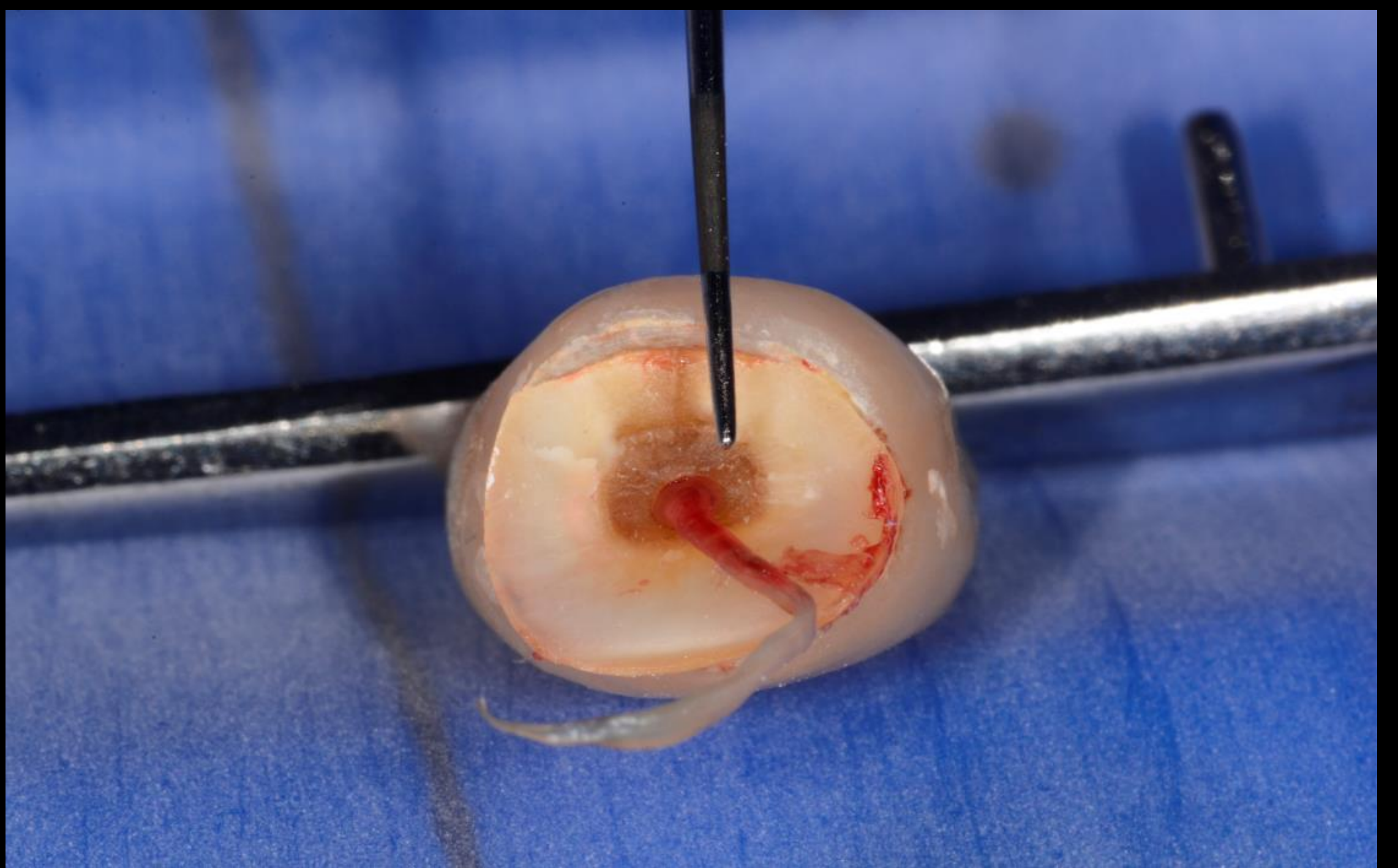
A different
toothache
patient we saw
recently...

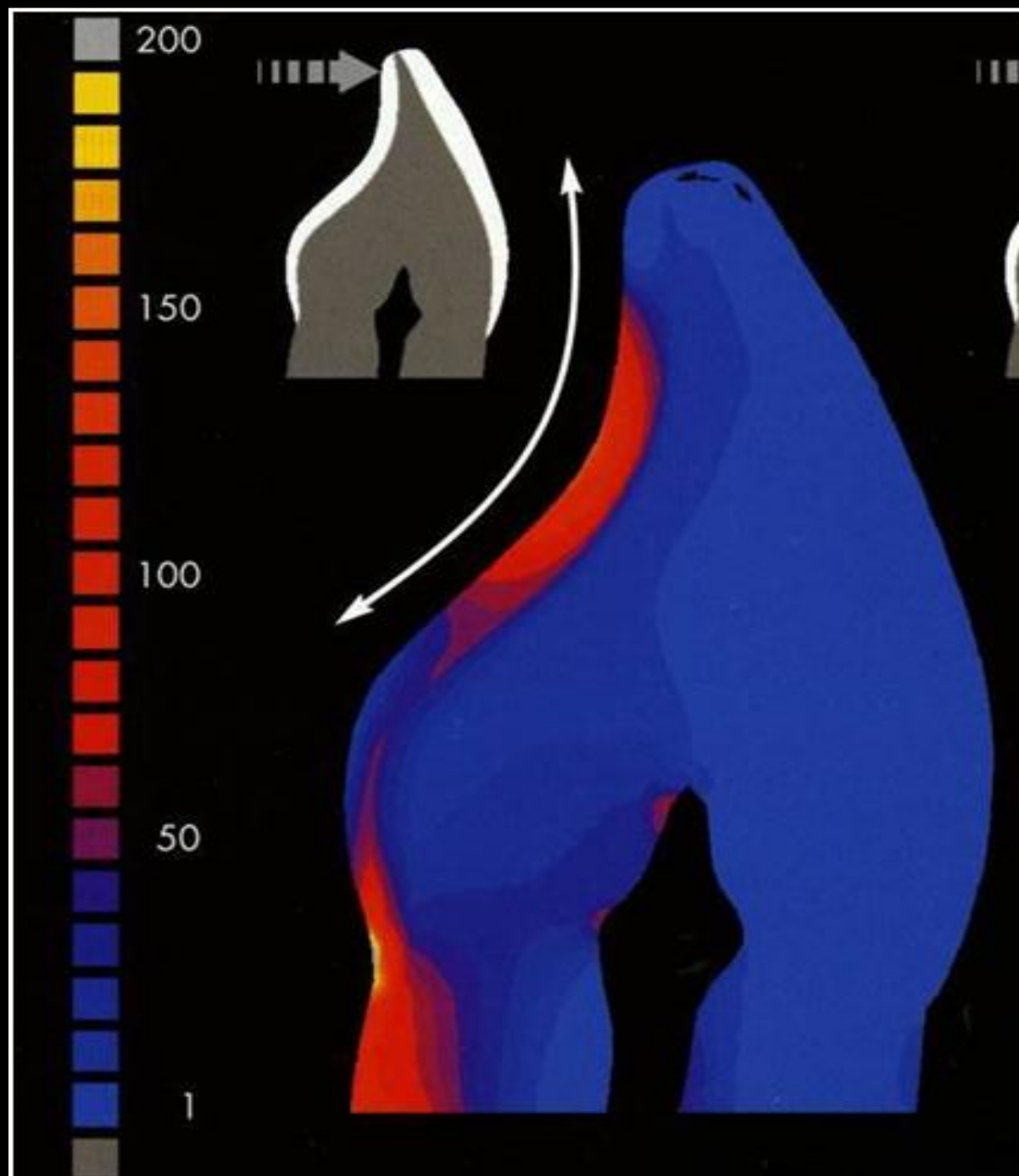
















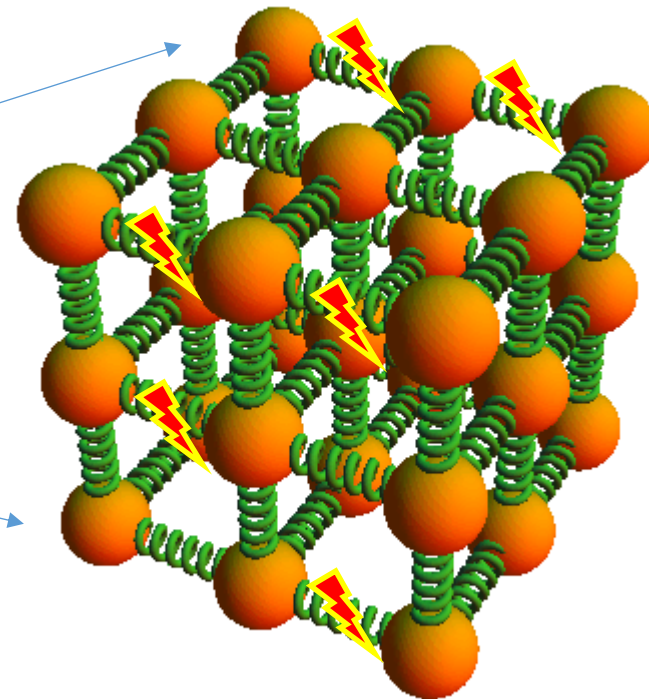
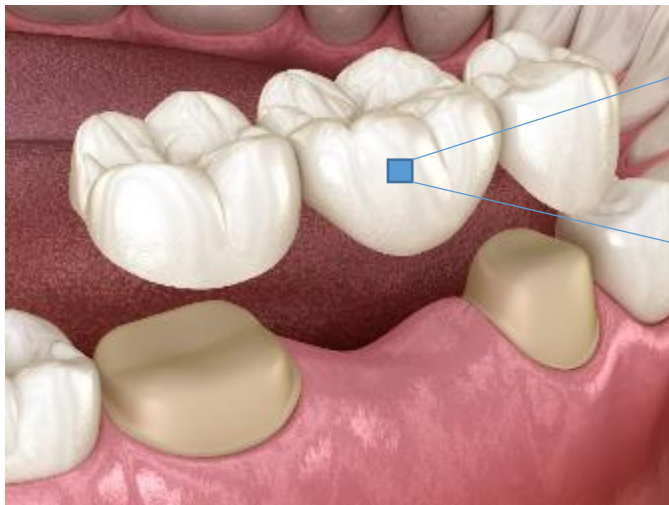




Basics of Solid Mechanics



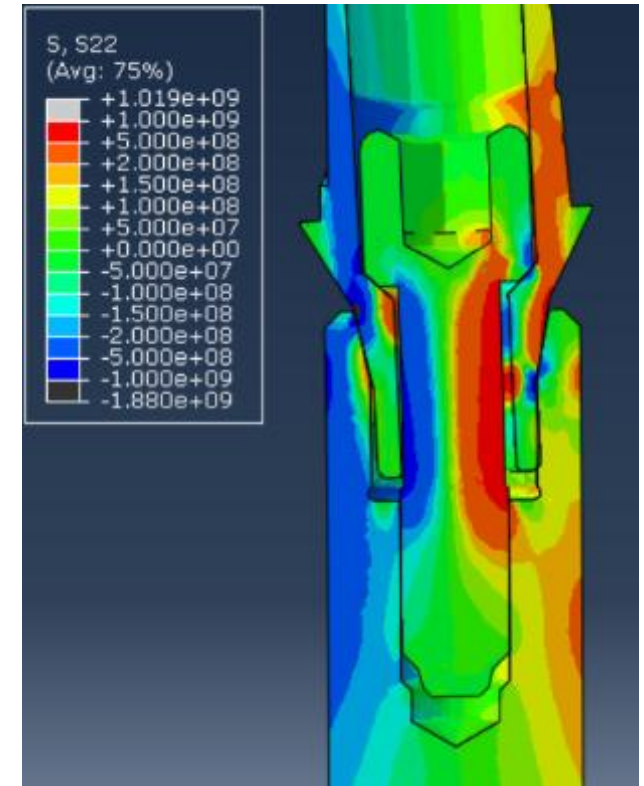
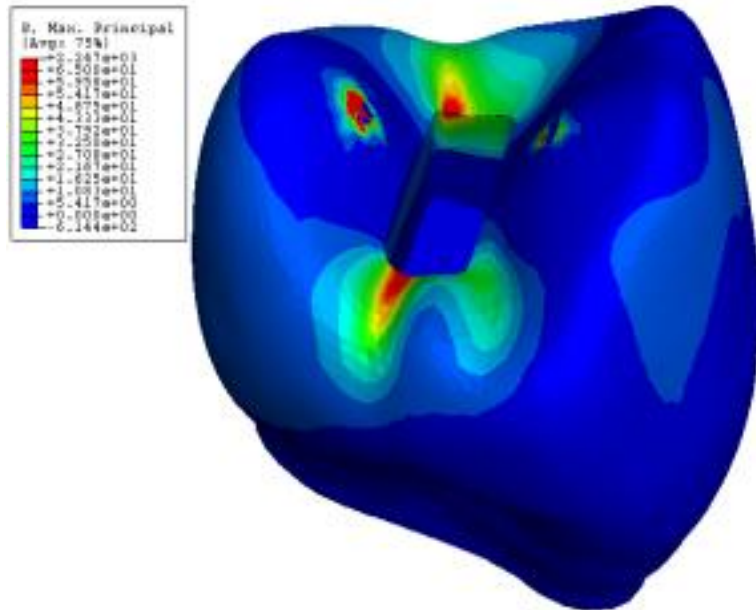
All solid structures can be considered as an assembly of many interconnected springs.



Stress/strain concentration

This occurs at

- Abrupt changes in geometry
- Mismatches in mechanical properties
- Concentrated loads



What is the percent of coronal volume removed in a conservative full porcelain crown preparation?

~3/4 Crown



53.0

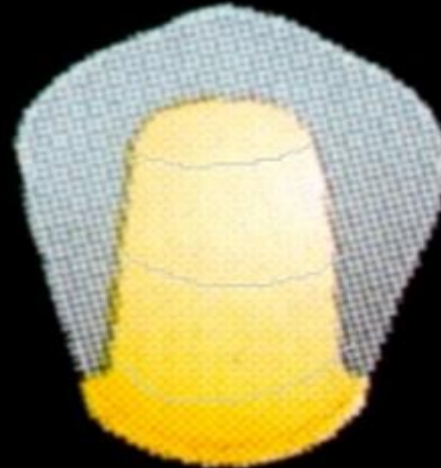
34 *

All Ceramic
.8 Margin



70.4

All Ceramic
1 mm Margin



74.1

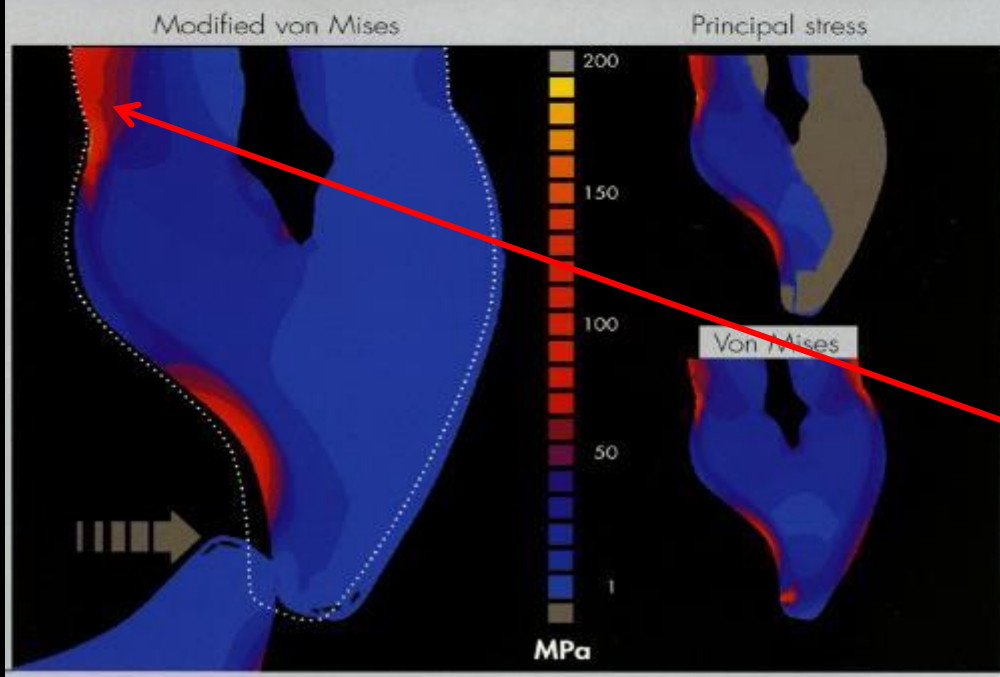
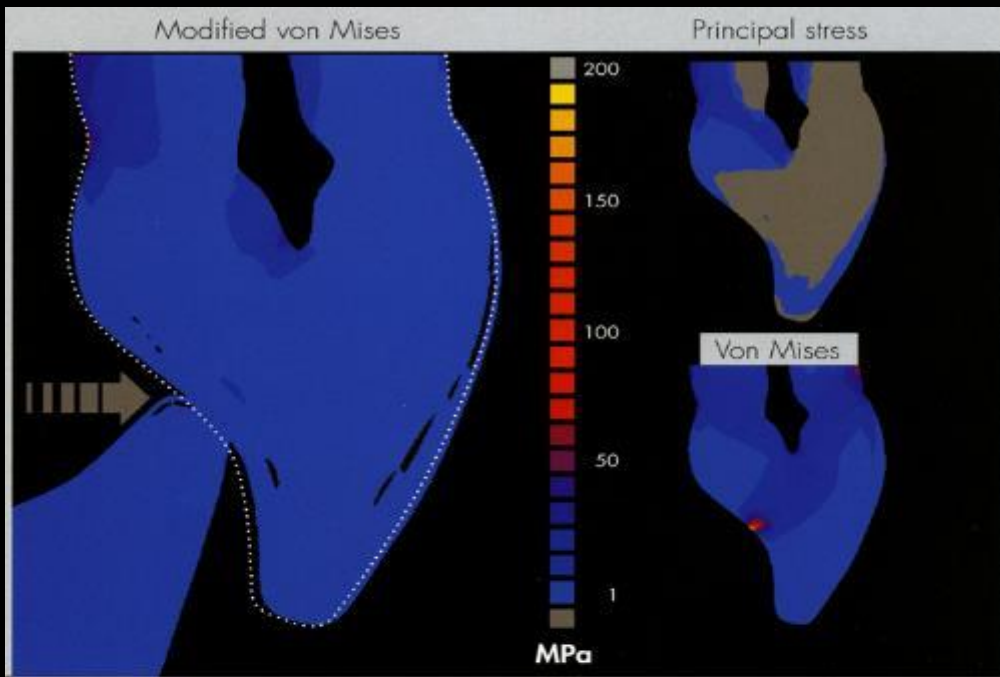
All Ceramic
1.4 mm Margin



75.9

Edelhoff D, Sorensen JA.

1 Structure Removal Associated with Various Preparation Designs for Posterior Teeth.
Int J Periodontics Restorative Dent 2002; vol 22; 3: 240-249.



75.9% volume gone + stress concentration

Is monolithic injection molded composite a viable alternative to full ceramic crowns in some cases?

You be the judge of that



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1-855-712-5327



360 Veneer

Class V and to significantly increase overjet or correct anterior open bite.



TSS Kit

Anterior Teeth:
Class III, Class IV, Class V
Fractured Incisors
Severe Wear
Composite Veneer
Full Composite Crown



BT (Black Triangle) Kit

Anterior Teeth:
Black Triangles
Peg Laterals
Diastema Closure
Instant Ortho
Class V



Evolve Matrix Kit

Posterior Teeth:
Class I, Class II, Class V



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BY  BIOCLEAR



140 Anterior Matrices

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Small & Medium Lower Incisor

75 Wedges

25 Small Wedges
50 Medium Wedges

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We're taking the
guesswork out of to
matrix selection

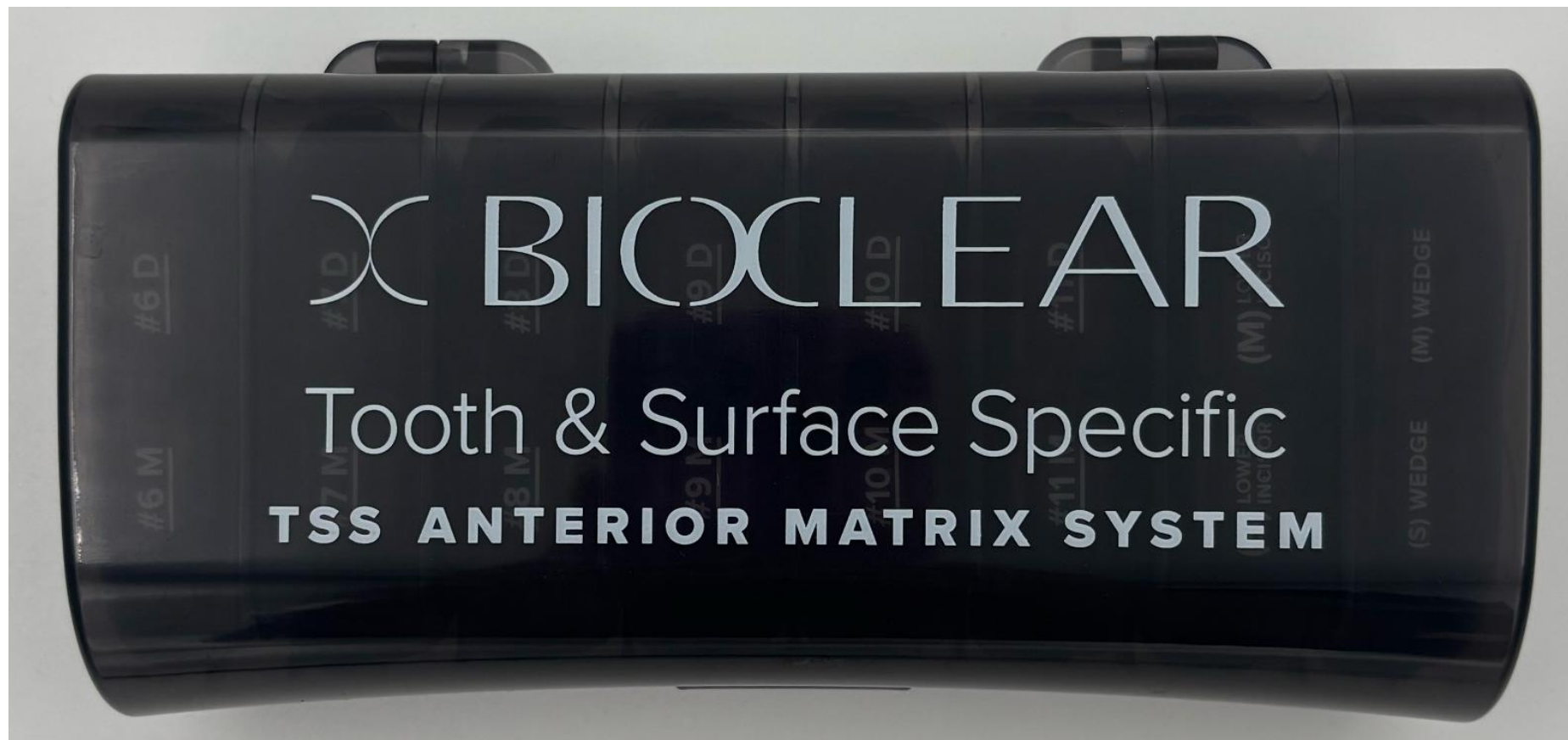


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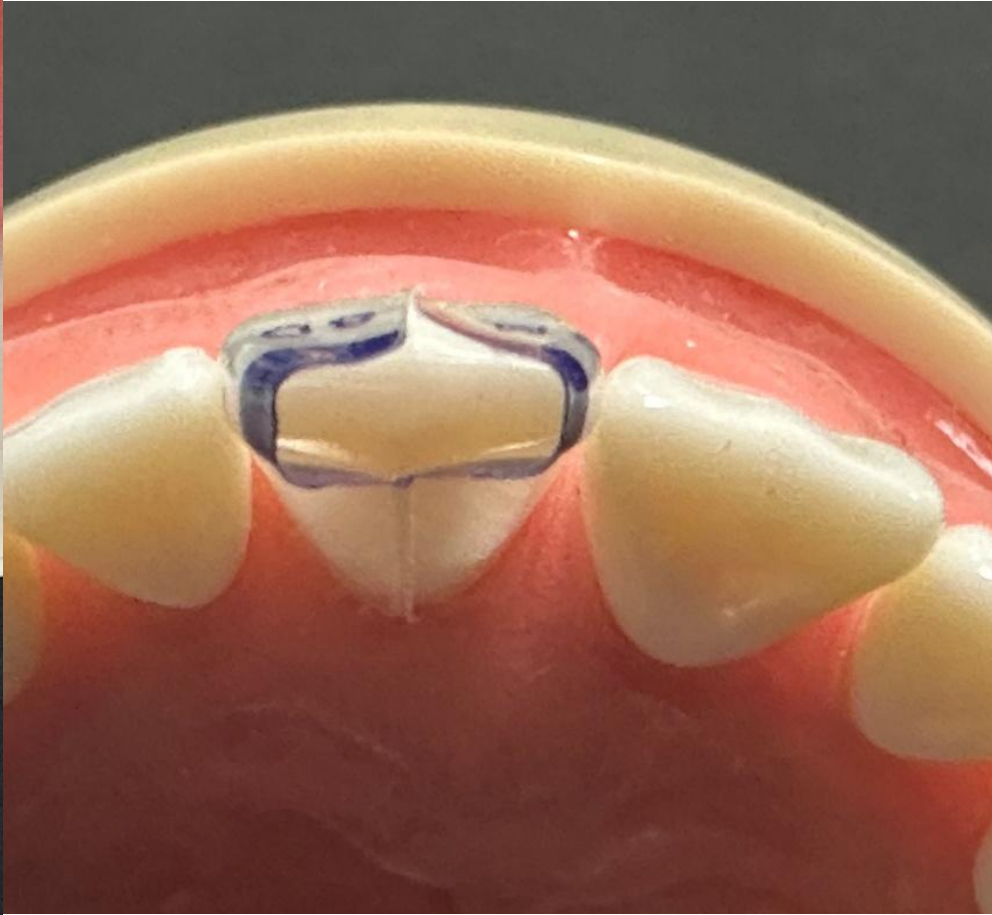
1.855.712.5327

The TSS system is for small and large anterior restorations, broken teeth and anterior esthetic veneering when you DO NOT have a black triangle or diastema















Khairul's regular dentist restored the tooth, but the patient was unhappy with the outcome. Khairul had two major complaints and one major concern:

- The restoration shreds floss
- The restoration is the wrong shape
- He does NOT want a crown



Pre-Operative View





- The restoration shreds floss
- The restoration is the wrong shape
- He does NOT want a crown



TSS

TOOTH & SURFACE SPECIFIC
MATRIX SYSTEM
BY BIOCLEAR



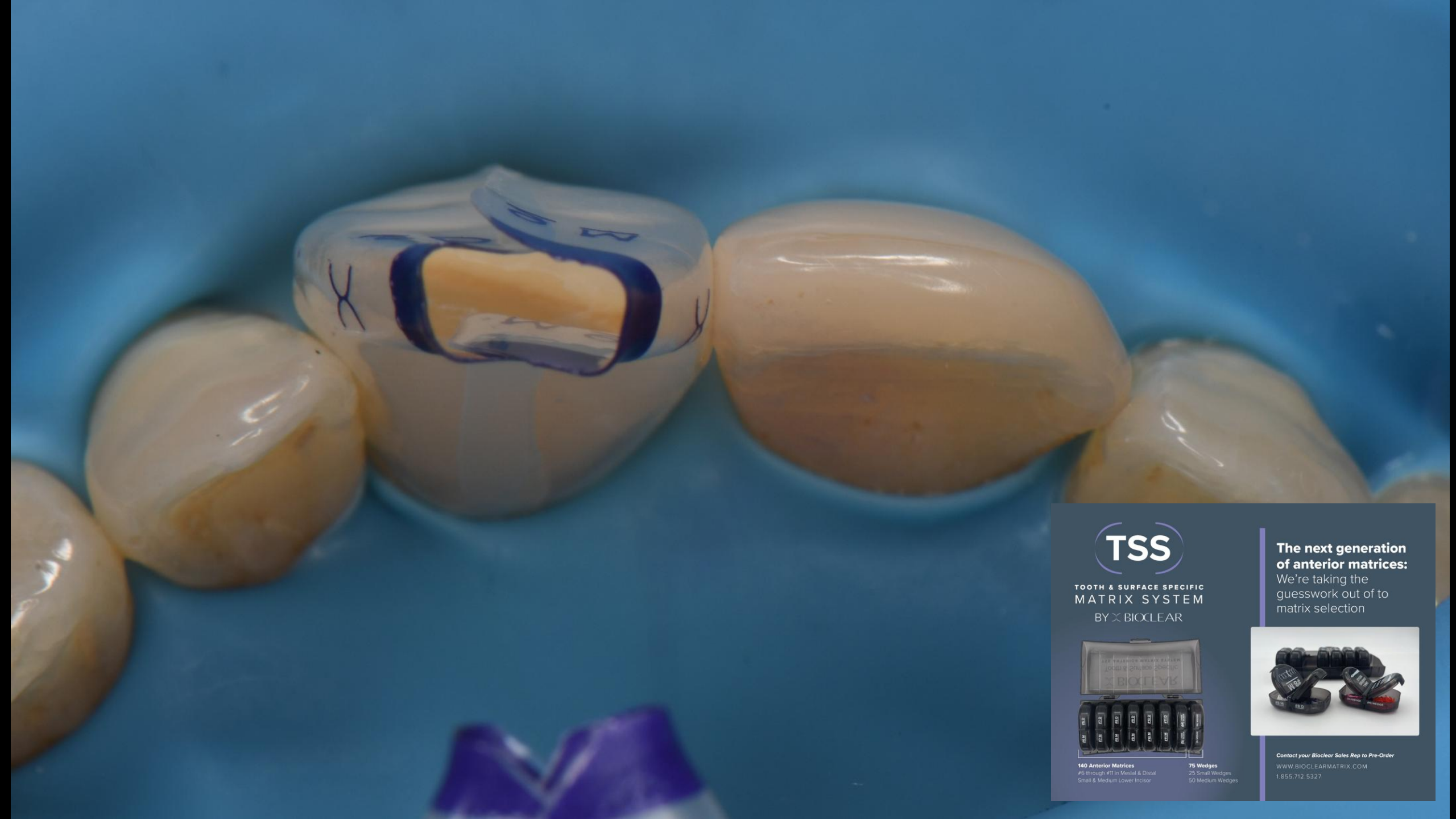
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Small & Medium Lower Incisor

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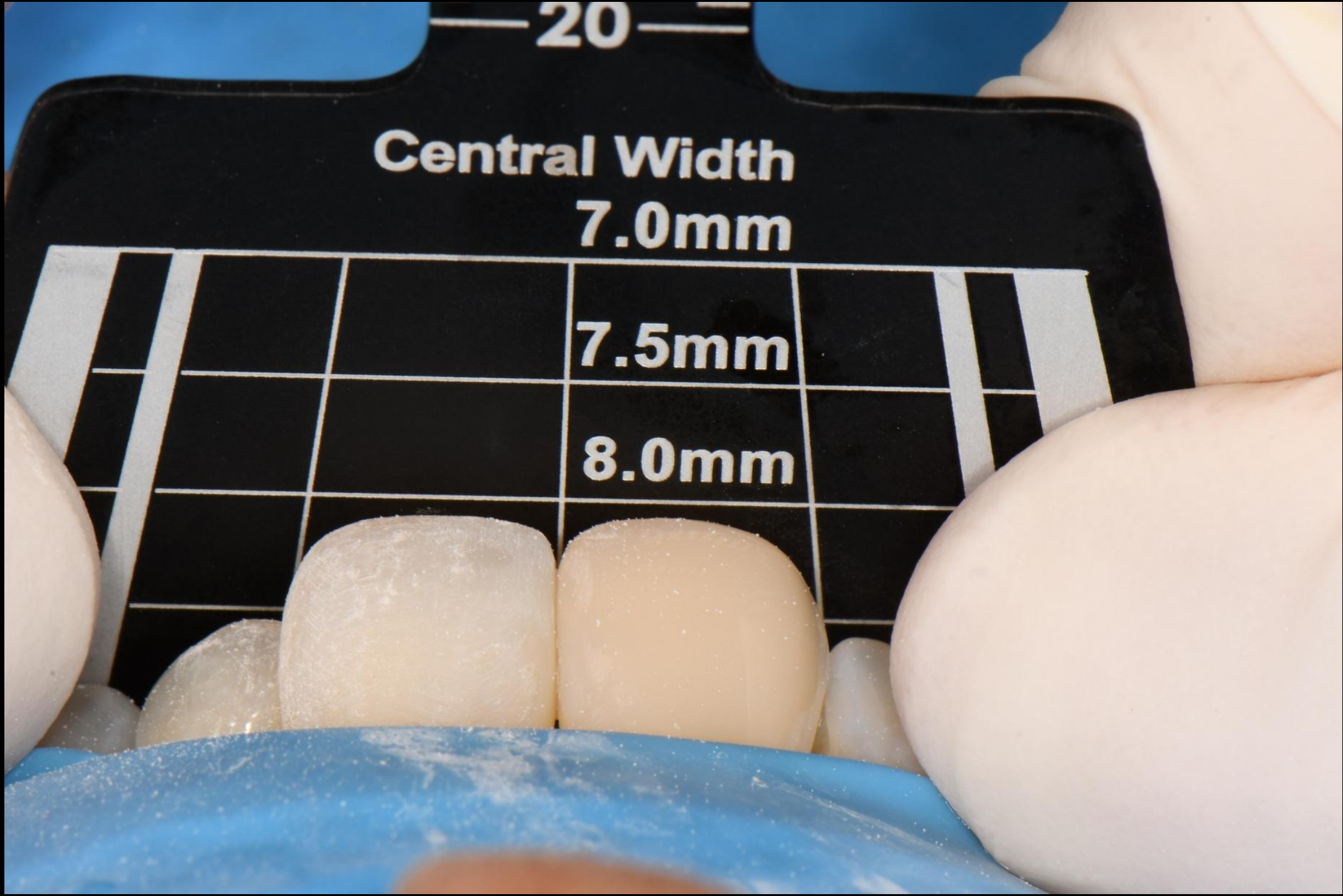


20

Central Width
7.0mm

7.5mm

8.0mm



- Before we started the procedure, I let Khairul know that the composite on the 11 had turned a bit yellow.
- I also let him know that it is impossible to get a perfect match to neighboring aged composite or natural teeth.
- I always ask the patient, “Do you want me to err on the light side or the dark side with shade? We can always bleach the natural teeth later and replace older yellowing composite on other teeth with a more color stable composite”.
- He chose to err on the light side in terms of shade selection.



Pre-Operative View



Immediate post-op. He asked for floss. It flossed perfectly. The patient loved it, hugged me and later posted marvelous reviews on Google



Kuraray Majesty ES: B1 flowable and paste



pre-op view



post-op view







TSS

TOOTH & SURFACE SPECIFIC
MATRIX SYSTEM
BY BIOCLEAR



140 Anterior Matrices
45 Standard Anterior & Diagonal
Small & Medium Lateral Incisors

75 Wedges
25 Small, Medium
50 Medium Wedges

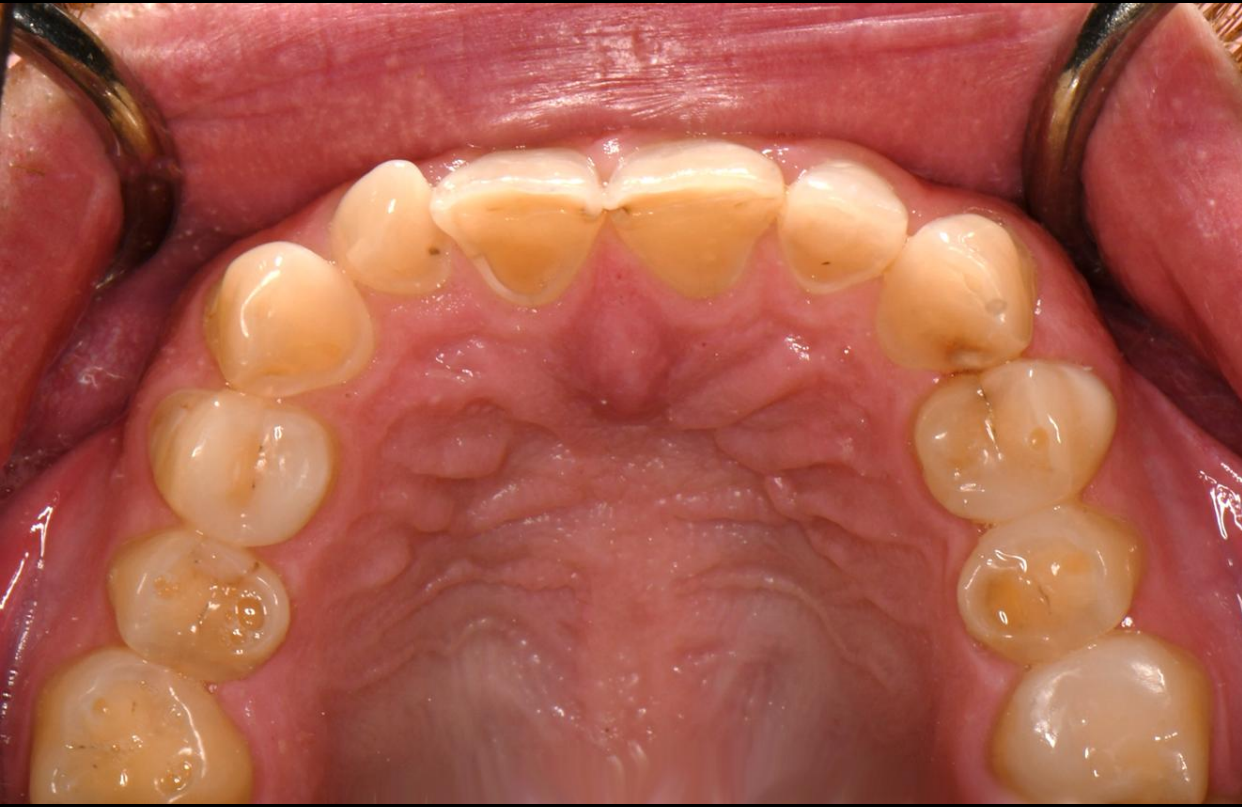
**The next generation
of anterior matrices:**

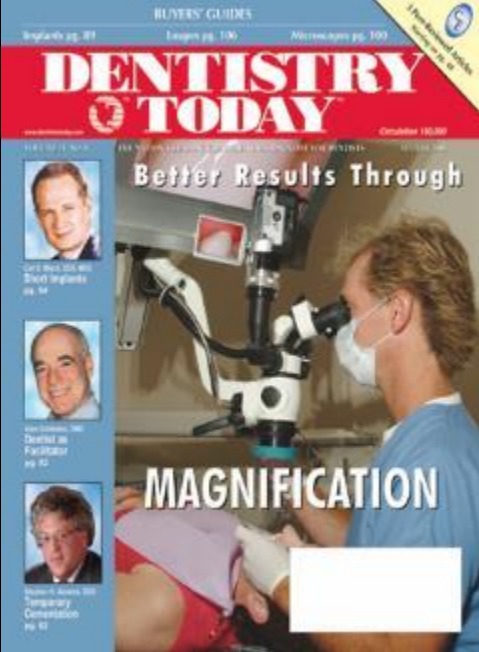
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matrix selection



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The Epidemic of Cracked and Fracturing Teeth



Dr. David J. Frazier, D.D.S., M.S.

Tooth and denture failure is a real number. Cracked and fractured teeth are one of the most leading causes of tooth loss in industrialized nations.¹ Denture teeth with osseointegrated analogues and components are working and being used. Cracked teeth, both anterior and posterior, are fracturing at all three levels. Fractured teeth treated with veneers, inlaying, onlaying, and crowns (Figure 1). Additionally, endodontics are reporting that cracked teeth are now replacing crown teeth for sensitive etiologies in a number of patients referred for endodontic treatment.

We assume that the reason of the prevalence and growing problem is not too far from being longer life span, stress levels are rising, and chewing and tension are also more general. It is the advent of the high-speed handpieces, speeded billions of horsepower (HP), high speed preparations that have work and powder teeth (Figure 2) and the deep etching preparations in the case of porcelain conductive, and yet aggressive "cross-link" substrate change in denture, new enamel resin.

Dentistry has great options (including a poorly understood process). A dramatic change in the form of combining dental materials, bonded, ceramic, denture, blending, and implants has shifted our attention more from some of the most integral aspects of the building and of dentistry, oral cavity, top that but. It is now that our profession face with a tremendous problem that will require a significant commitment and reevaluation of



Figure 2. A, In the anterior region, and fractured with a substrate. B, In the posterior region, and fractured with a substrate. C, In the posterior region, and fractured with a substrate. D, In the posterior region, and fractured with a substrate.

resources to address appropriately. There is no need to assess. Many, to start simply will require a new paradigm and part to work.

BRINGING DIAGNOSIS AND PREVENTION OFF OF THE SCENE

Microscopic and operator-driven diagnosis have been the accepted modalities for the diagnosis of cracked teeth. The following list

of items of the lack of visual endodontics results therapies that education can be used in the treatment process. They bring first experience of vision through the clinical microscope in the diagnosing array of cracks that cause visible and structures (Figure 3). Traditional visual exam (visual or biopsy) limits the dentist's ability to assess the pro-

cessed on page 48

Table 1. How Can We Eliminate Teeth Fracturing?

Phase 1:	Phase 2:	Phase 3:	Phase 4:	Phase 5:
Diagnose the root of the problem (to be used in the case of the patient)	Diagnose the root of the problem (to be used in the case of the patient)	Diagnose the root of the problem (to be used in the case of the patient)	Diagnose the root of the problem (to be used in the case of the patient)	Diagnose the root of the problem (to be used in the case of the patient)

Table 2. Quick Reference Guide for Microscopic Cracks in Posterior Teeth.

1. Most teeth in aging adults display enamel cracks.
2. Cracked cracks, even traumatic cracks, do not necessarily indicate that the tooth is cracked.
3. Only enamel cracks do not penetrate significantly (70-80%).
4. Only enamel cracks that extend below the gum line, more than one multiple cracks.
5. Three types of crack types: longitudinal, horizontal, and vertical.
6. Vertical cracks, decay, and subclinical enamel are contributing to microleakage enamel's substrate.
7. Denture cracks should be considered as structural cracks.
8. Denture cracks that are very close to the pulp, generally positioned in the middle of the pulp flow, are "structural" and should generally considered as "structural" (Figure 4).
9. There will be a high level of dental needs, higher needs on also on the "rigorous" stabilizer will be to be prepared that each microscopic and treatment. All teeth with denture cracks should be considered as structurally unsound.

References/Notes: P10-10

1. Microscopic cracks in denture materials can also indicate a lack of control structural integrity.
2. Microscopic cracks in denture materials can also indicate a lack of control structural integrity.
3. Microscopic cracks in denture materials can also indicate a lack of control structural integrity.

“Dentistry’s last great mystery, that of fracturing, is a poorly understood process.”



The Epidemic of Cracked and Fracturing Teeth



Tooths are fracturing faster in dental numbers. Cracked and fractured teeth are now the third leading cause of tooth loss in industrialized nations.¹ Fractured teeth with conservative analgesic and antibiotic care, sealing, and being crown, cracked teeth, both posterior and anterior, are fracturing off at three levels. Fractured teeth treated with veneers, inlaying off, and bridge (Figures 1). Additionally, endodontics are reporting that cracked teeth are now replacing crown teeth for restorative therapy in a number of patients referred for endodontic treatment.

We assume that the reason of this period and growing problem are not so obvious longer. Do our stress levels are rising, and chewing and bruxism are also more general, or the advent of the high-speed handpieces, speeded billions of horsepower (HP) that every preparation that have work and powder teeth (Figure 2) and the deep axial crown preparations in the case of porcelain crowns, and yet aggressive "cross-hatch" subodontia change is definite, new dental resin.

Dentistry has great capacity (evolution) is a poorly understood process. A dramatic change in the form of combining dental education, dental materials, dentistry, bleaching, and implants has shifted our attention away from some of the most integral aspects of the building and conditioning of teeth, top that but. We now find our profession faced with a tremendous problem that will require a significant reevaluation and reeducation of



Figure 2. In an anterior right, and buccal view of a maxillary C19 (the preparation) that has been placed the back to the tooth, and the other cracked buccal face of an anterior lower mandibular premolar.

residents to address appropriately. There is no need to assess. Many, to start simply will require diagnosis and part to work.

BRINGING DIAGNOSIS AND PREVENTION OUT OF THE ROOM
Microscopic and operator-driven diagnosis have been the accepted modalities for the diagnosis of cracked teeth. The following list

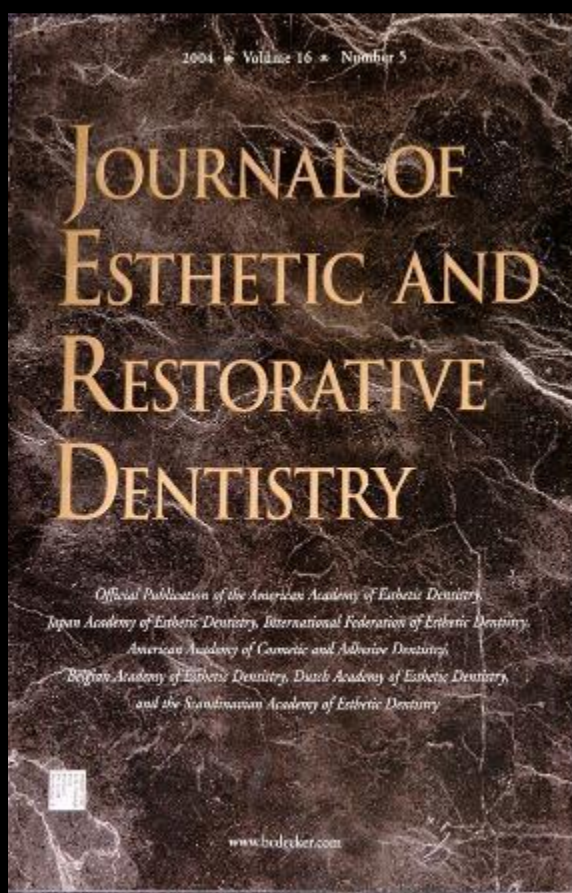
of signs of the lack of visual confirmation create therapies that education can contribute to the treatment process. One looking first impression of cracks through the clinical microscope is the staggering array of cracks that exist within tooth structures (Figure 3). Traditional visual examination (or longer) limits the clinician's ability to assess the pro-

Table 1. How Can We Eliminate Tooth Fracturing?

Phase 1:	Phase 2:	Phase 3:	Phase 4:	Phase 5:
Diagnose the tooth at depth, do forward single gate, direct to the preparation, direct to the preparation, direct to the preparation.	Recognize a lot of new early preparation or preparation, direct to the preparation, direct to the preparation, direct to the preparation.	Recognize the tooth at depth, do forward single gate, direct to the preparation, direct to the preparation, direct to the preparation.	Recognize the tooth at depth, do forward single gate, direct to the preparation, direct to the preparation, direct to the preparation.	Recognize the tooth at depth, do forward single gate, direct to the preparation, direct to the preparation, direct to the preparation.

Table 2. Quick Reference Guide for Microscopic Cracks in Posterior Teeth.

1. Most teeth in aging adults display enamel cracks.
 2. Cracked teeth, even traumatic cracks, do not necessarily indicate that the tooth is cracked.
 3. Only enamel cracks do not penetrate significantly (70-80%).
 4. Only enamel cracks that do not penetrate significantly (70-80%).
 5. Three types of crack propagation will produce enamel cracks:
 - Enamel cracks, direct, and subodontal enamel (not contributing to microleakage enamel's resistance).
 - Enamel cracks should be considered as structural cracks.
 - Enamel cracks do not penetrate significantly (70-80%), generally positioned in the middle of the pulpal floor, are "enamel" and "direct" generally confined at the pulp floor (only preparation, see "Direct" Figure 4).
 - Only teeth with both types of enamel cracks (both enamel and subodontal enamel) preparation will be considered as structurally cracked and treatment. All teeth with enamel cracks should be considered as structurally cracked.
- Relevant Microscopic Findings:**
1. Microscopic cracks in restorative materials can indicate a lack of correct structural integrity.
 2. Microscopic cracks in restorative materials can indicate a lack of correct structural integrity.
 3. Microscopic cracks in restorative materials can indicate a lack of correct structural integrity.



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Belgian Academy of Esthetic Dentistry, Dutch Academy of Esthetic Dentistry,
and the Scandinavian Academy of Esthetic Dentistry

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Prognostic Diagnosis of Early Enamel and Dental Cracks Based on Microscopic Evaluation

DAVID J. CLARK, DMD,
CURELTH G. SHEETS, DDS,
JACINTHE M. BAQUETTE, DMD

OBJECTIVE: Cracks and fractures of cracked teeth and incomplete coronal fracture have historically been symptoms of the dental operating microscope at x16 magnification can fundamentally change a clinician's ability to diagnose such conditions.

We have been observing cracks under extreme magnification for nearly a decade. Patients come clear that can lead to appropriate treatment prior to symptoms or deterioration to fracture occur. Conversely, many cracks are not structural and can lead to misdiagnosis treatment. Methodically microscopic examination, an understanding of crack progression, appreciation of the types of cracks will guide a doctor to making appropriate decisions.

Teeth can have structural cracks in various stages. To date, diagnosis and treatment are very often at an end stage of crack development.

CLINICAL SIGNIFICANCE

This article gives new guidelines for recognition, visualization, classification, and treatment of cracked teeth based on the specific use of x16 magnification. The significance of enamel cracks as they relate to dental cracks is detailed.

(J Esthet Restor Dent 15:XXX-XXX, 2003)

Microscopic and symptom-driven diagnoses have been the accepted modalities for cracked teeth. The inherent limitations of the lack of visual confirmation mask it therapies that often come too late in the treatment process. One lacking first impression of vision through a clinical microscope is the staggering array of cracks that exist within tooth structures. Traditional visualization is limited

or ocular (visual) limits the clinician's ability to assess the presence or severity of the majority of these cracks (Figure 1).

At extreme magnification levels (x14 and greater), the translucent nature of enamel yields a wealth of information. Subtle color changes within the enamel may indicate early decay, microleakage, and a lack of structural integrity of dentin and

enamel. Being able to see previously invisible cracks can lead to earlier diagnosis to more appropriate early treatment of compromised teeth before devastating fractures, pulpitis involvement, and periodontal breakdown occur. The value of early diagnosis of the structural breakdown of teeth will become even more significant with our aging population coupled with increased tooth retention in this population.

*President, Academy of Microscopic Esthetic Dentistry,
Torrance, Calif.; Director, The Great Oral Facial Institute, Torrance, Calif.; clinical professor,
Restorative Dentistry, USC School of Dentistry, Los Angeles, Calif., USA
Consultant, Director, The Great Oral Facial Institute, Torrance, Calif.; associate professor,
Restorative Dentistry, USC School of Dentistry, Los Angeles, Calif., USA*

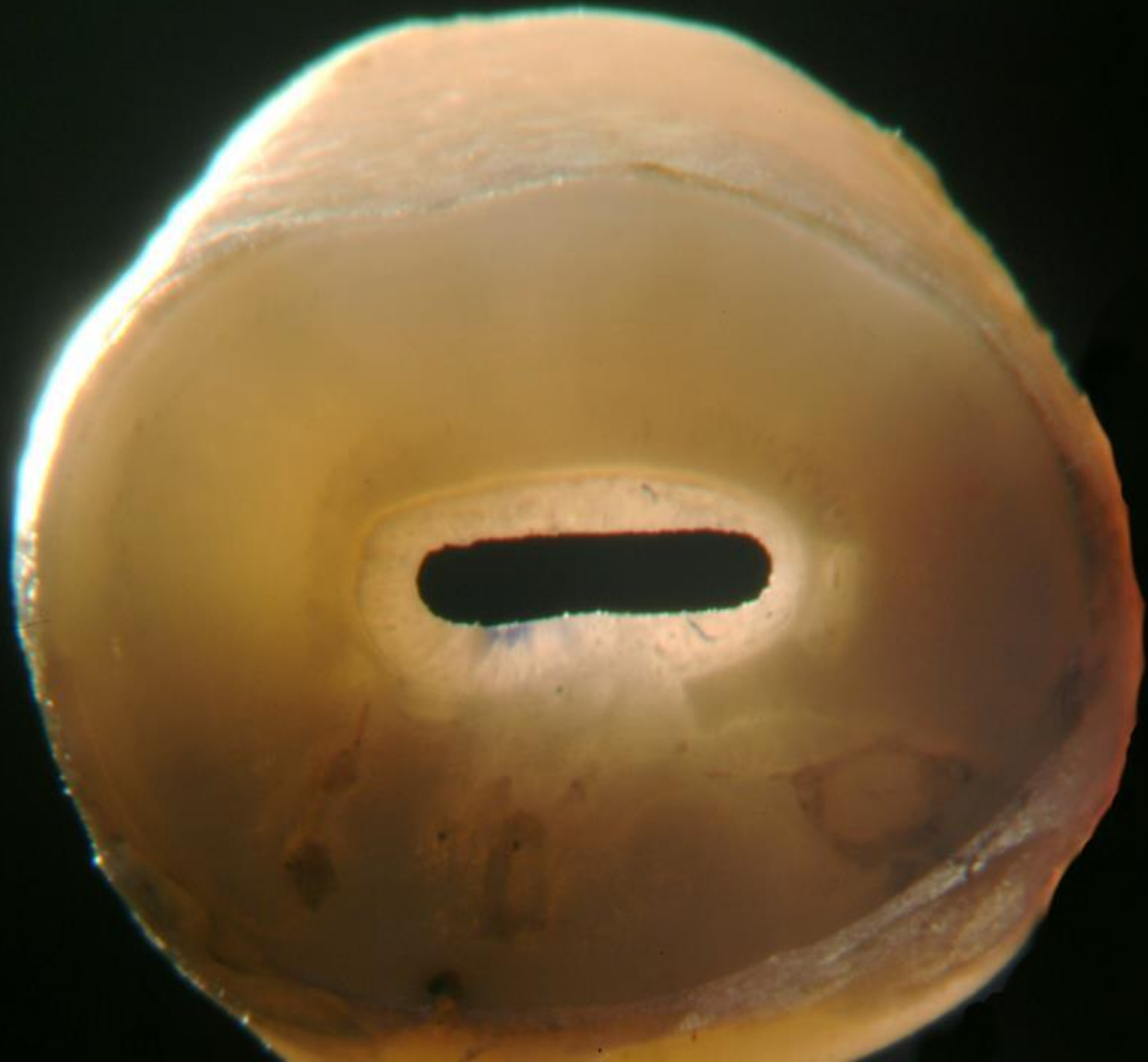


**ONE OF THE ENDURING
FIRST IMPRESSIONS OF
CLINICAL MICROSCOPE
DENTISTRY IS THE
STAGGERING ARRAY OF
CRACKS THAT ARE
SUDDENLY VISIBLE**

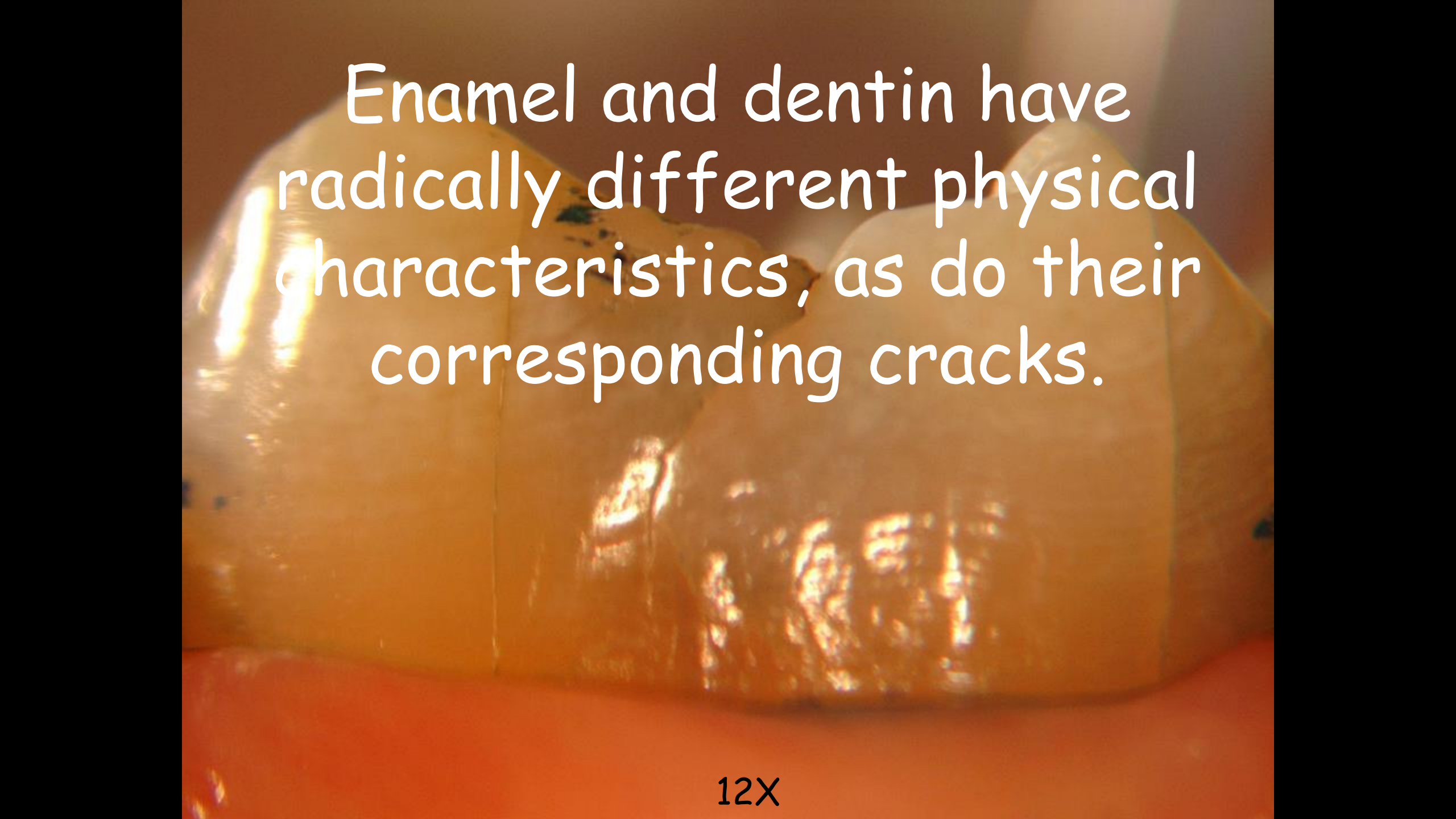
Clark, D.J., Paquette J., Sheets C., *Journal of Esthetic and Restorative
Dentistry*; Special Edition, 2004

Nature does
nothing
uselessly.

Aristotle 322 BC

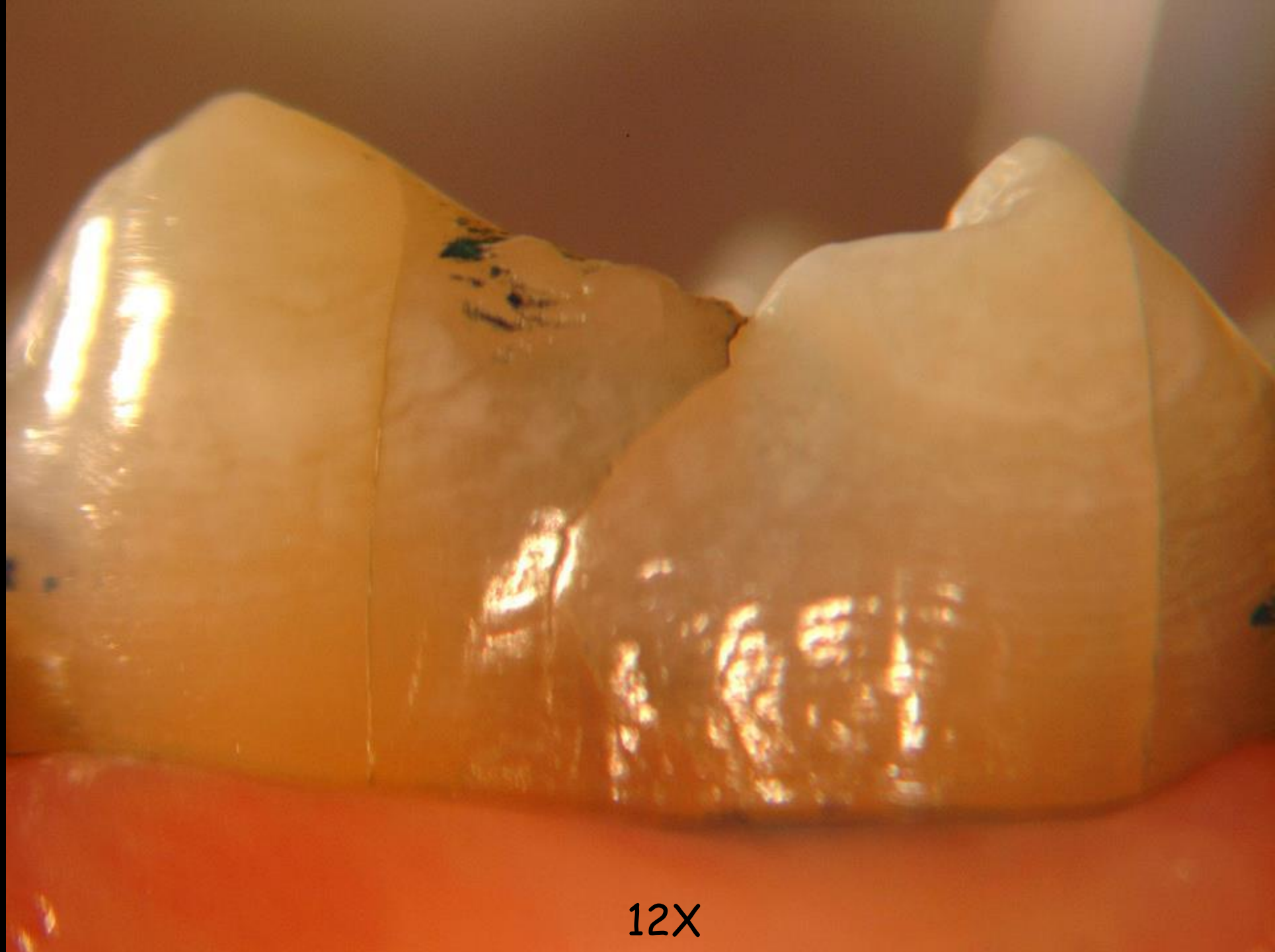


Enamel and dentin have radically different physical characteristics, as do their corresponding cracks.

A microscopic view of a tooth cross-section, showing the enamel and dentin layers. The enamel is the outer, lighter-colored layer, and the dentin is the inner, darker-colored layer. The image shows several cracks or fractures in the enamel and dentin, illustrating the text's claim that they have radically different physical characteristics. The cracks are visible as dark lines and irregular shapes within the tooth structure.

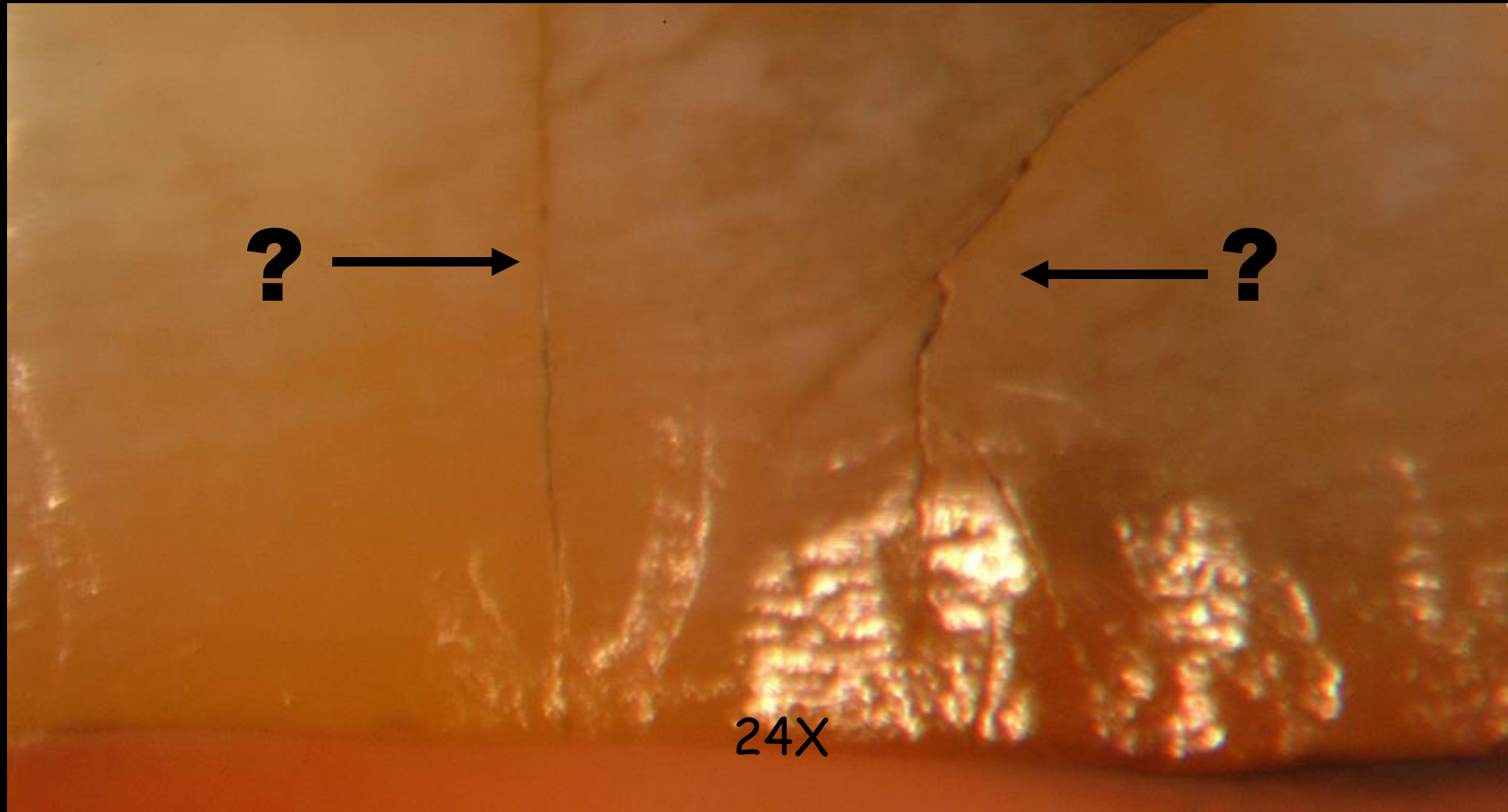
Enamel and dentin have radically different physical characteristics, as do their corresponding cracks.

12X



12X

Which enamel crack is "native", which crack is indicative of underlying pathology?



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British Academy of Esthetic Dentistry, Dutch Academy of Esthetic Dentistry,
and the Scandinavian Academy of Esthetic Dentistry

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Definitive Diagnosis of Early Enamel and Dentinal Cracks Based on Microscopic Evaluation

DAVID J. CLARK, DDS,
DORLAND G. SMITH, DDT,
JACQUELINE B. QUINN, DMD

ABSTRACT

The diagnosis of cracked tooth and incomplete coronal fracture have historically been symptomatic. The dental operating microscope at 40x magnification can fundamentally change a clinician's ability to diagnose such conditions.

Clinicians have been observing cracks under extreme magnification to be merely cosmetic. Patients are becoming clear that an early or appropriate treatment option is symptomatic or detection in tooth structure occur. Generally, many cracks are not structural and can locate microleakage and overextension. Methodologic microscopic investigation, an understanding of crack progression, and an appreciation of the types of cracks will guide a clinician in making appropriate decisions.

Teeth can have structural cracks in various stages. To date, diagnosis and treatment are very often a trial and error of crack development.

CLINICAL SIGNIFICANCE

This article gives new guidelines for recognition, classification, and treatment of cracked teeth based on the routine use of 40x magnification. The significance of enamel cracks as they relate to coronal cracks is detailed.

(J Esthet Restor Dent 16:XXX-XXX, 2004)

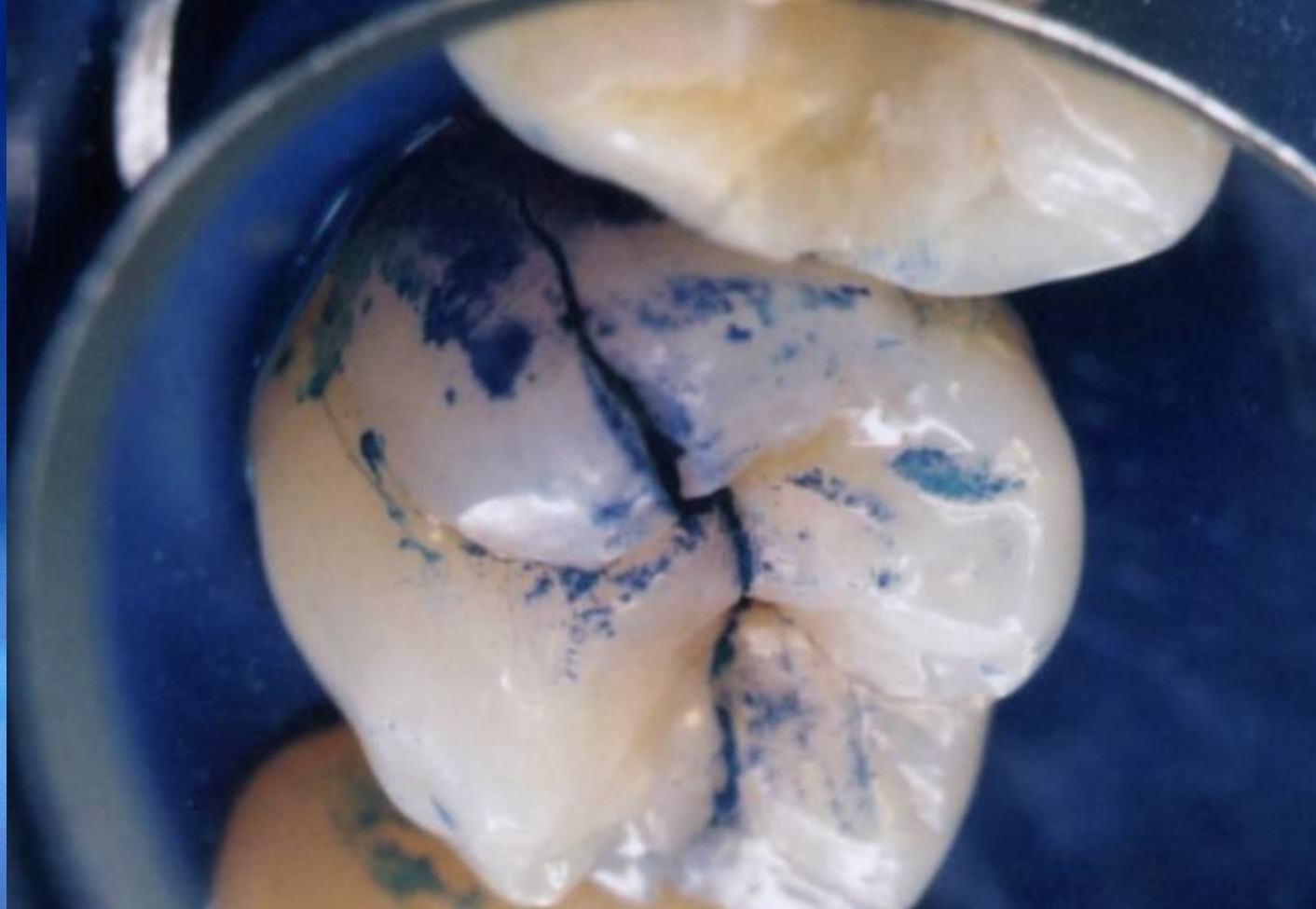
Microscopic and symptomatic diagnoses have been the accepted modalities for cracked teeth. The inherent limitations of the lack of visual confirmation result in therapies that often come out late in the treatment process. One limiting factor, irrespective of vision through a clinical microscope is the enlarging array of cracks that color visible tooth structures. Traditional visualization (unaided

or ocular) cannot reliably distinguish the presence or severity of the majority of these cracks (Figure 1A).

At extreme magnification levels (40x and greater), the translucent nature of enamel yields a wealth of information, such as color changes within the enamel may indicate early decay, microleakage, and a lack of structural integrity of dentin and

enamel. Being able to see previously invisible decay can aid restorative decisions to more appropriate early treatment of compromised teeth before developing trauma, pulp involvement, and periodontal breakdown occur. The value of early diagnosis of the structural breakdown of teeth will become even more significant with our aging population coupled with increasing tooth retention in this population.

¹President, Academy of Microscopic Oral and Esthetic Dentistry
²Consultant, American Society of Esthetic Dentistry, Newport Beach, CA; Clinical Professor of Restorative Dentistry, USC School of Dentistry, Los Angeles, CA, USA
³Consultant, American Society of Esthetic Dentistry, Newport Beach, CA; Associate Professor, Restorative Dentistry, USC School of Dentistry, Los Angeles, CA, USA



Vertical Crack End Stage:
Complete Tooth Fracture
(split tooth)

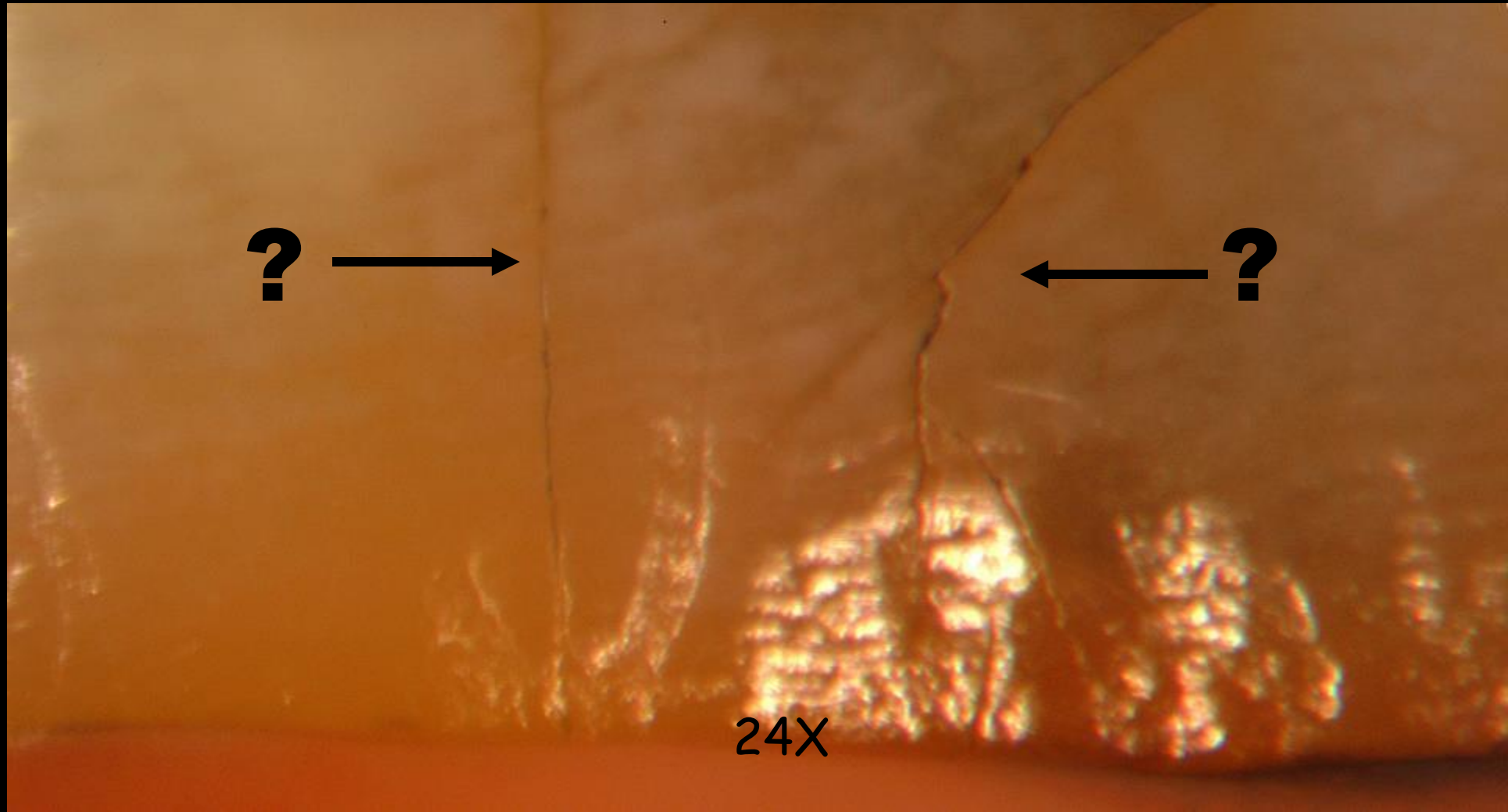
Endstage Oblique Fracture Cuspal Fracture

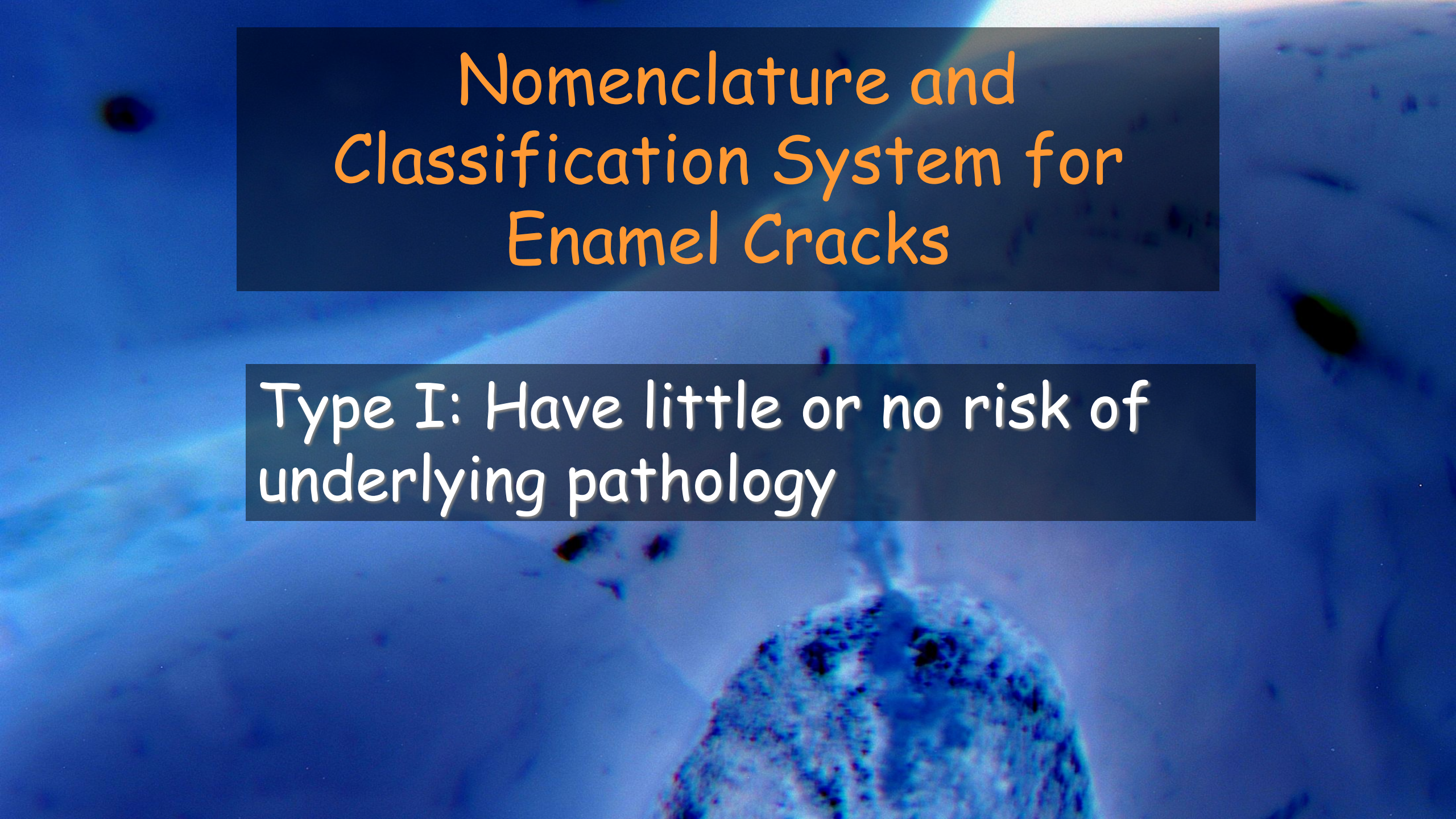


Enamel and dentin have radically different physical characteristics, as do their corresponding cracks.

12X

Which enamel crack is "native", which crack is indicative of underlying pathology?



A microscopic image of an enamel crack, showing a dark, irregularly shaped crack running through the enamel structure. The background is a light, textured surface. The crack is the central focus of the image.

Nomenclature and Classification System for Enamel Cracks

Type I: Have little or no risk of
underlying pathology

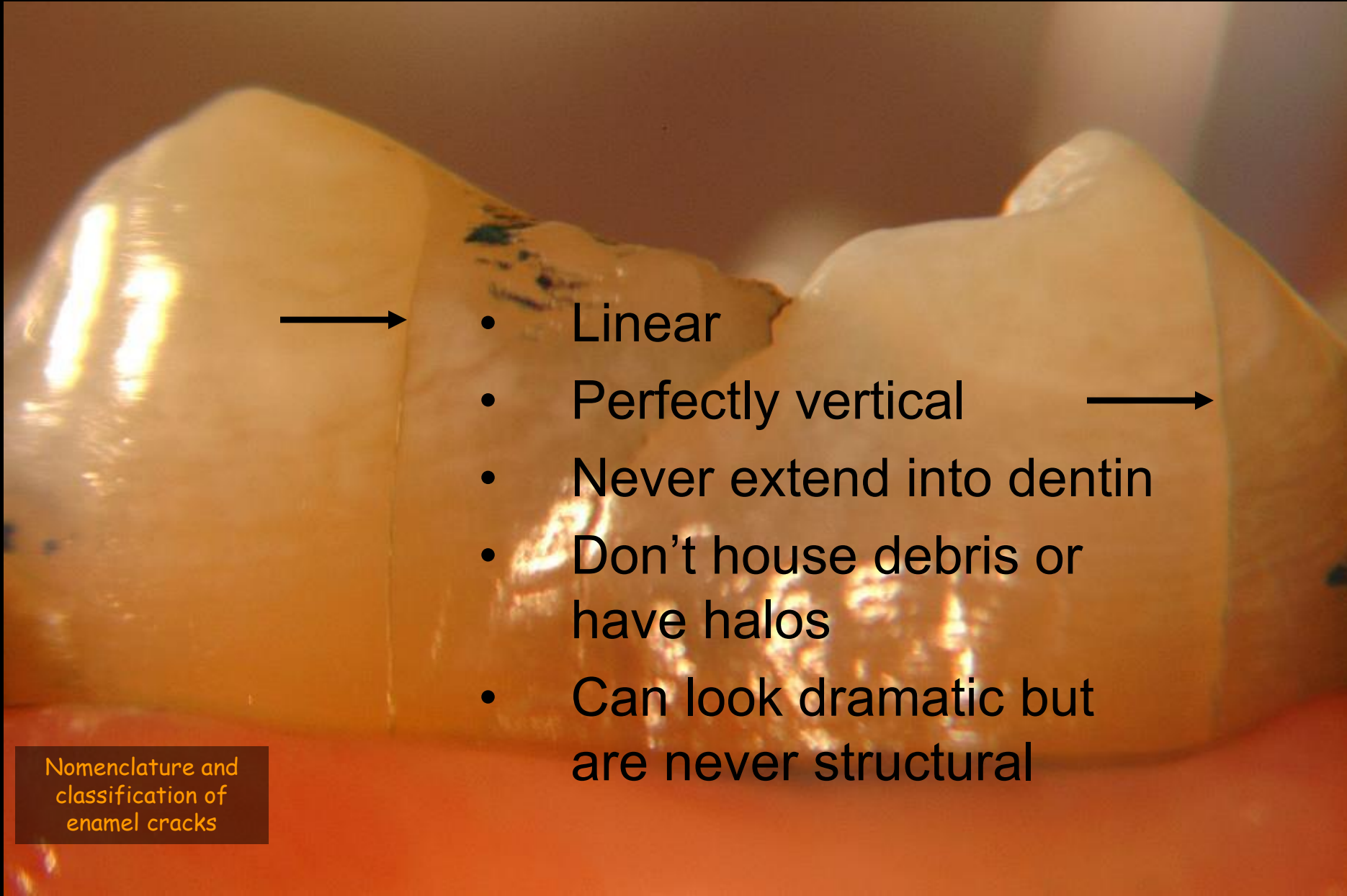
Type I: Have little or no risk of underlying pathology

- A) Craze lines
- B) Small vertical cracks
- C) Cracks that follow natural anatomic grooves
- D) Cracks with superficial stain penetration

Type I: Have little or no risk of underlying pathology

- F) Cracks Resulting from Polymerization Shrinkage of Composite
- G) Enamel Crackling in Aging, Thin, Cervical Enamel

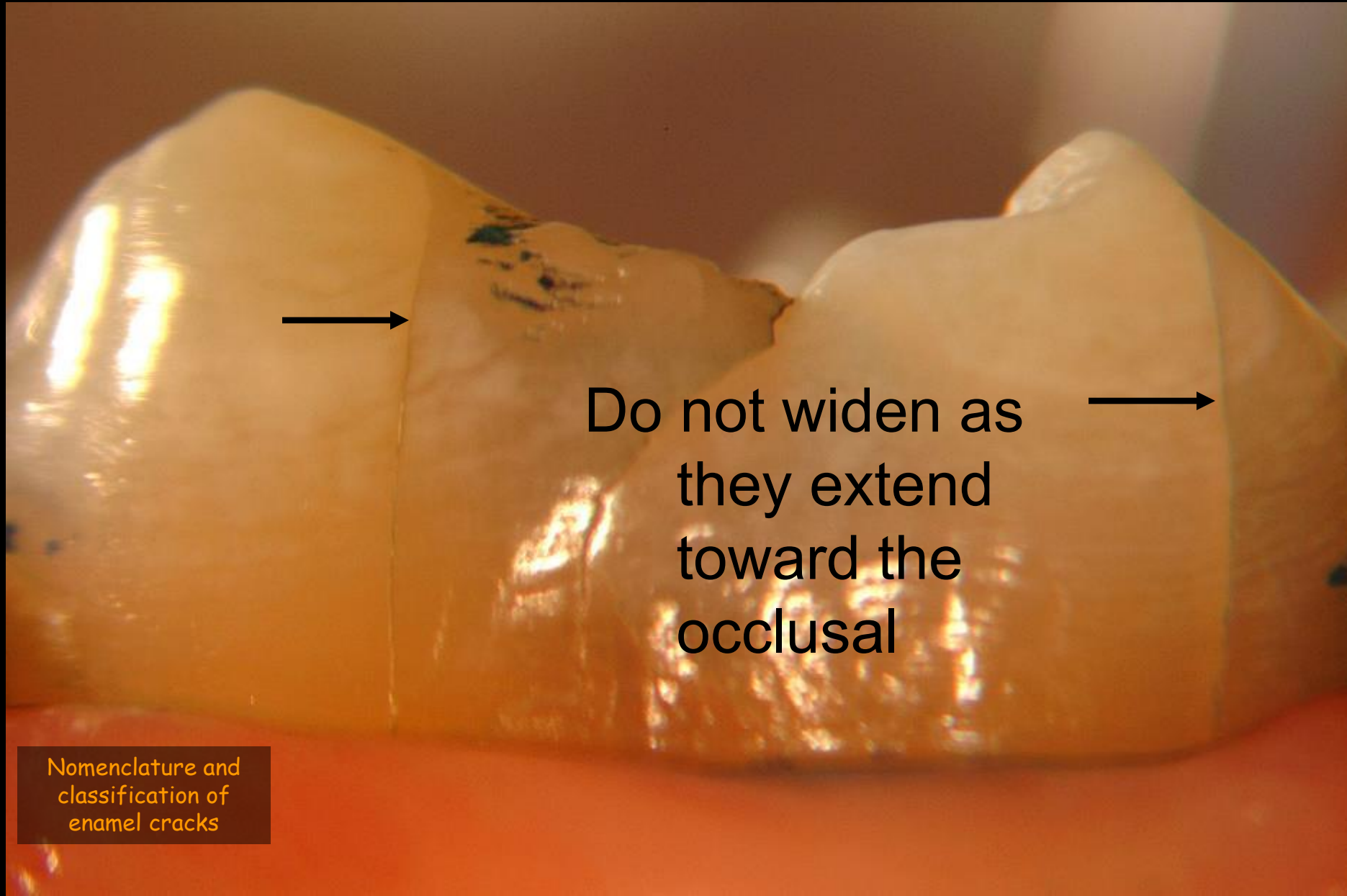
Craze Lines



- Linear
- Perfectly vertical
- Never extend into dentin
- Don't house debris or have halos
- Can look dramatic but are never structural

Nomenclature and
classification of
enamel cracks

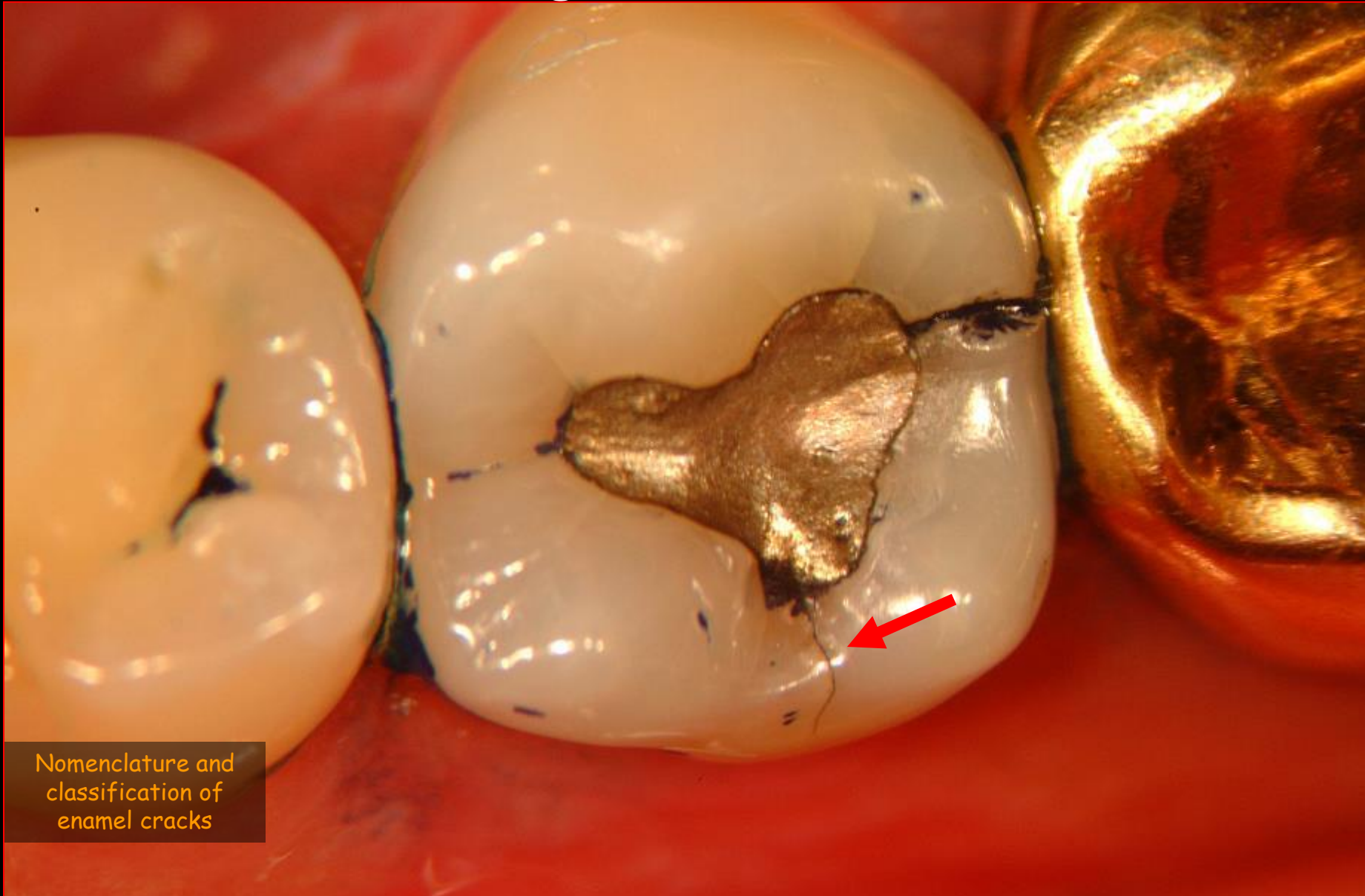
Craze Lines



Do not widen as
they extend
toward the
occlusal

Nomenclature and
classification of
enamel cracks

C. Cracks that follow anatomic grooves

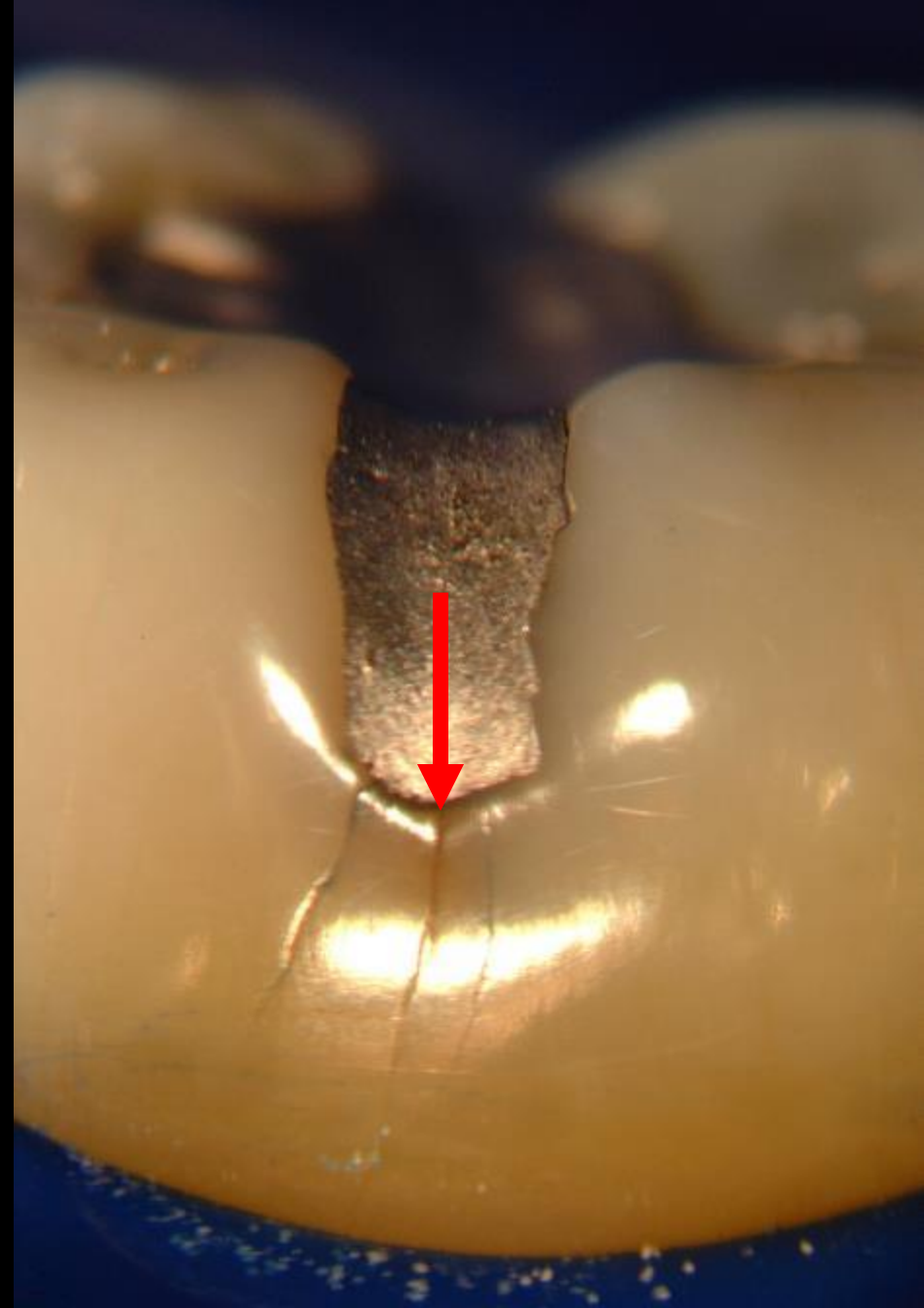


Nomenclature and
classification of
enamel cracks

C. Cracks that follow natural anatomic grooves

D Superficially Stained Cracks

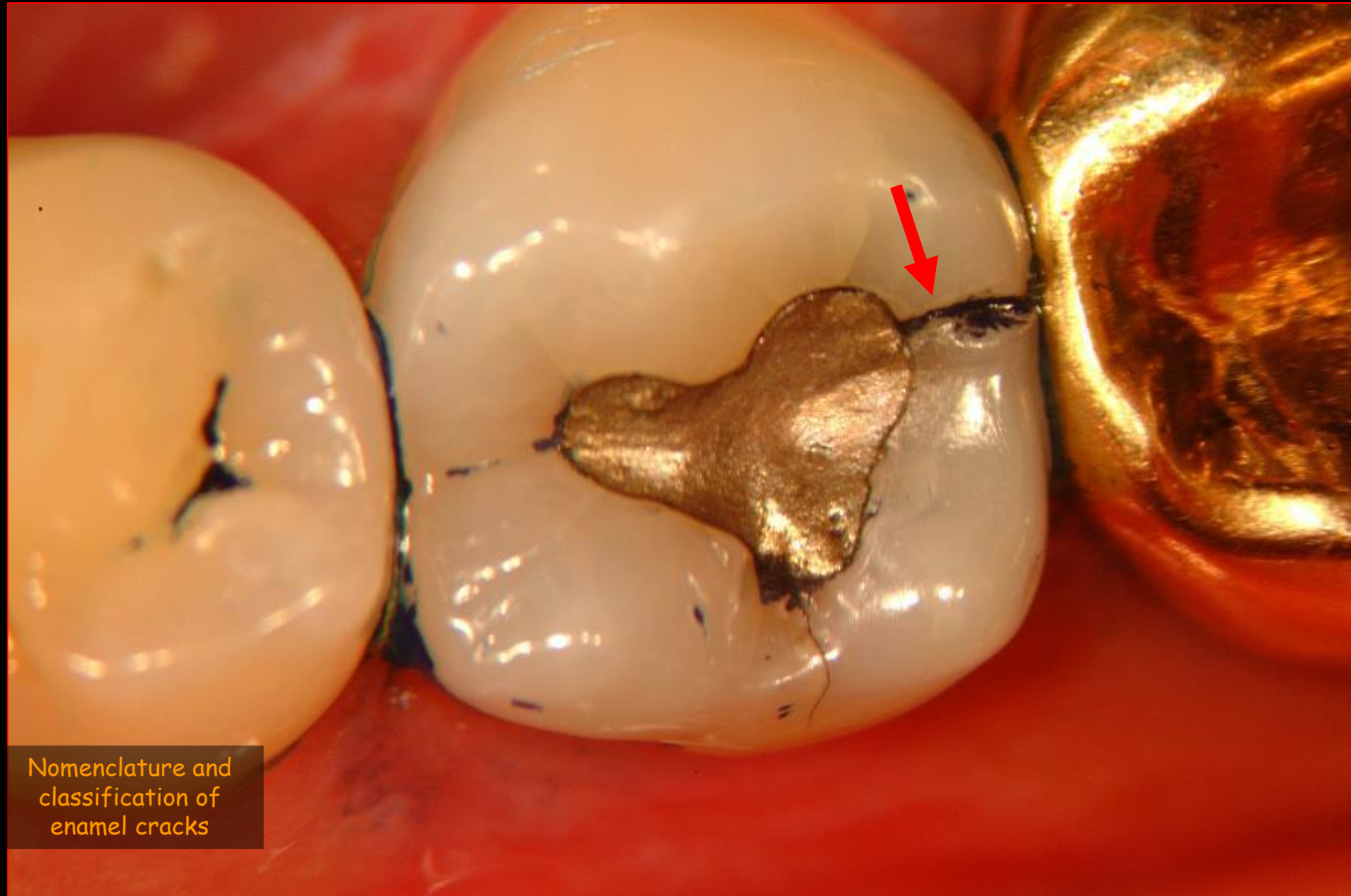
Nomenclature and
classification of
enamel cracks



Type II: Have moderate risk of underlying pathology

- A) V-shaped enamel ditching with no adjoining restoration often associated with a wear facet centered over an otherwise benign crack
- B) V-shaped enamel ditching with a prior restoration often associated with a wear facet centered over an otherwise benign crack
- C) Cracks that detour from or do not follow natural anatomic grooves

B. V shaped ditching



Nomenclature and
classification of
enamel cracks

C. Non linear cracks that detour from or do not follow natural anatomic grooves



Type II: Have moderate risk of underlying pathology

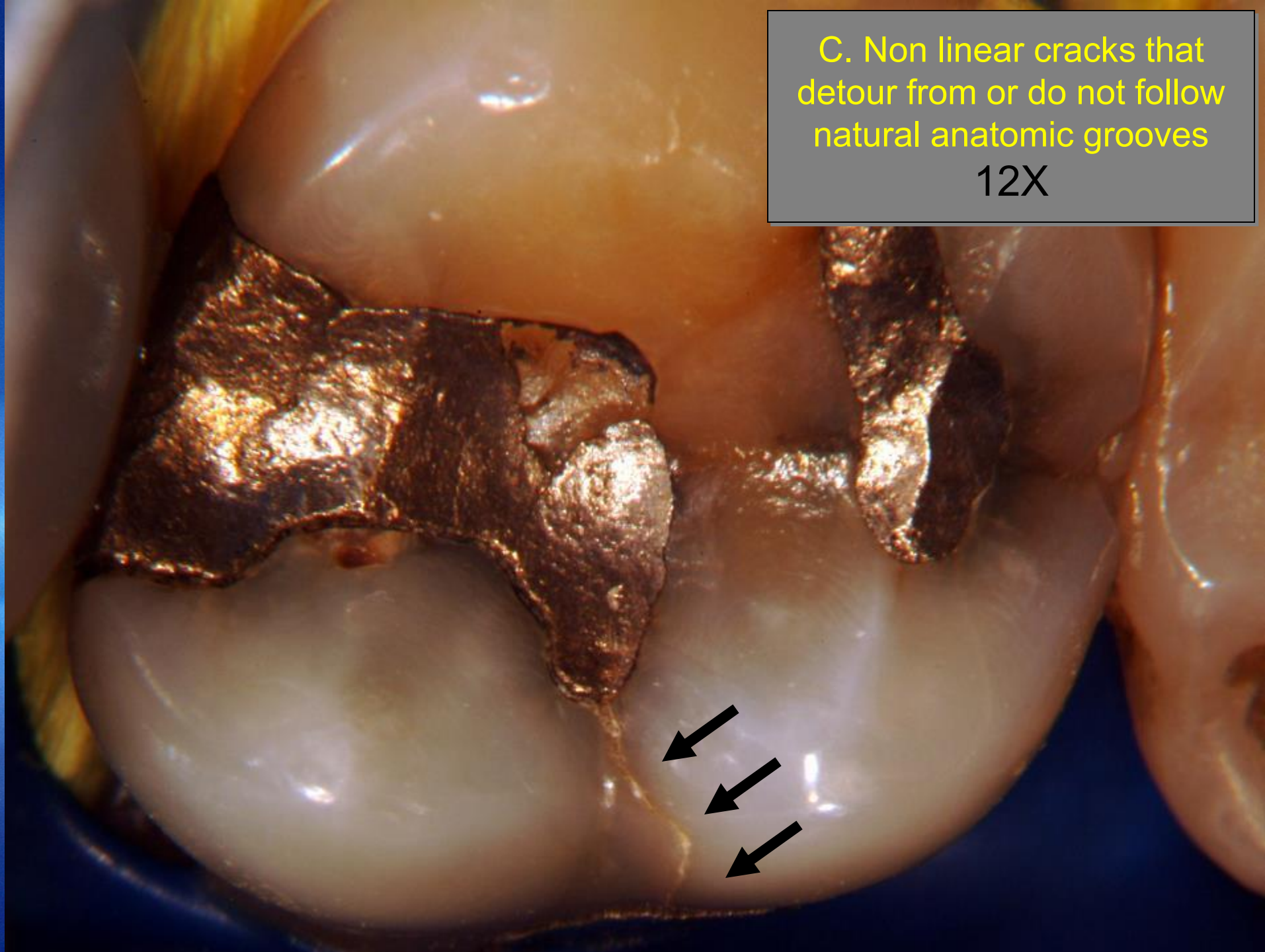
- A) V-shaped enamel ditching with or without an adjoining restoration often associated with a wear facet centered over an otherwise benign crack
- B) Cracks that detour from or do not follow natural anatomic grooves



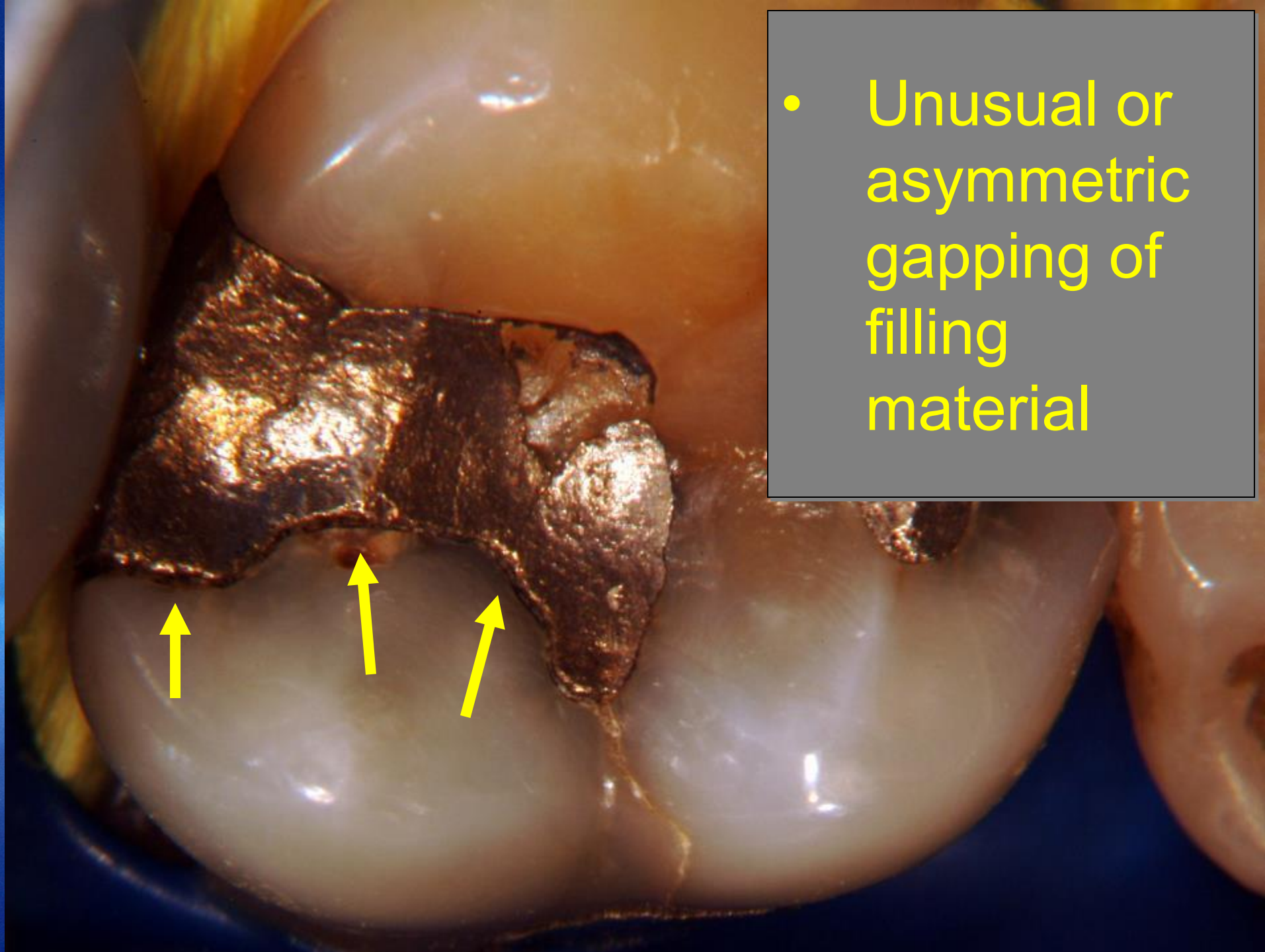
8X

C. Non linear cracks that
detour from or do not follow
natural anatomic grooves

12X

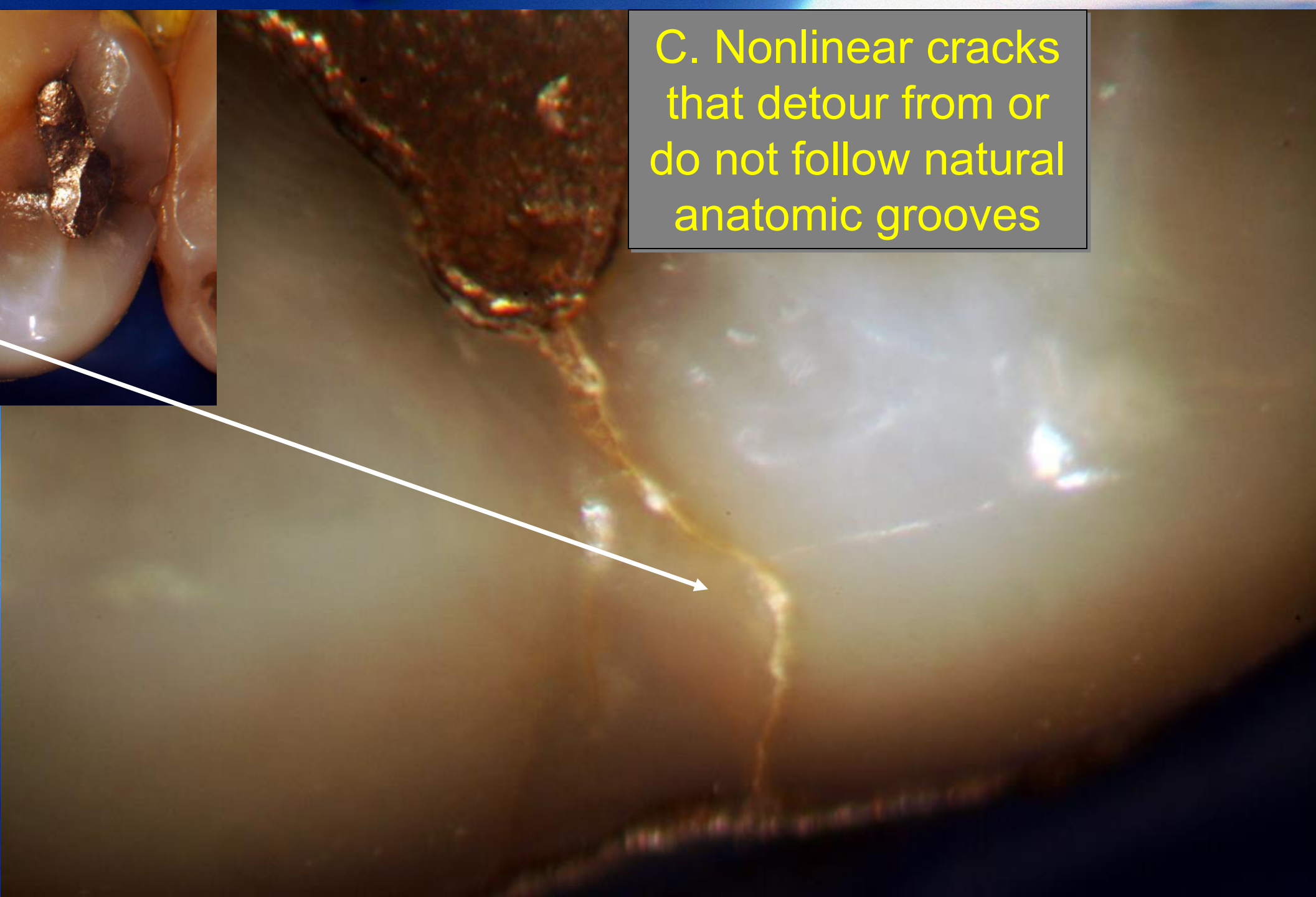


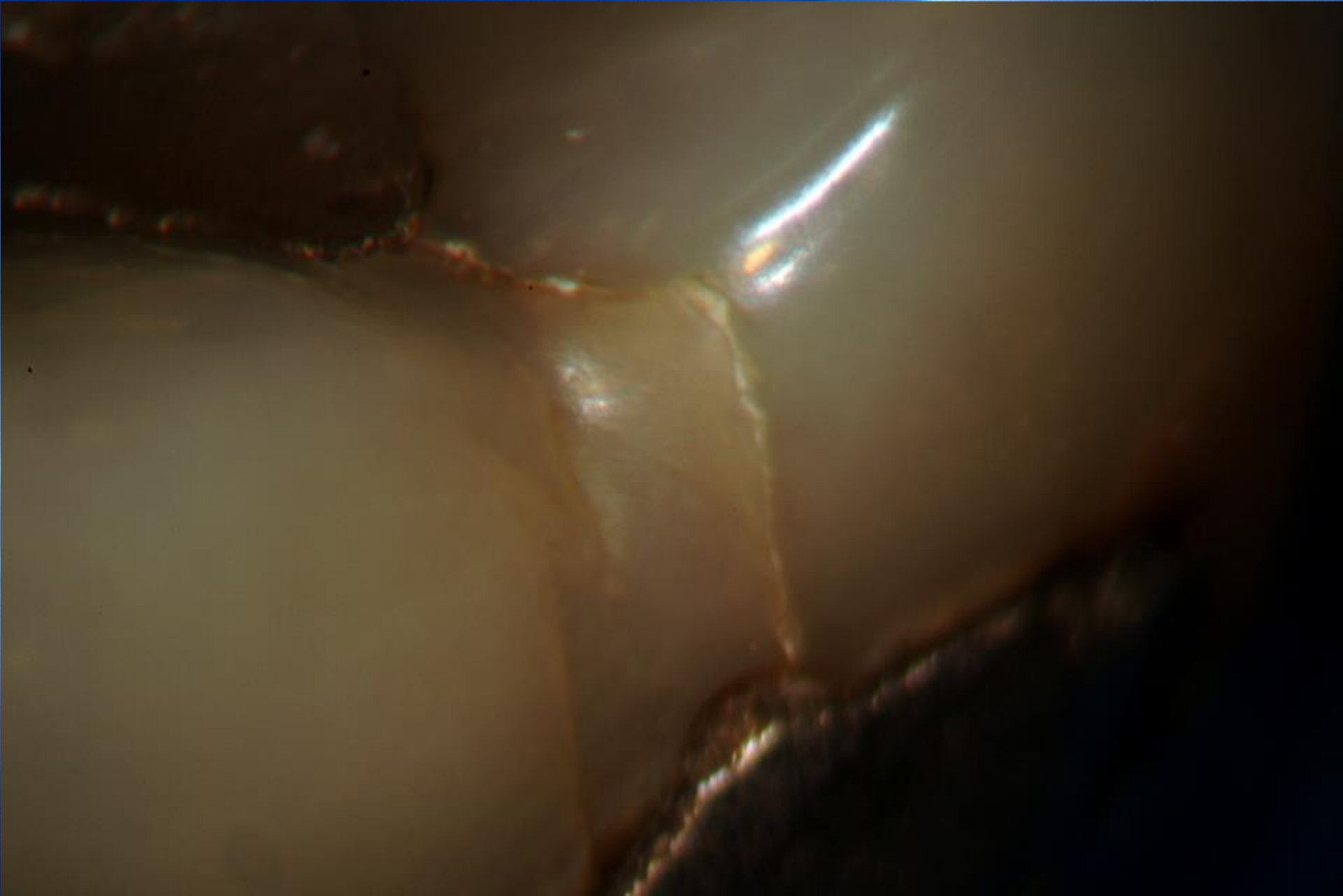
- Unusual or asymmetric gapping of filling material



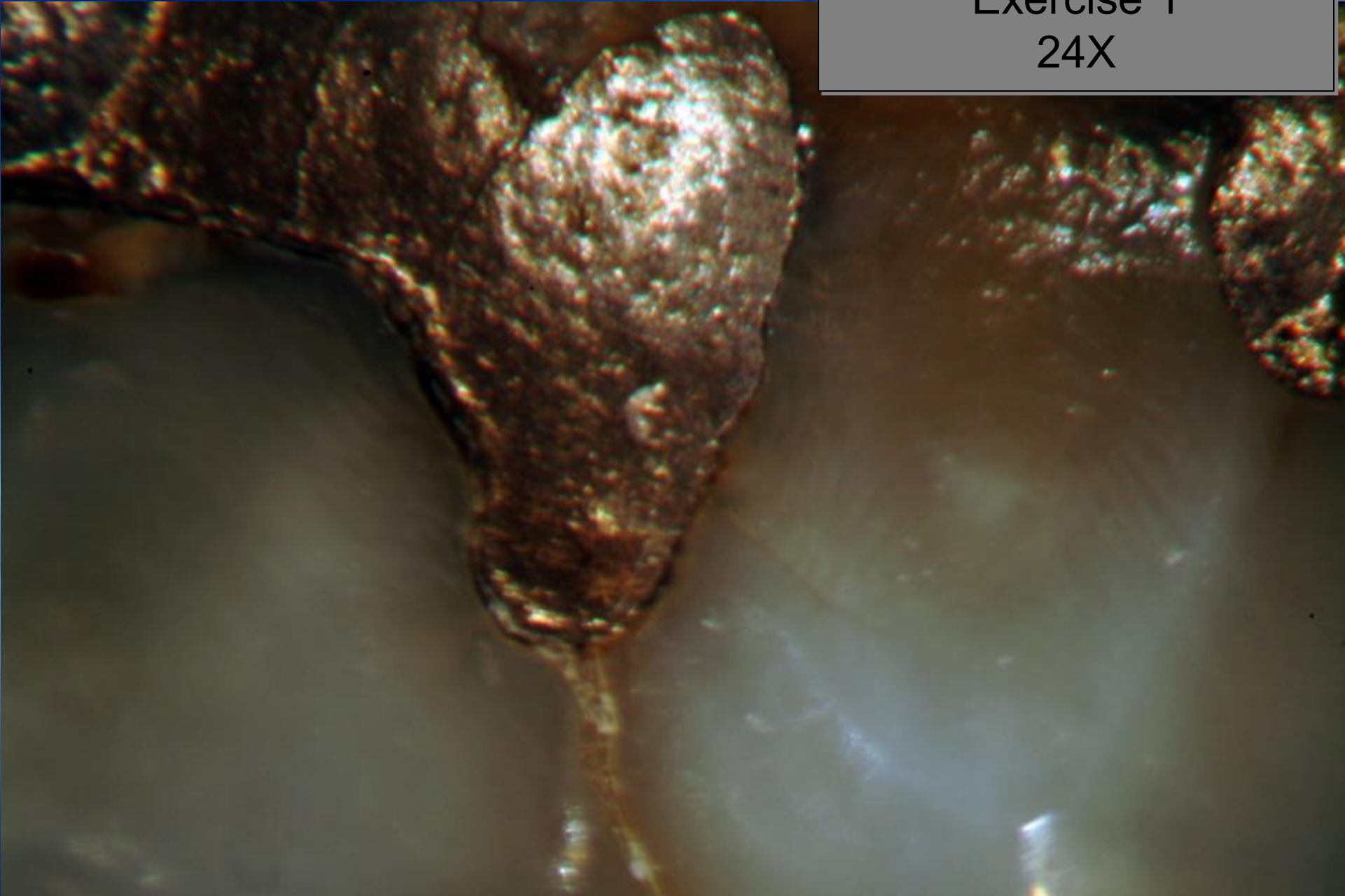


C. Nonlinear cracks that detour from or do not follow natural anatomic grooves

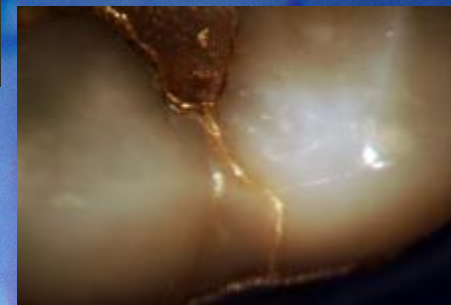
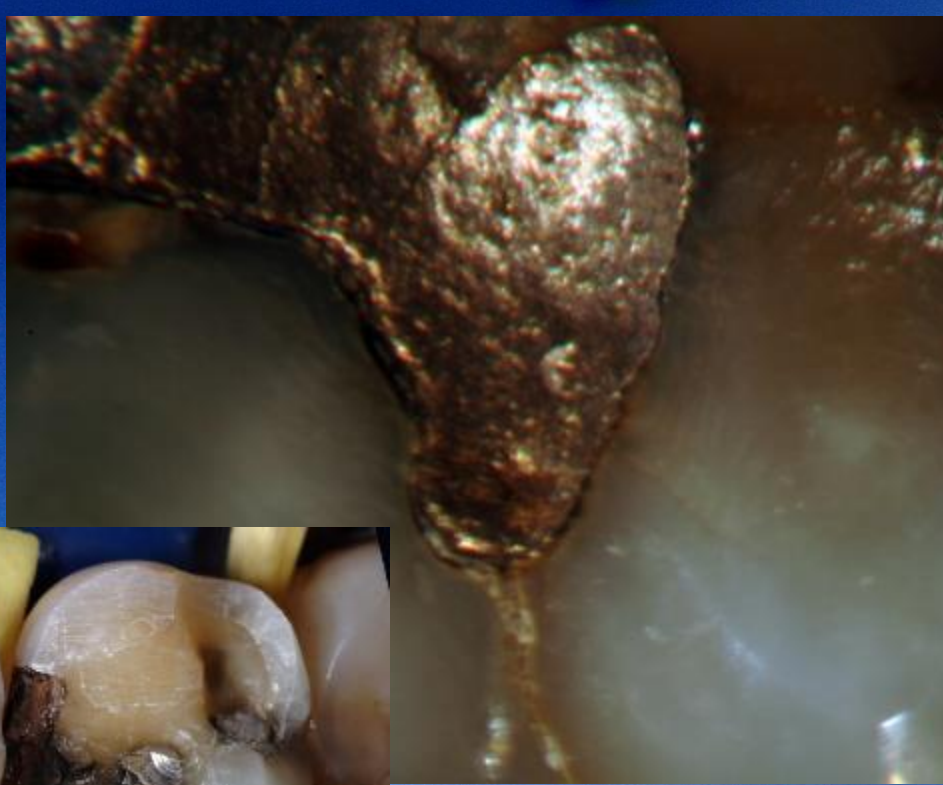




Exercise 1
24X



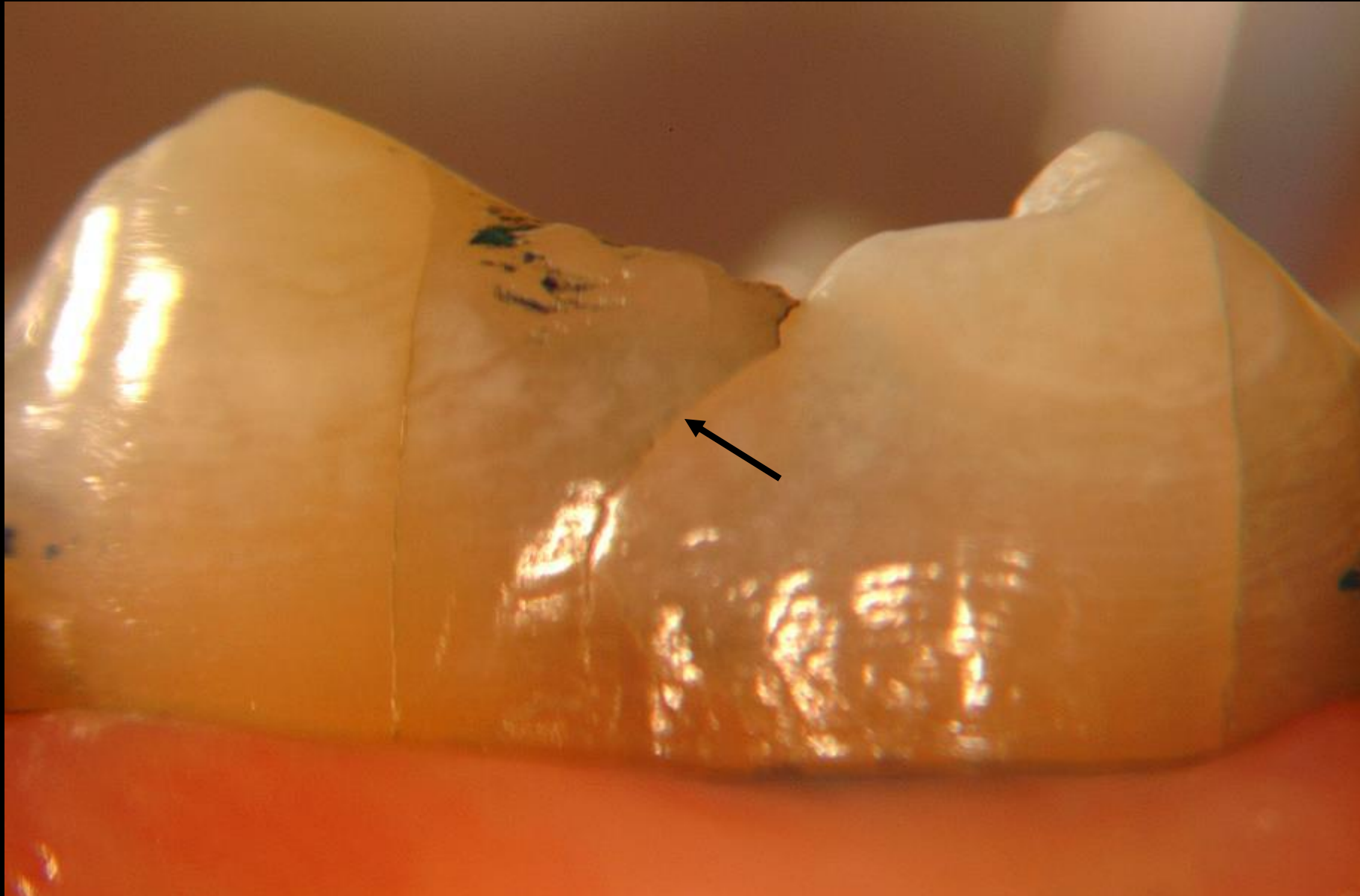




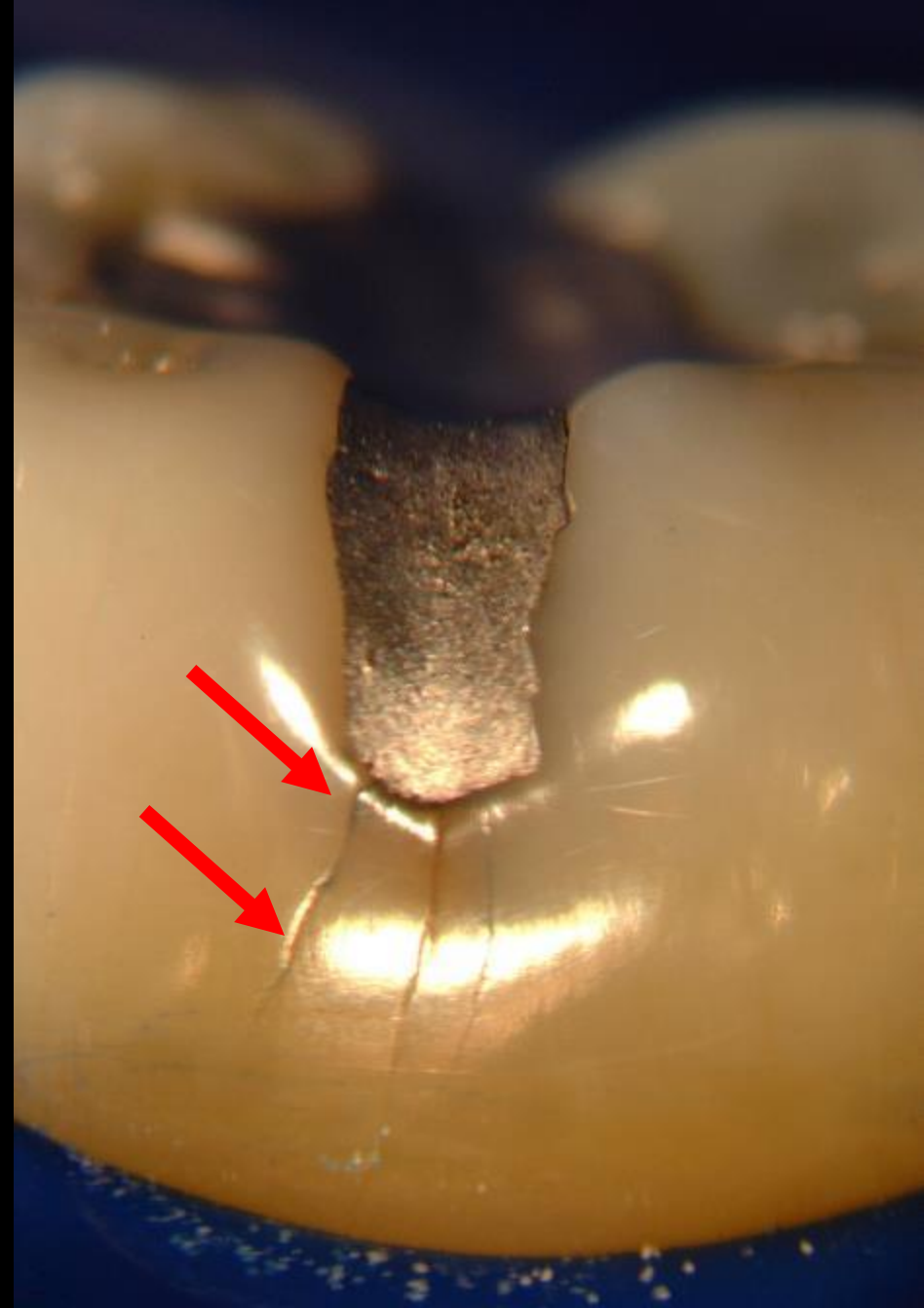
Type III: Have high risk of underlying pathology

- A) Diagonal cracks branching off a vertical crack
- B) Horizontal or diagonal cracks that emanate from the corner of a restoration
- C) Cracks that house debris
- **D) The tooth looks gray**

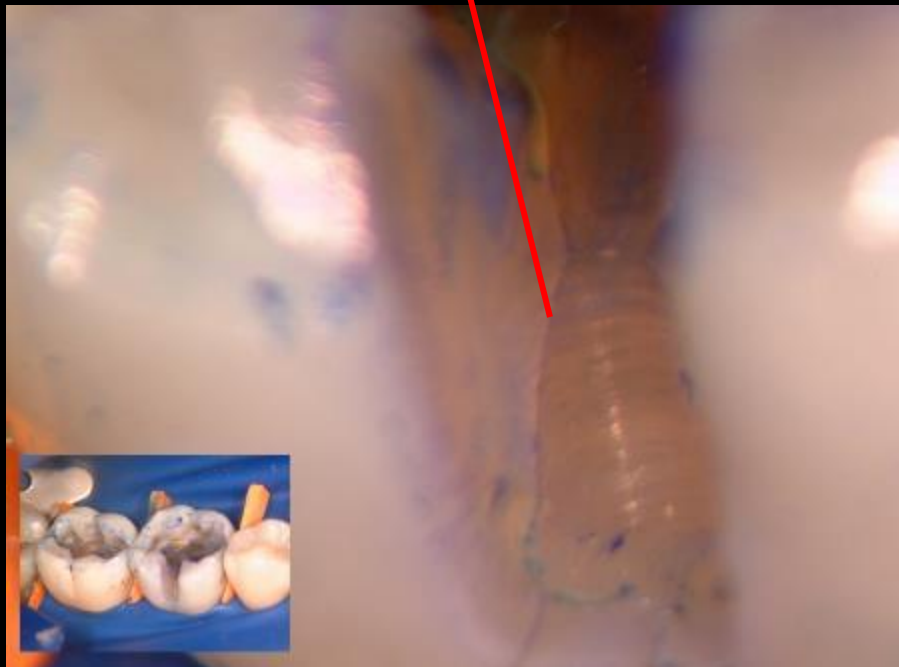
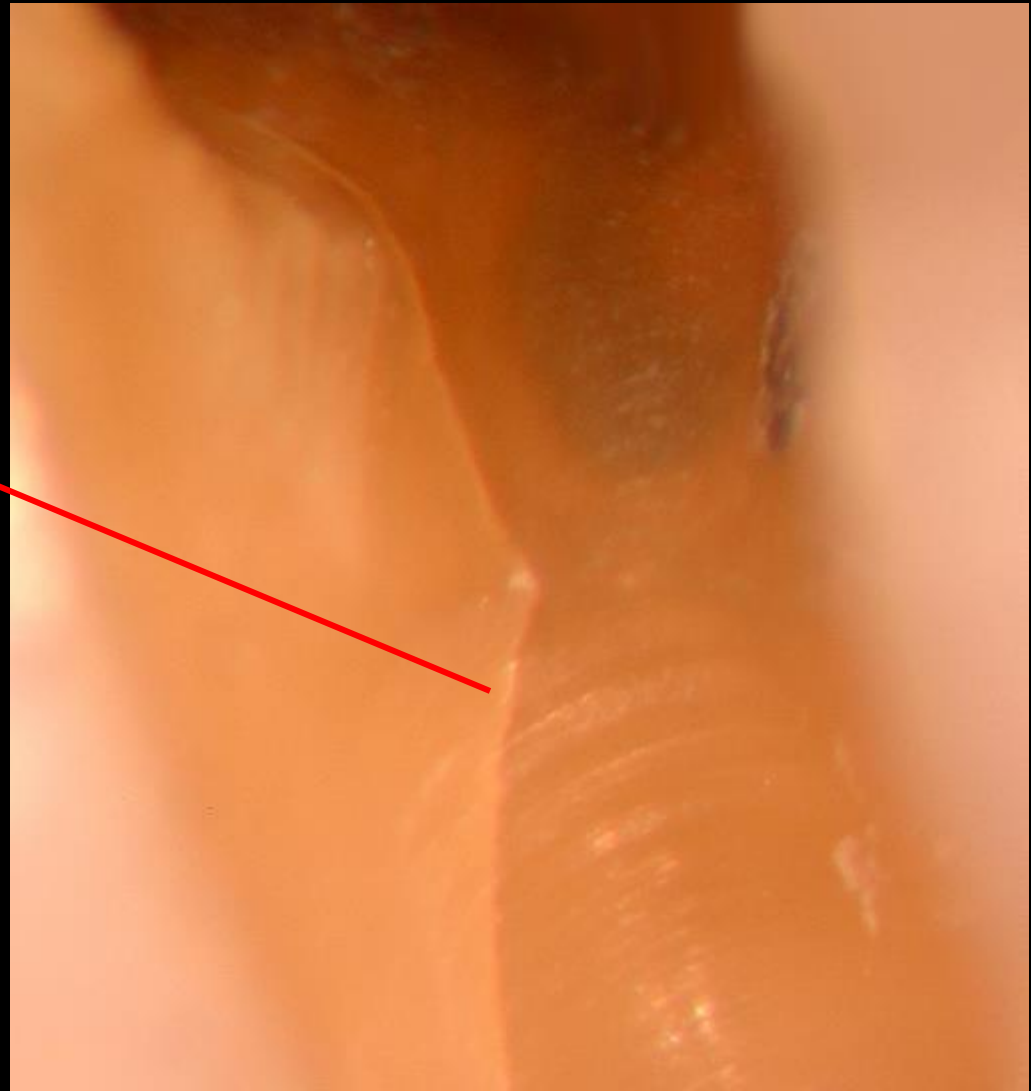
A. Diagonal cracks



B. Diagonal cracks that emanate from the corner of a restoration

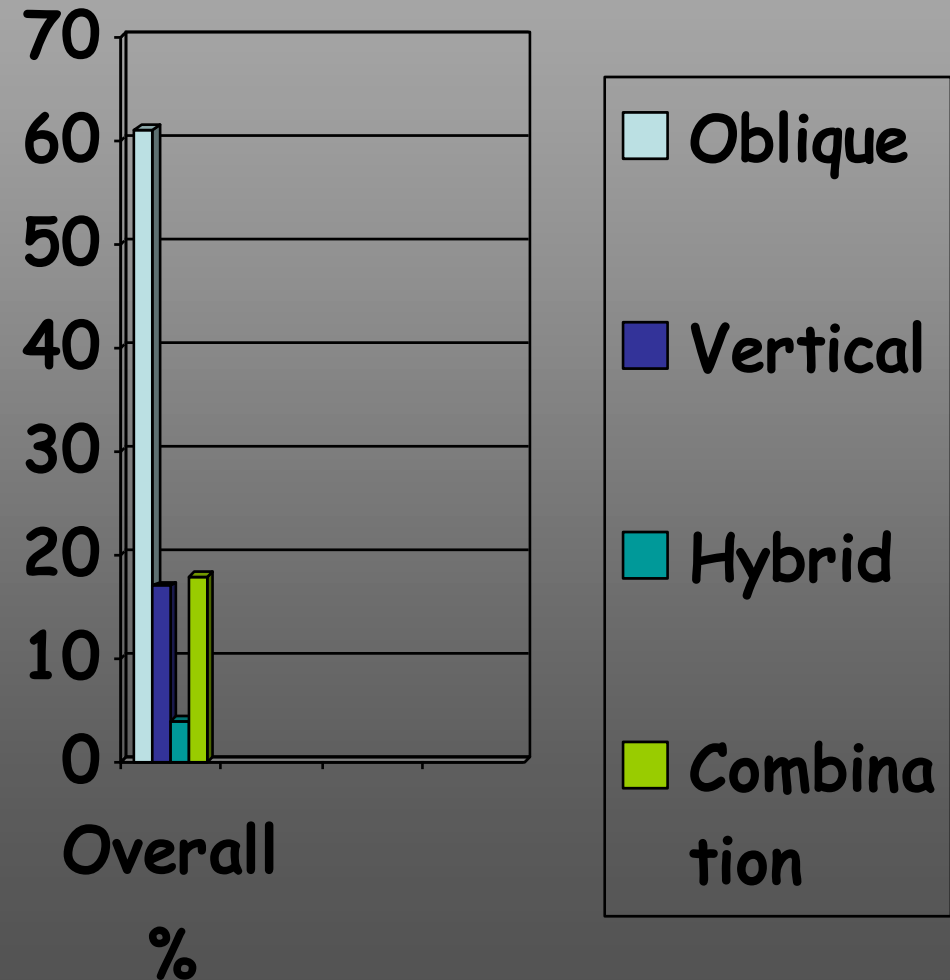


Nomenclature and
classification of
enamel cracks



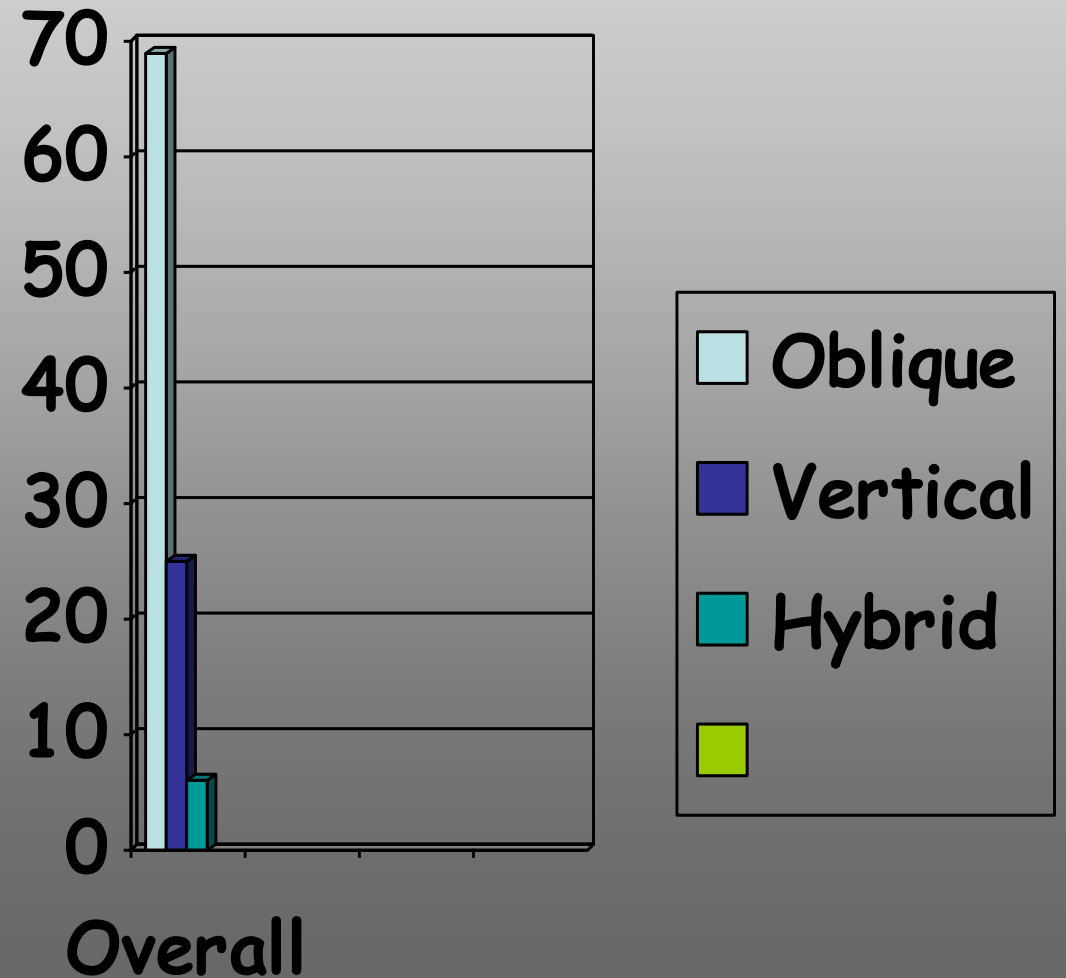
A Two Year Study 2001-2003

- 120 Teeth
- 24 months
- Every tooth treated restoratively examined at 16x after restorative material removed

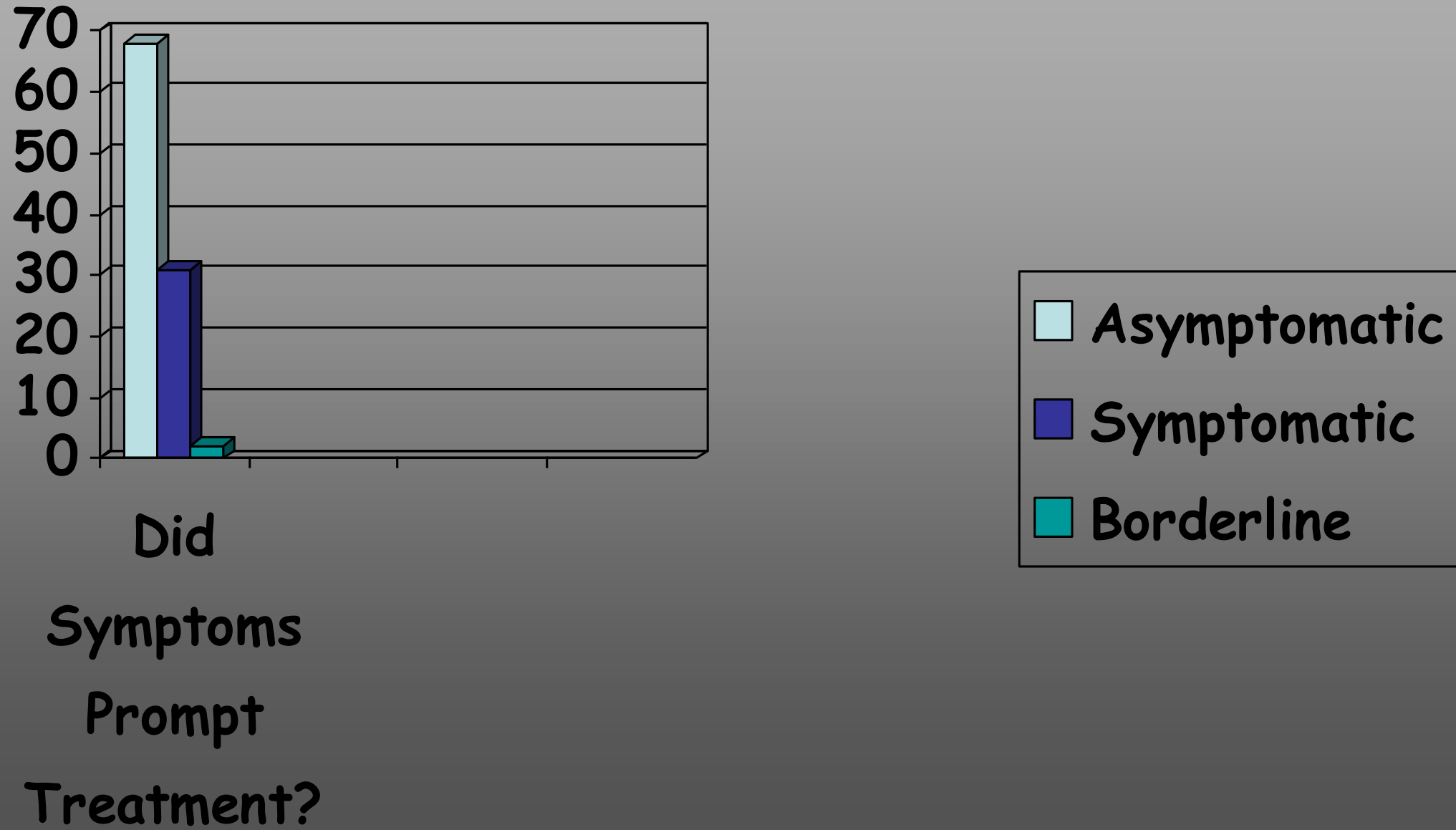


A Two Year Study

- 120 Teeth
- 188 Dentin Cracks
(Incomplete Fractures)



A Two Year Study



- The third leading cause of tooth loss today is from splits/fractures. (Lynch CD McCinnel RJ. The cracked tooth Syndrome. J Dent Assoc Sept 2002; 68(8):470-475)
- Crack initiation and progression should not be labeled a “syndrome”
- Diagnosis and treatment should be similar to approaches we utilize to address other pathologies (i.e. caries, periodontal disease)

B. Diagonal cracks that emanate from the corner of a restoration



2X

Nomenclature and
classification of
enamel cracks

B. Diagonal cracks that emanate from the corner of a restoration



4X

B. Diagonal cracks that emanate from the corner of a restoration



8X

B. Diagonal cracks that emanate from the corner of a restoration



B. Diagonal cracks that emanate from the corner of a restoration



12X

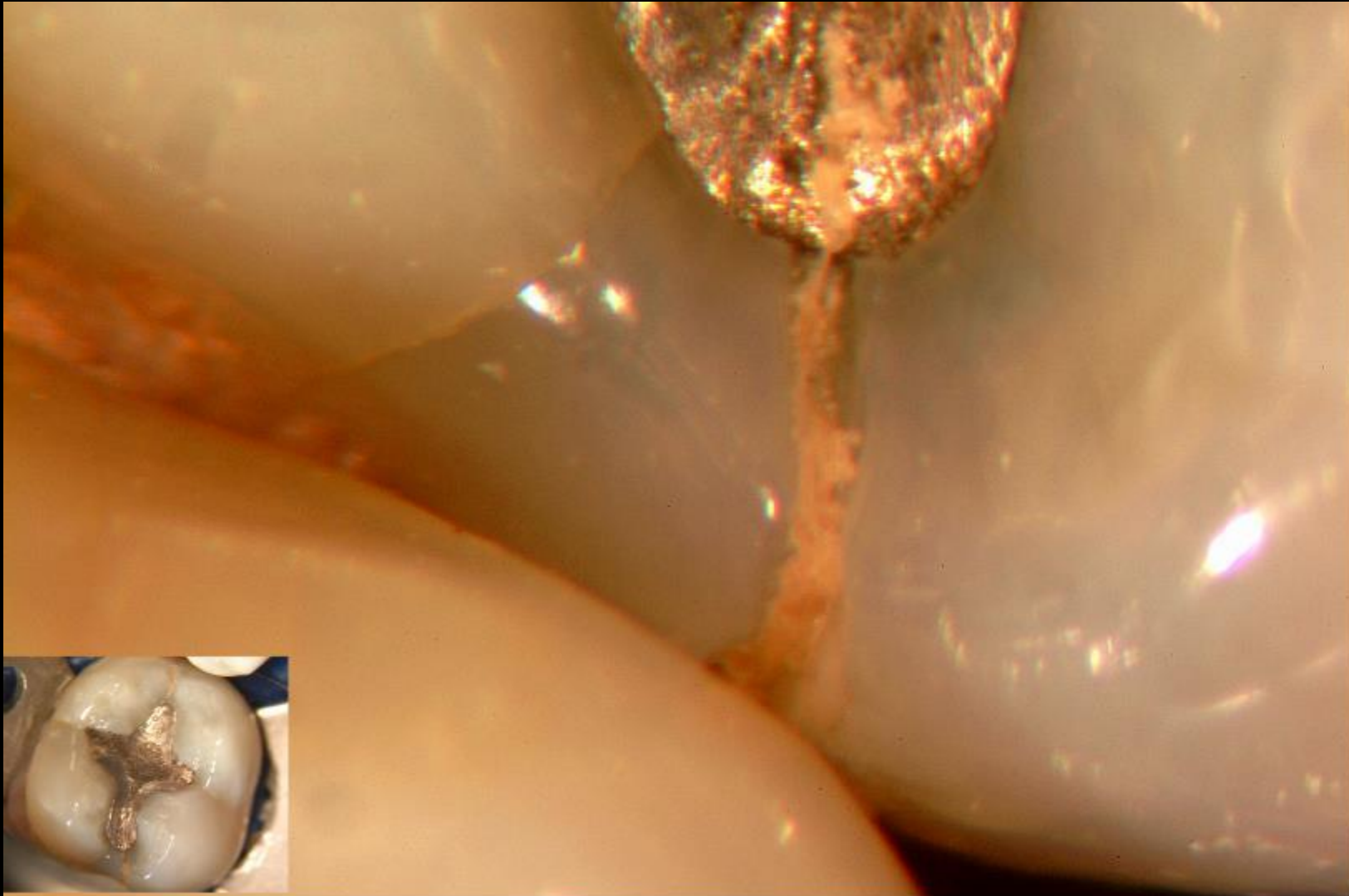


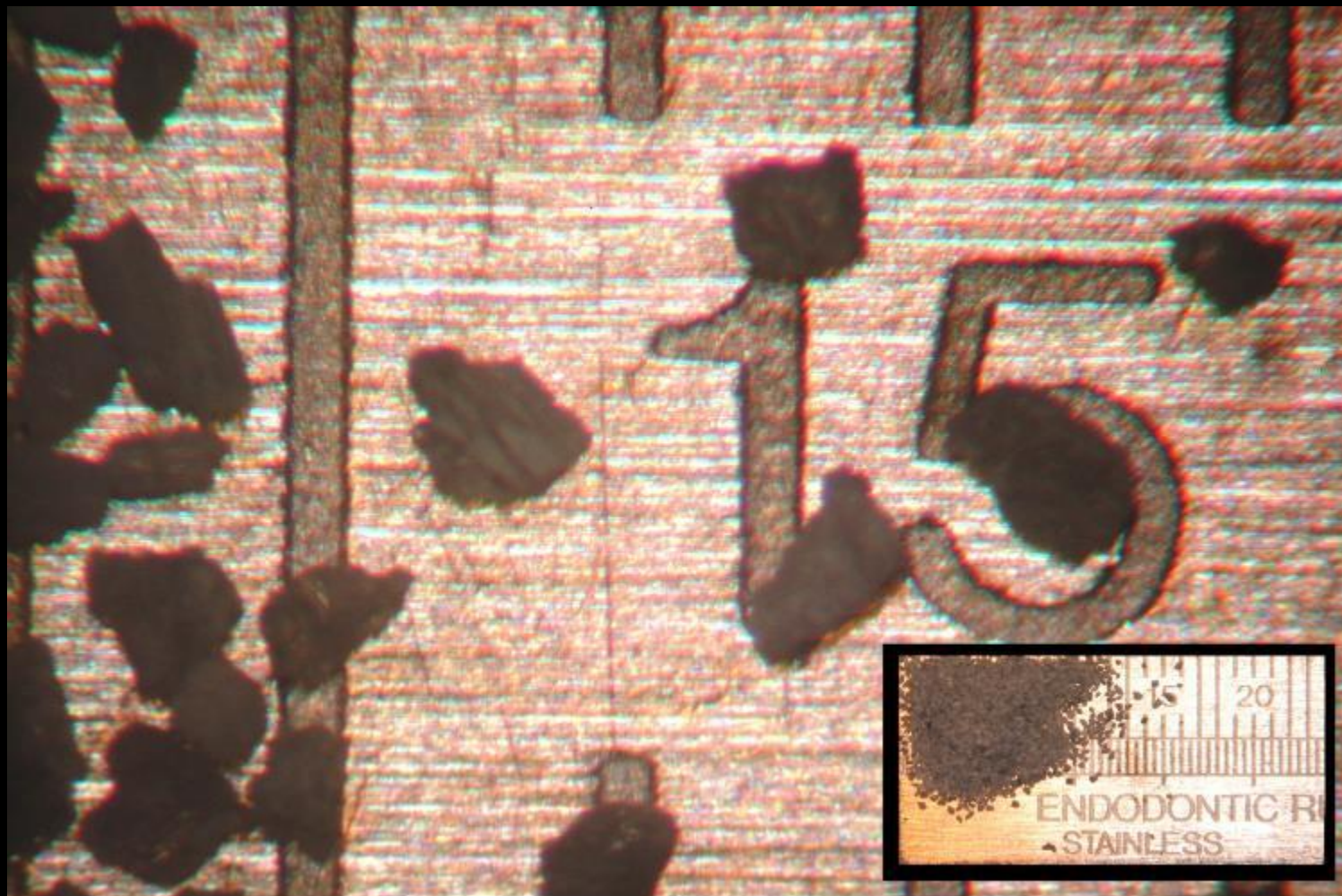
16X

B. Horizontal cracks



C. Crack that houses debris





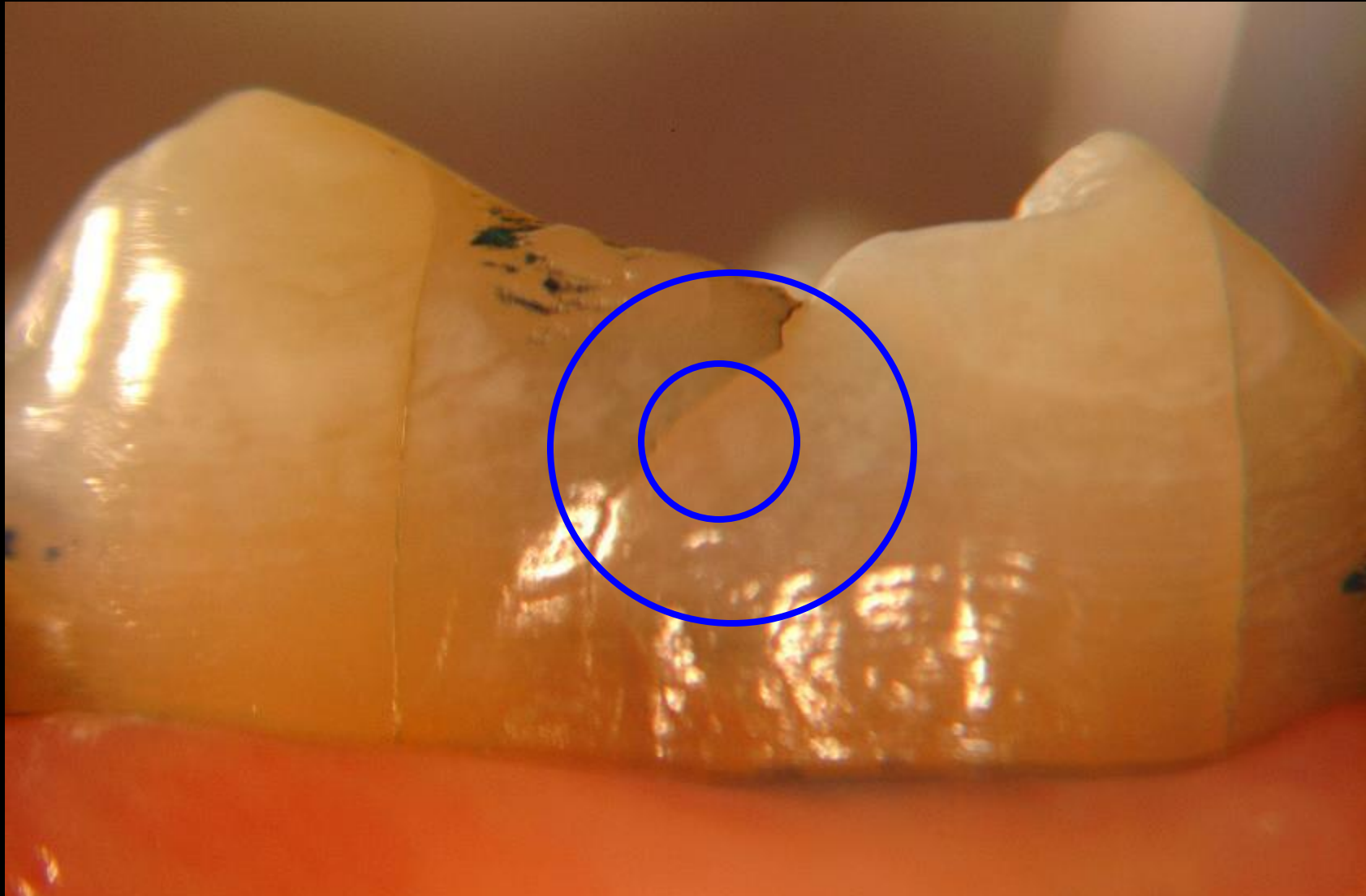
Type III: Have high risk of underlying pathology

- D. Pair of cracks that outline an area (cusp or marginal ridge) of discolored enamel
- E. Crack with corresponding halo of brown, grey or white centered on crack

D. Pair of cracks that outline an area (cusp or marginal ridge) of discolored enamel



E. Crack with corresponding halo of brown, grey or white centered on crack



E. Crack with corresponding halo of brown, grey or white centered on crack



Other Microscopic Findings That Can Indicate a Lack of Coronal Structural Integrity

- Unusual or asymmetric gapping of filling material
- Crack in Filling material
- Gray discoloration of a cusp or cusps



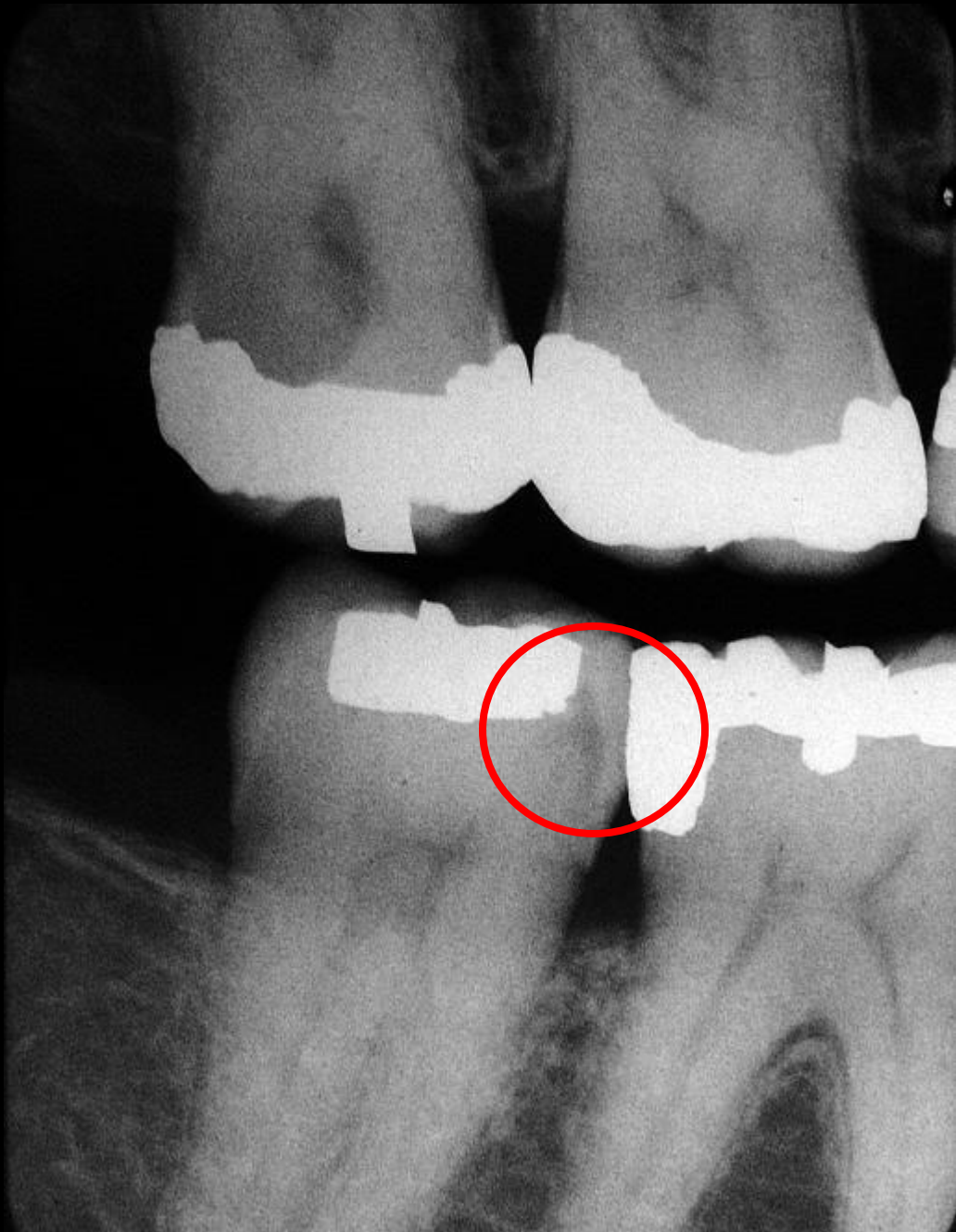


A Tale of Three Marginal Ridges



A Tale of Three Marginal Ridges



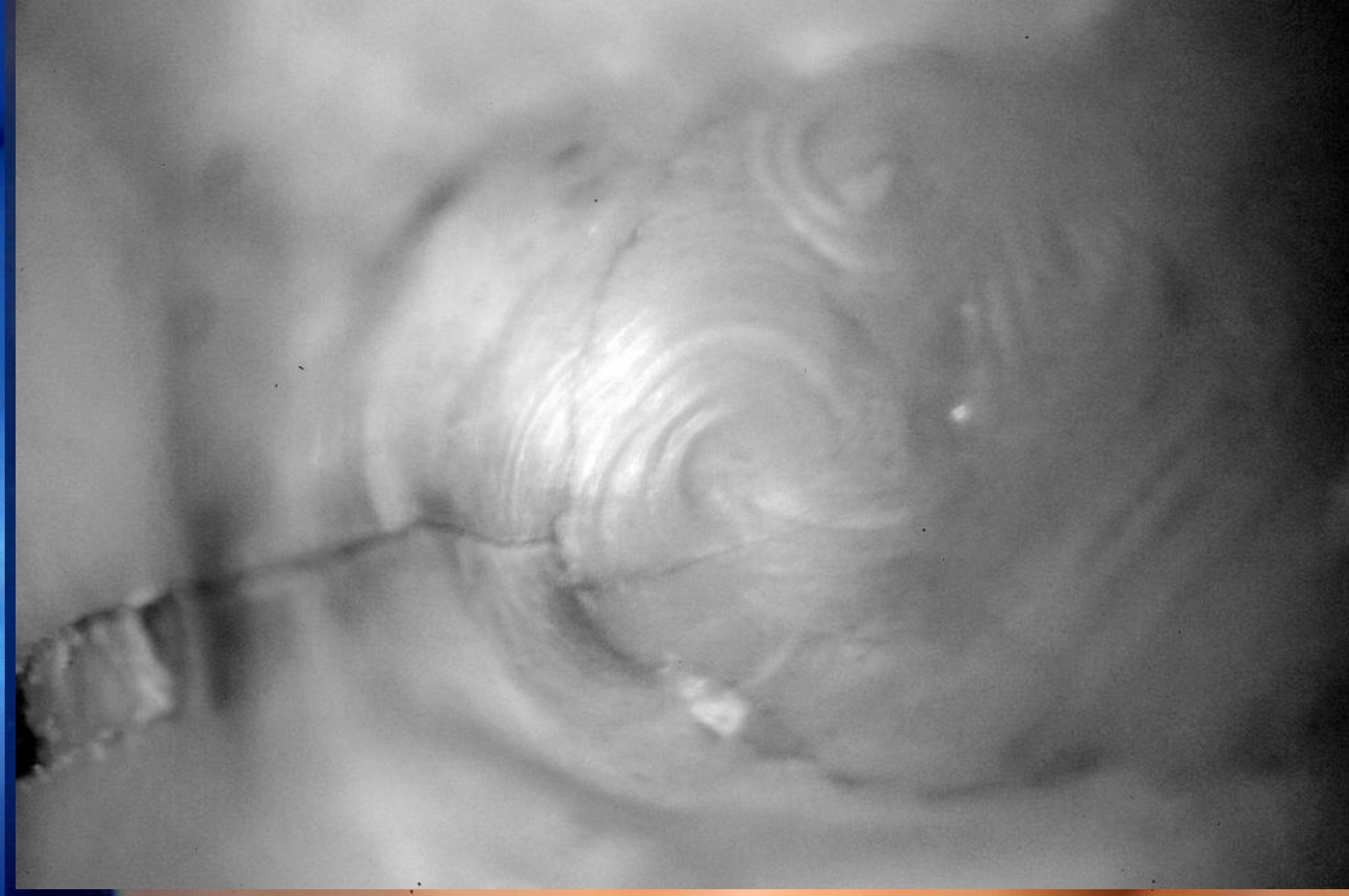


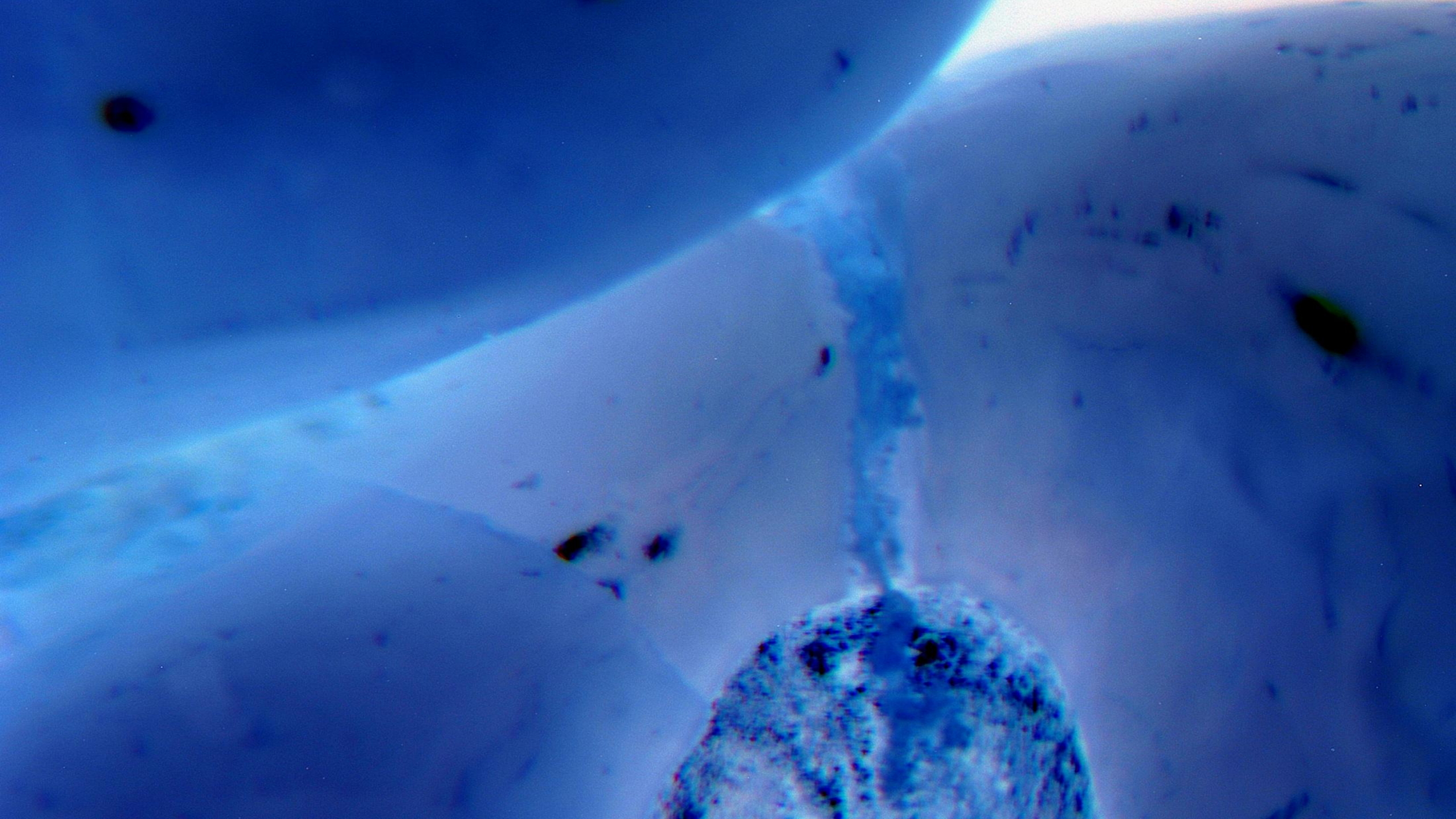


A Tale of Three Marginal Ridges



A Tale of Three Marginal Ridges





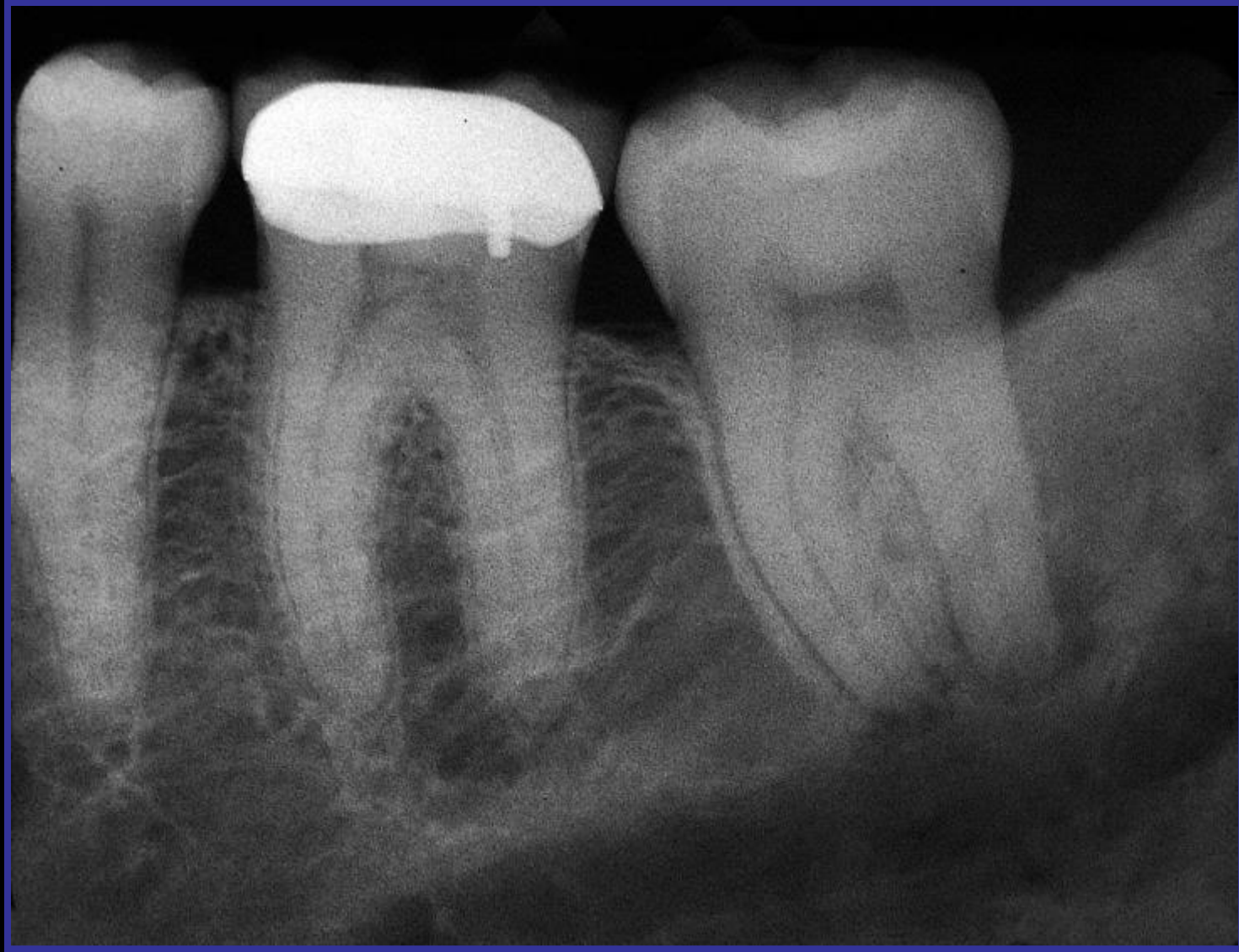


A Tale of Three Marginal Ridges

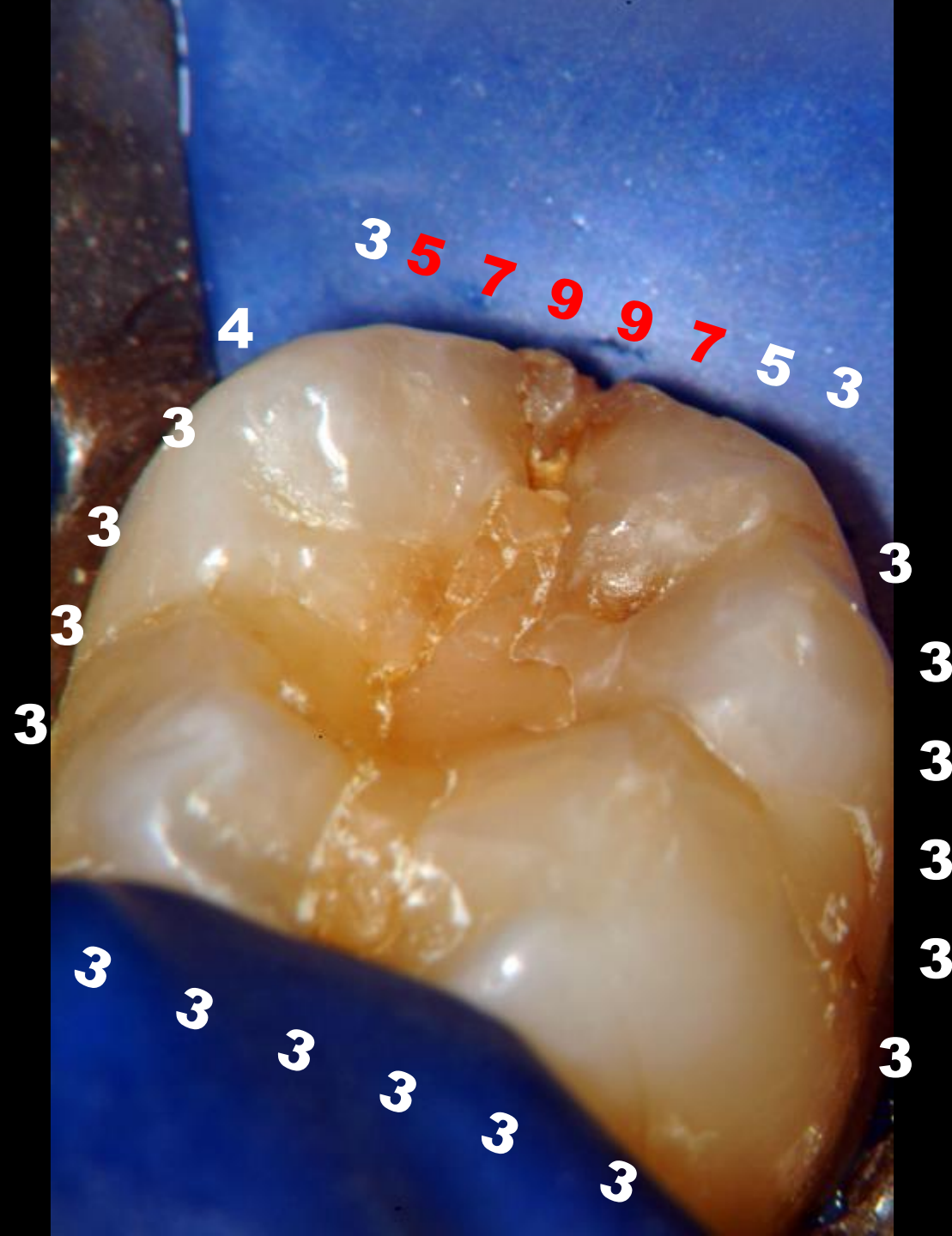


A Tale of Three Marginal Ridges

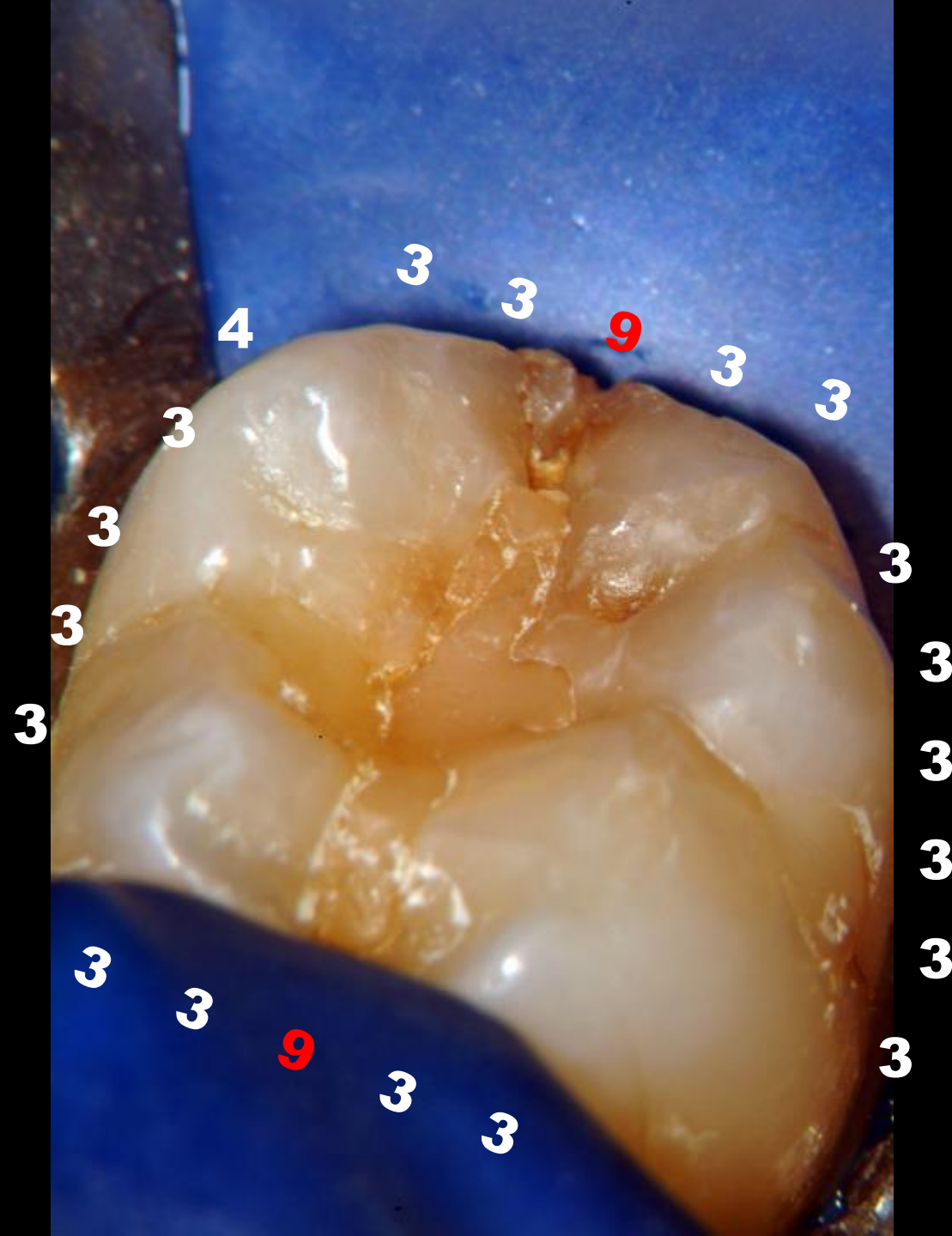




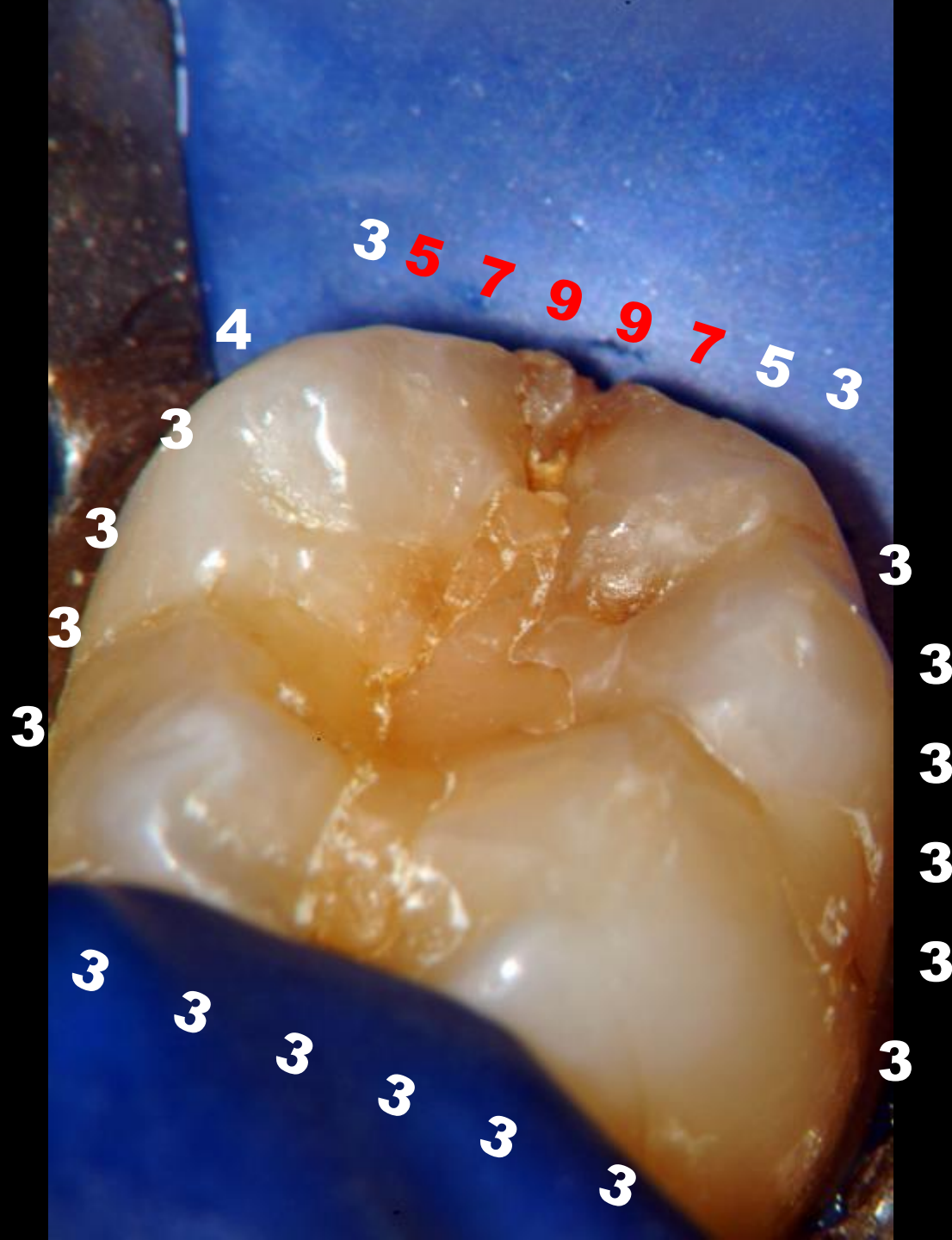
What
we
probed

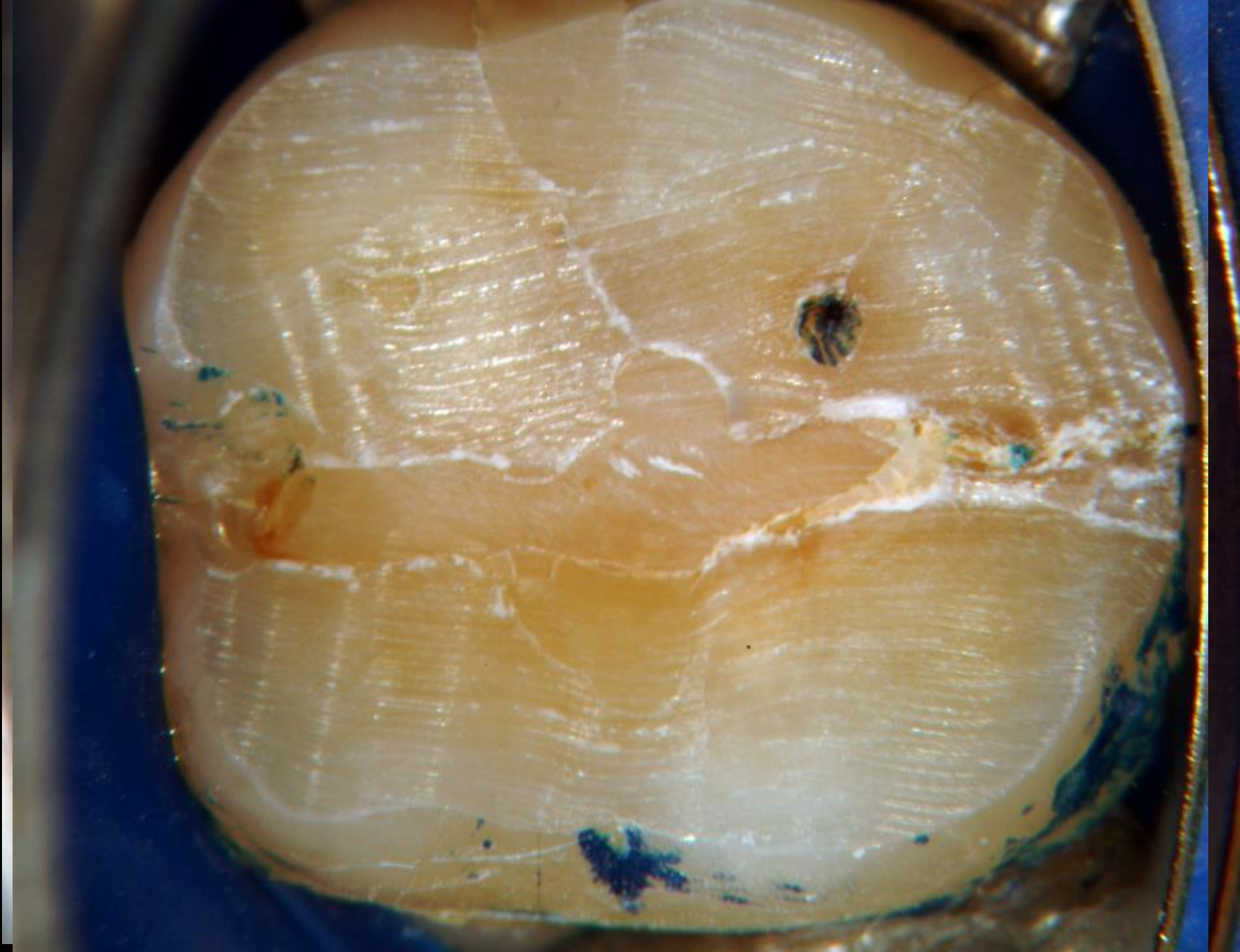


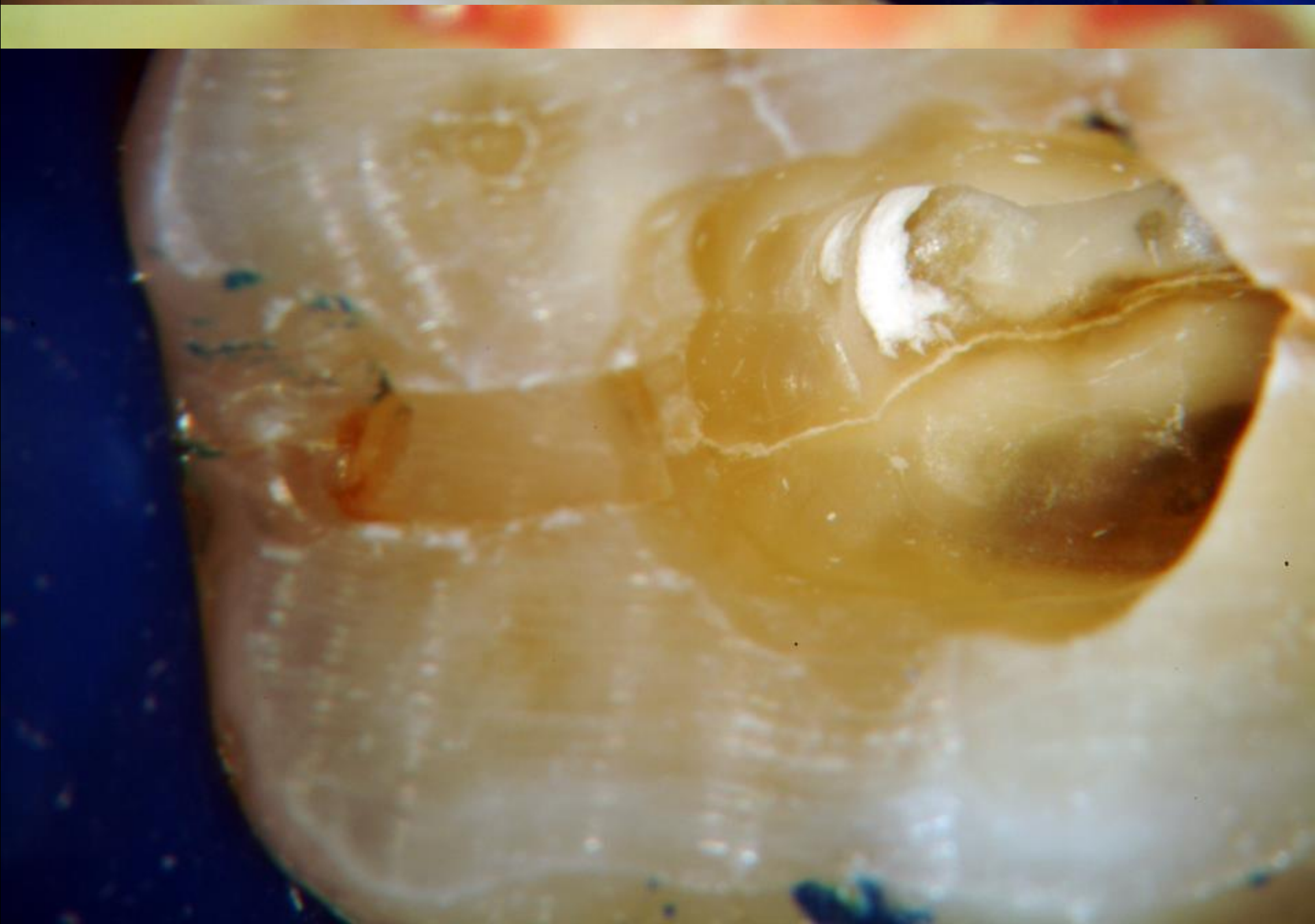
What
we
expected

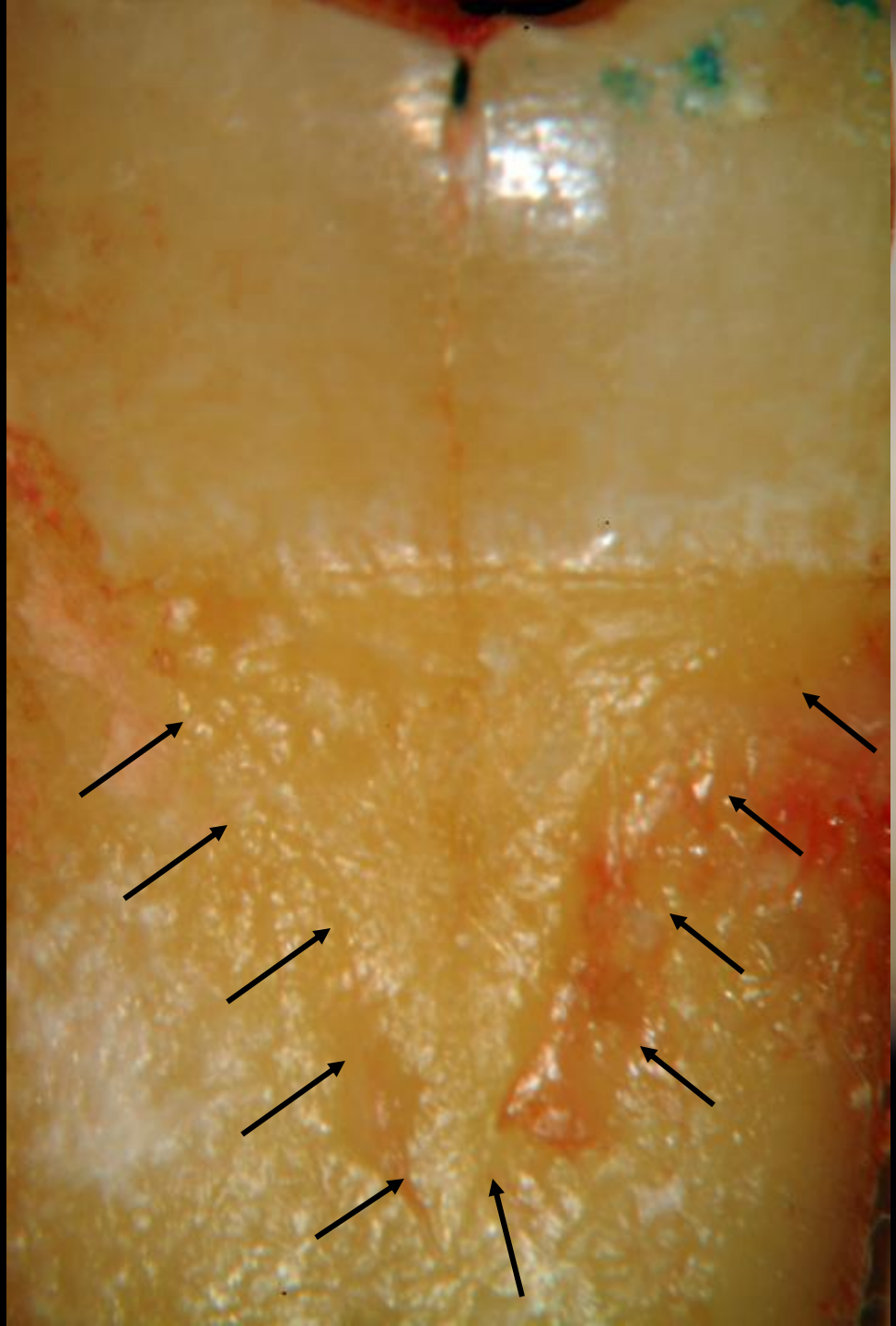


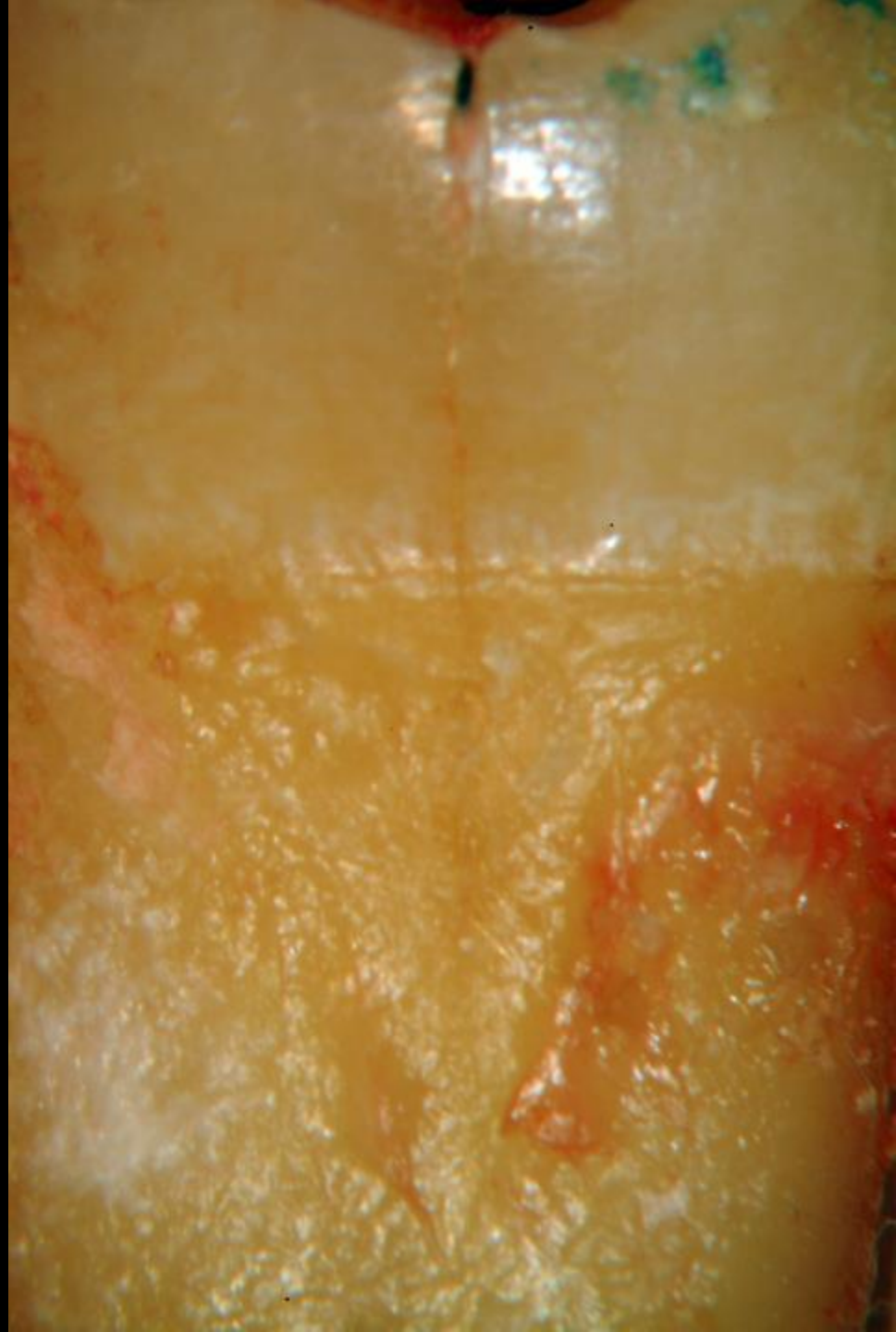
What
we
probed



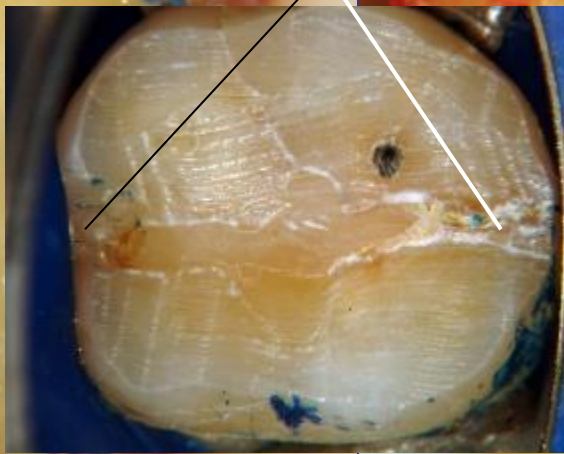
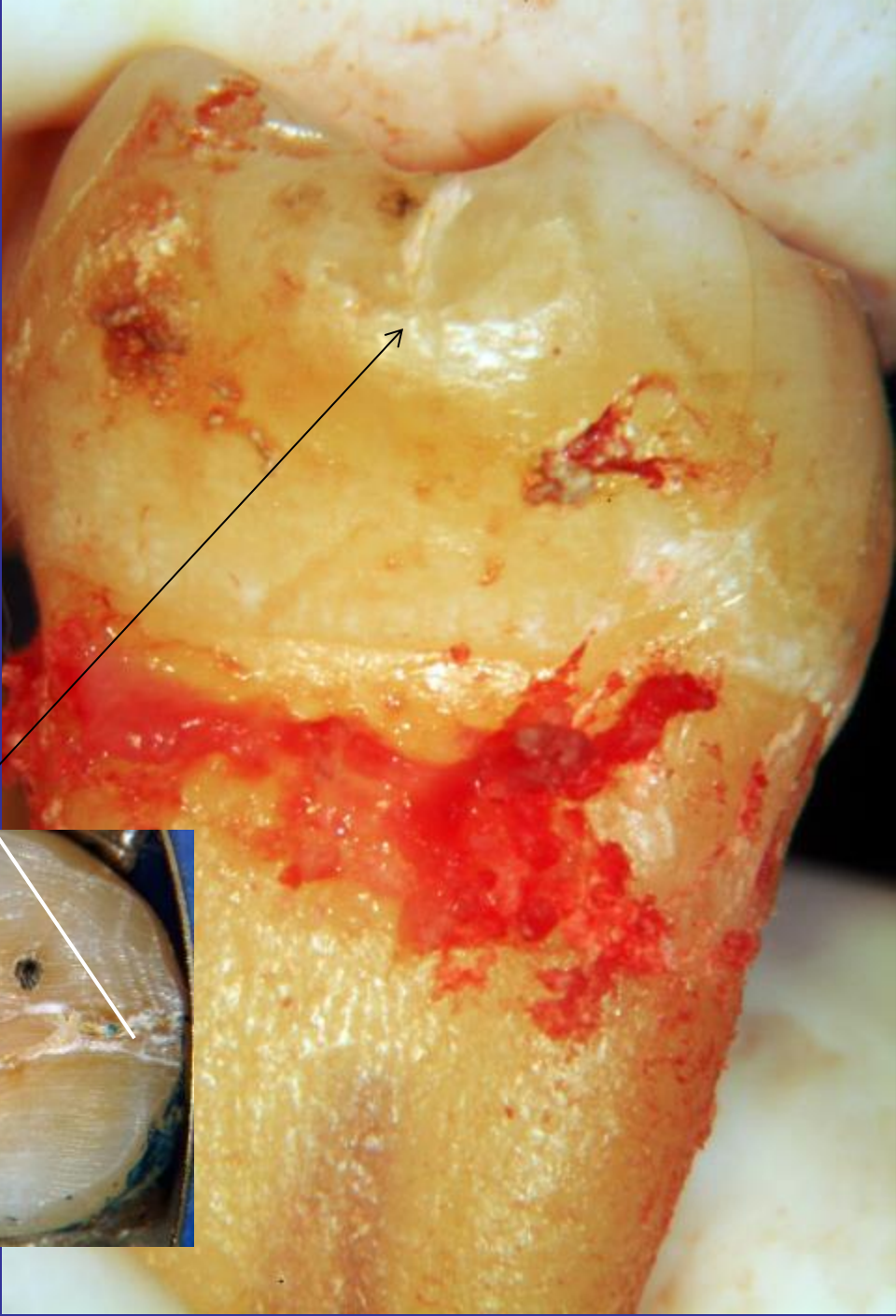
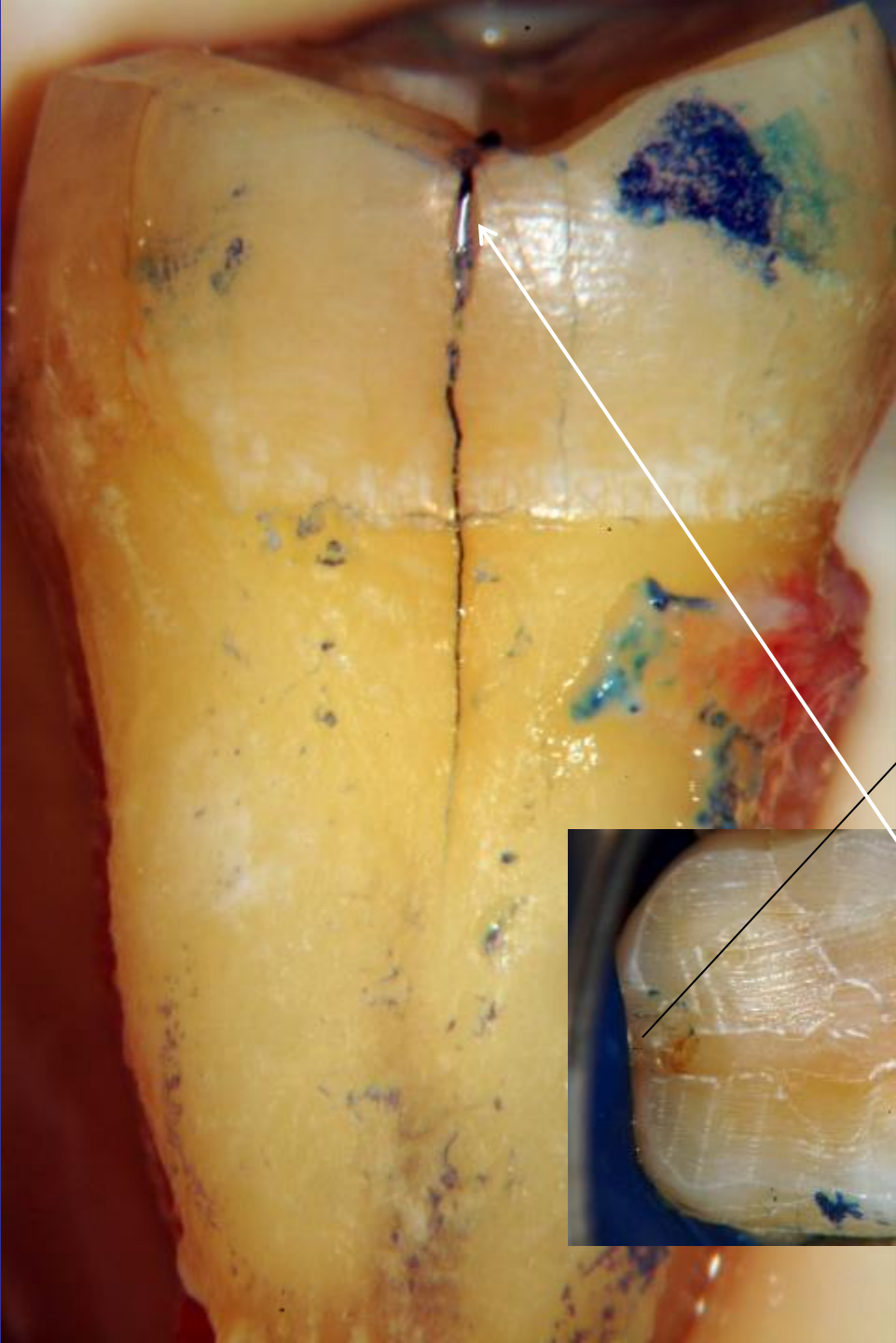






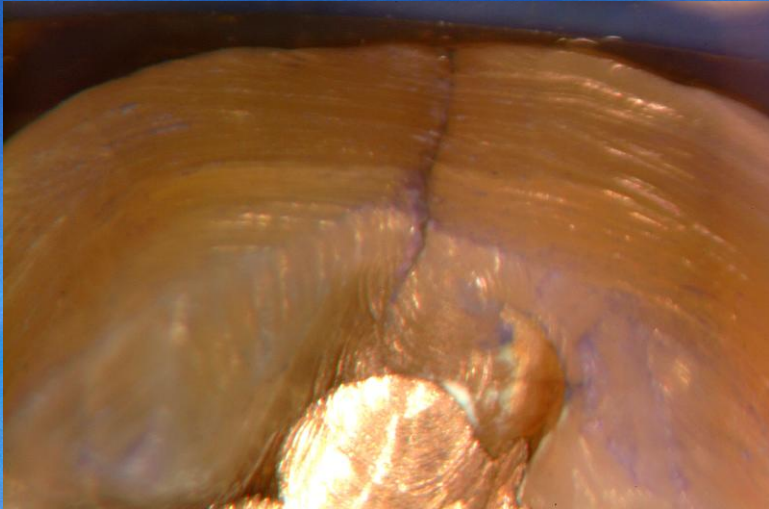




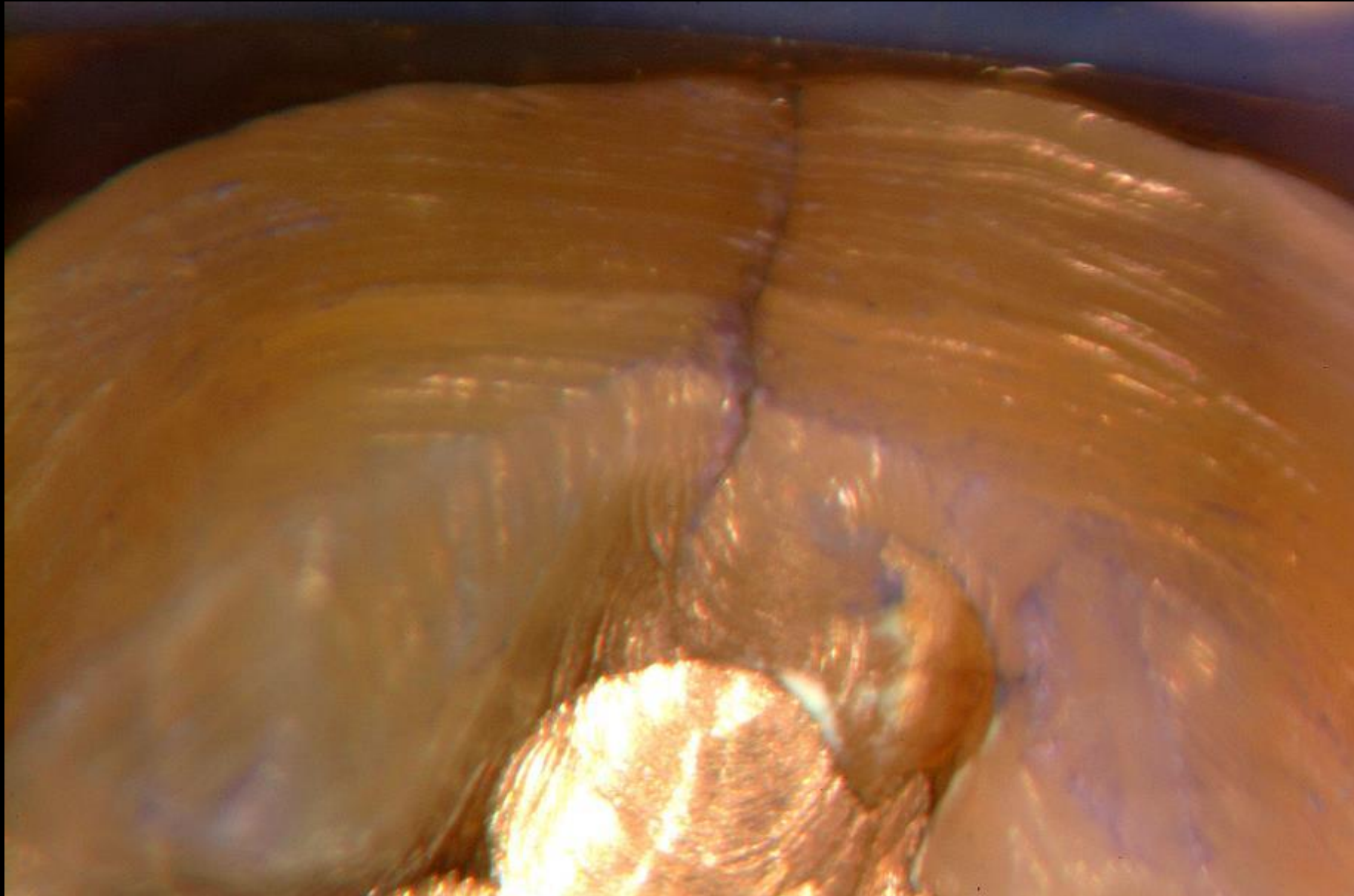


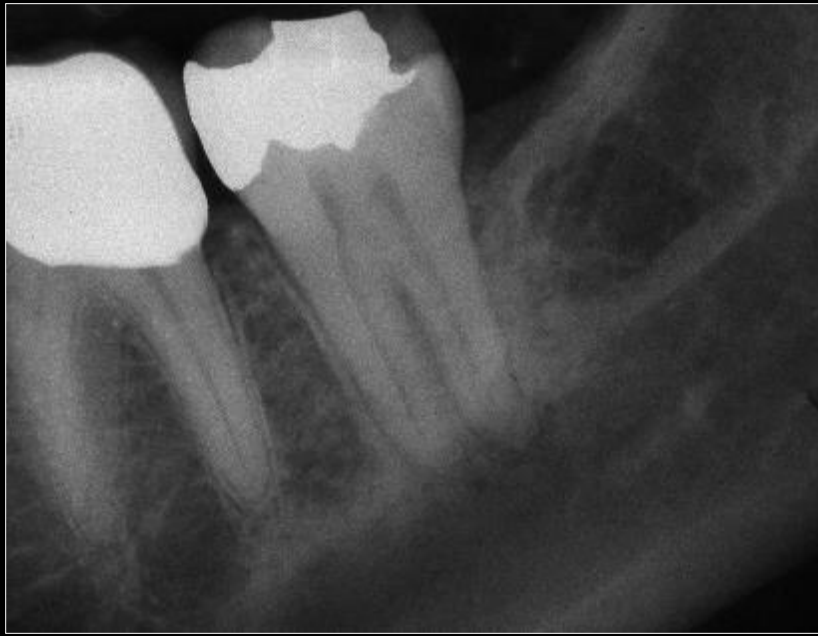
Incomplete and Complete Fractures

Case Study



Occlusal view of distal





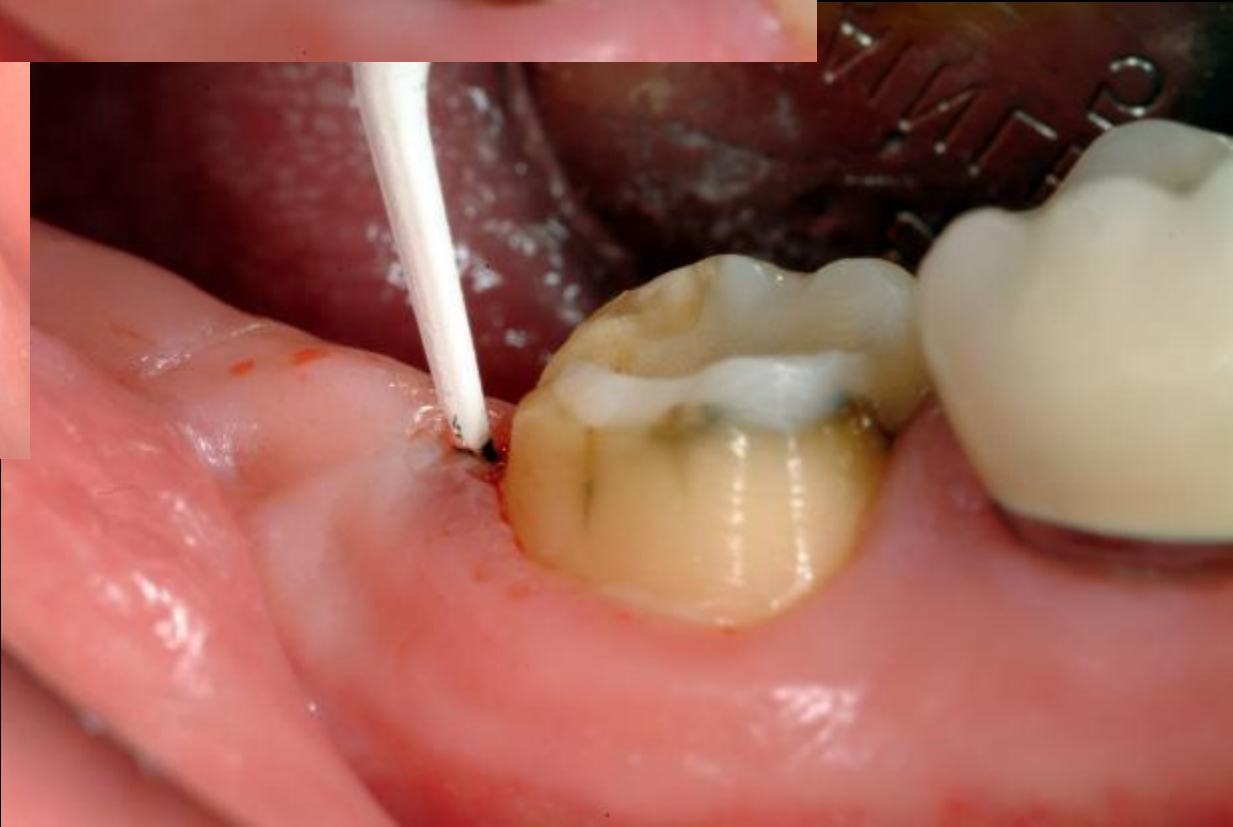
Initial
appointment



3-6 month
wait with
temp crown



4 month
wait





The Old Cracked Tooth Classification System...

Was Based on Symptoms
and Conjecture

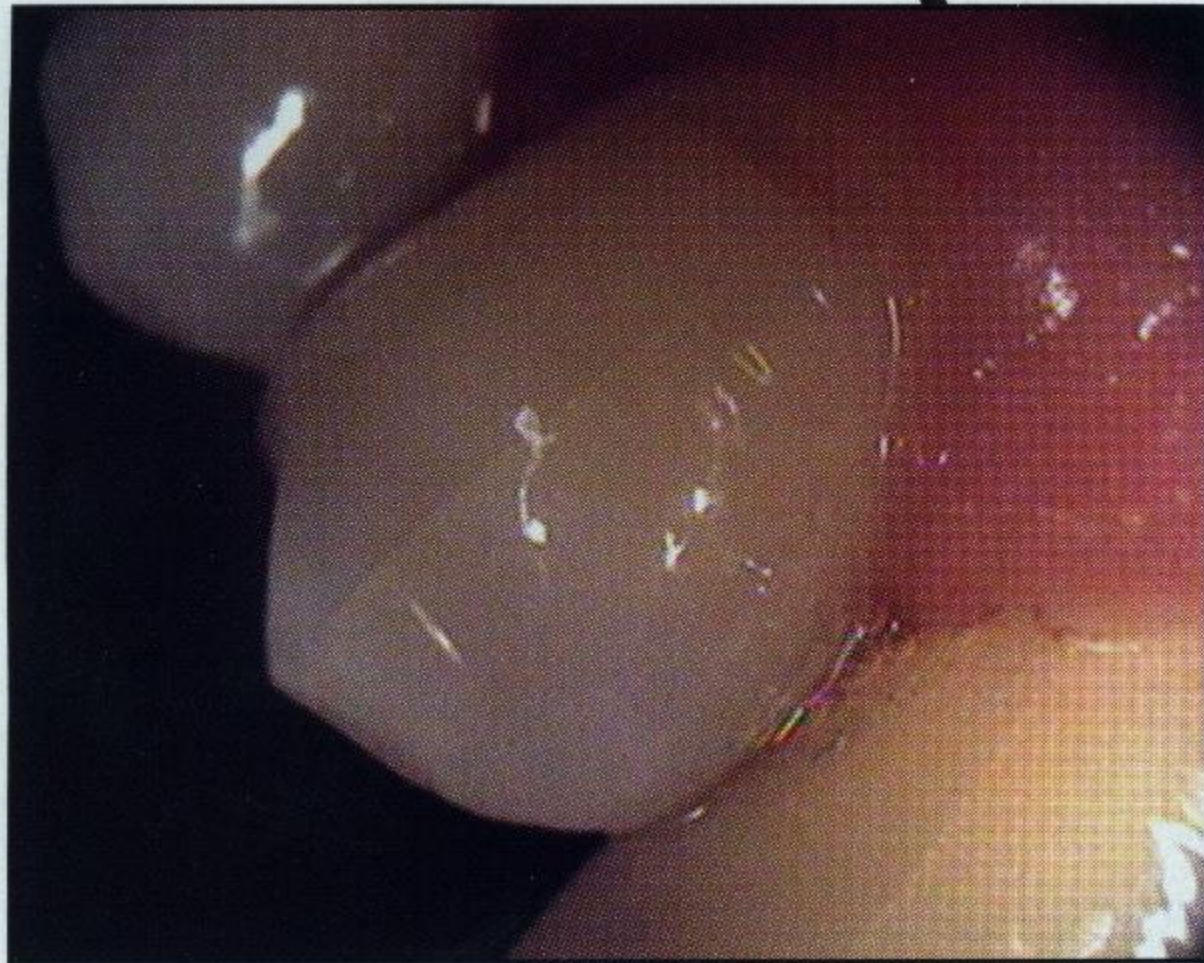
Epidemiologic
third most com
countries. This
syndrome is of

Cracked tooth syndrome

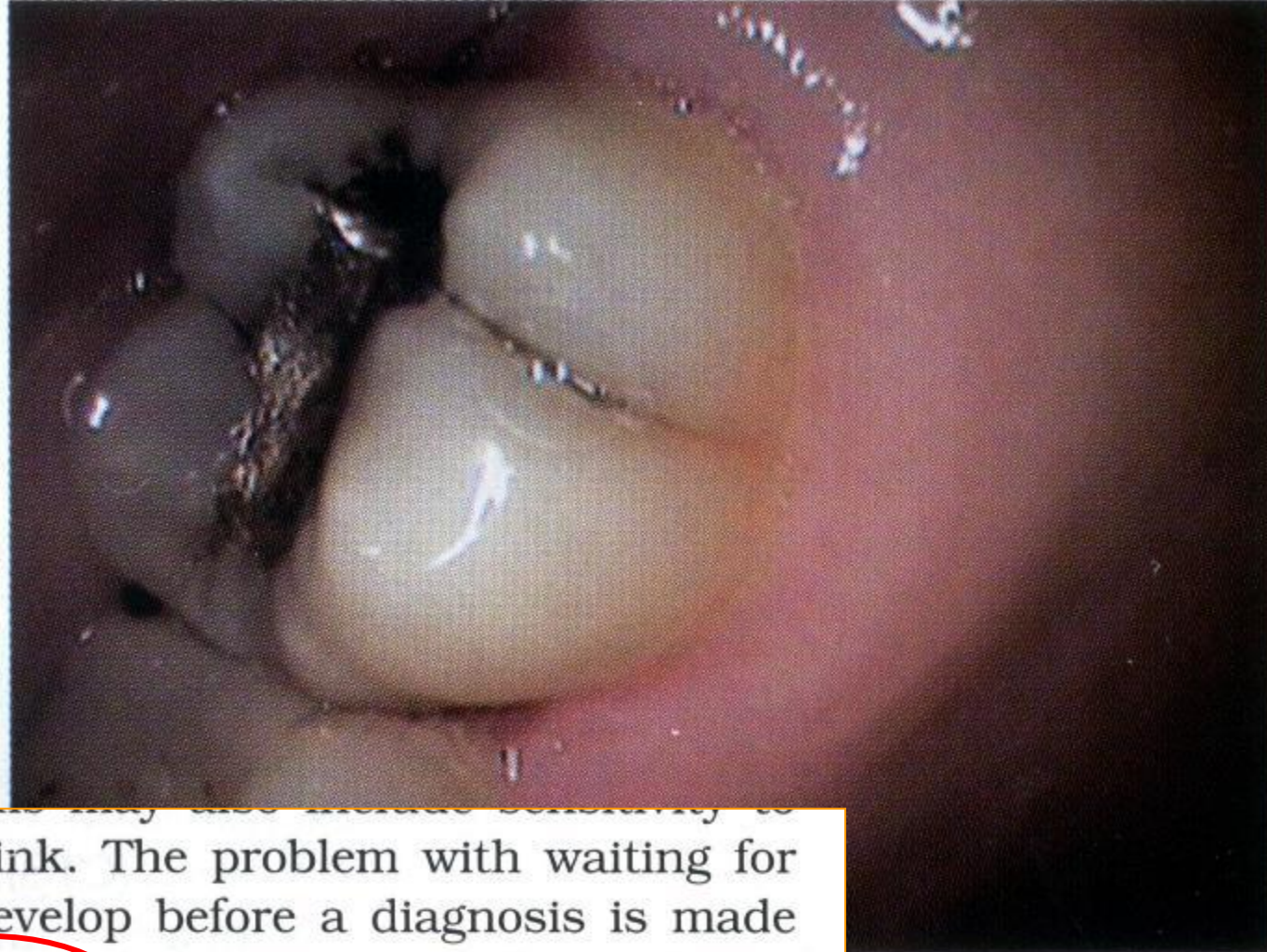
Figure 1



Figure 1



- Sad
main



cold food or drink. The problem with waiting for symptoms to develop before a diagnosis is made is that at this point the crack is usually at what is referred to by Clark⁵ as end-stage crack progression, requiring more aggressive treatment.

The emergence of the dental microscope has been a tremendous aid in the diagnosis and treatment of cracked teeth. The routine, methodical

“Build a bridge
from buccal to
lingual, and the
crack(s)
becomes
dormant.”



DR. ALEX FOK

Getting paid to be conservative

BIOCLEAR VS. CROWNS AND VENEERS

Bioclear is an alternative to traditional methods for enhancing a smile. Rather than preparing for a crown or veneer, the Bioclear Method preserves the natural tooth structure, enamel and tooth durability.



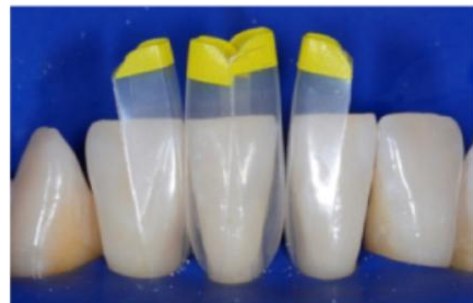
AN HONEST LOOK AT CROWN PREPARATIONS

As illustrated below, crowns, veneers, and onlays require the removal of a significant amount of healthy tooth structure. Bioclear dentists can leave most or all of the tooth structure. Bioclear is a very attractive option to patients.



~3/4 Crown
47% of tooth removed

Full Crown
76% of tooth removed



BIOCLEAR PREPARATION

Bioclear allows dentists to **conserve** healthy tooth structure



CROWN PREPARATION

Crowns require dentists to **remove an average of 76%** of the tooth structure prior to the procedure



VENEER PREPARATION

Veneers require dentists to **remove an average of 47%** of the tooth structure prior to the procedure



DC BIOCLEAR LEARNING CENTER

Tacoma USA · Solihull UK
Varberg Sweden · Cairo Egypt
Syracuse Italy · Taubate Brazil
Livermore CA (Bioclear pediatrics)
Seoul Korea · Madrid/Barcelona
Sydney Australia · Baghdad Iraq

∞ BIOCLEAR

Stop by convention

booth #1242

to...

- ✓ Hear more about Bioclear courses
- ✓ Meet our team of Bioclear and Kuraray experts
- ✓ Order products
- ✓ Register for courses



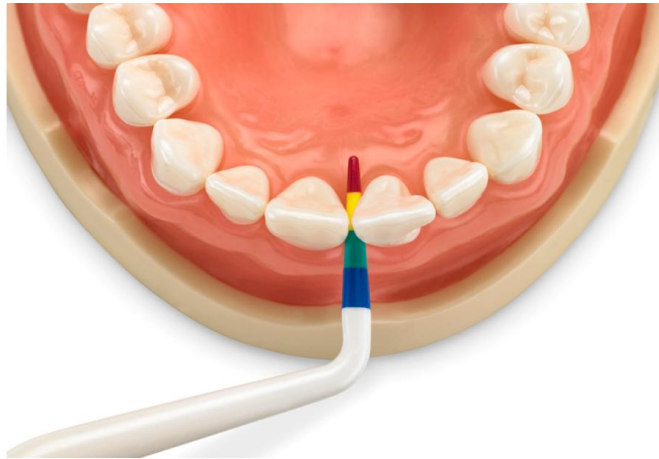
Treat yourself to a weekend with  BIOCLEAR

BLACK TRIANGLE

CERTIFICATION COURSE

18 CE CREDITS

This three-part live hands-on certification course will teach you how to treat black triangles, gingival recession, root abrasions, and perform confident restorations. In becoming a certified Bioclear black triangle doctor, you'll increase your overall skill and knowledge of Bioclear and learn to market your new skills to patients.



Upcoming Dates:

Denver

October 9th 2026

Walnut Creek

August 21st 2026

Limited spots available!

Scan to learn more
& sign up for your
local BT Course!



www.bioclearmatrix.com/live-courses/



BEFORE



AFTER



BEFORE



AFTER

2026 Certification Courses



- Core Anterior + Core Posterior • Complex Cases & Problem Solving
- Smile Design & Comprehensive Anterior Rejuvenation • Bioclear Alumni Summit

January

S	M	T	W	T	F	S
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February

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March

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April

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May

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June

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August

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September

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October

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November

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December

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27	28	29	30	31		

2027 Certification Courses



- Core Anterior + Core Posterior • Complex Cases & Problem Solving
- Smile Design & Comprehensive Anterior Rejuvenation

JANUARY

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FEBRUARY

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MARCH

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APRIL

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MAY

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JUNE

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JULY

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AUGUST

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29	30	31				

SEPTEMBER

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OCTOBER

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NOVEMBER

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DECEMBER

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21	22	23	24	25	26	27
28	29	30	31			

For a copy of today's presentation,
Learning Center info or the essential
Bioclear Library



∞ BIOCLEAR

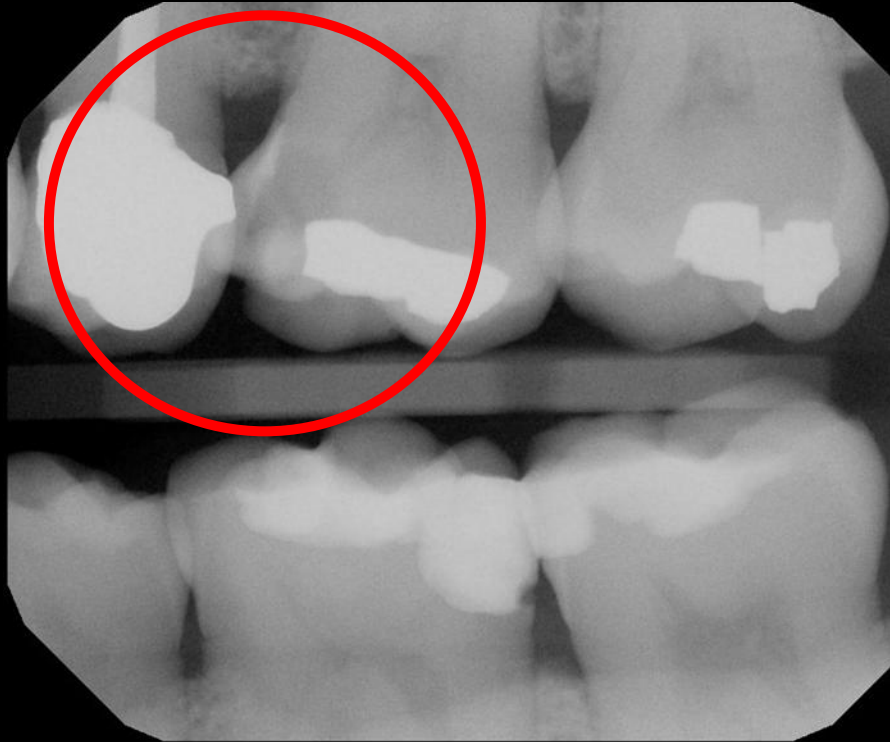
Stop by convention

booth #1242

to...

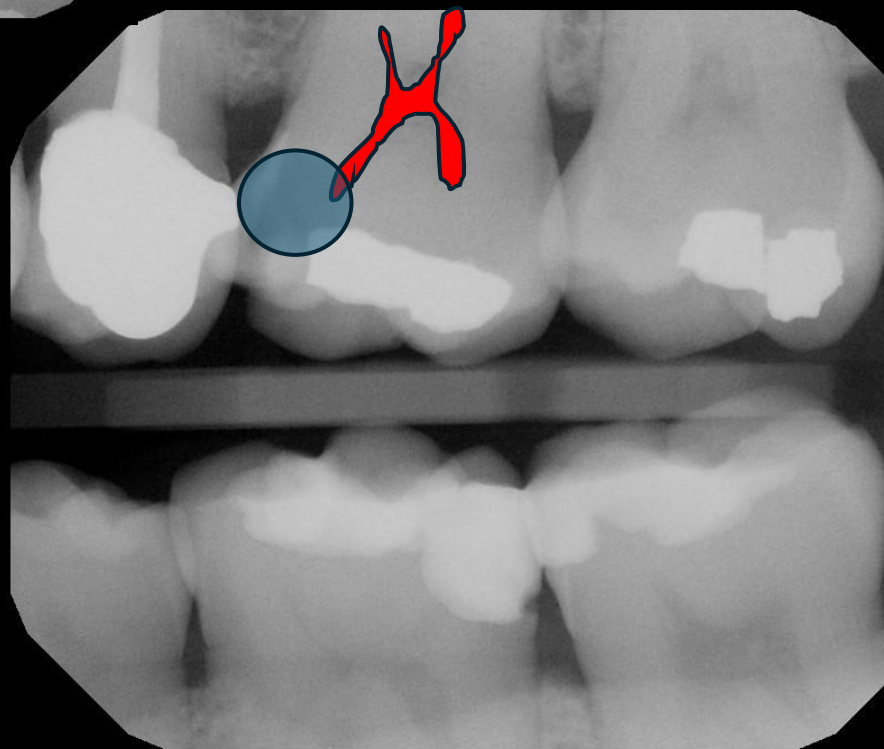
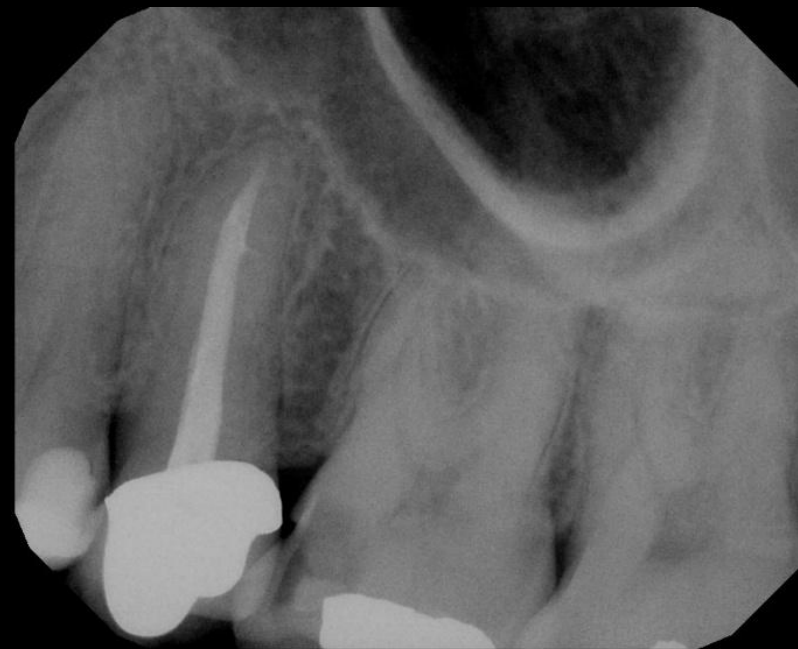
- ✓ Hear more about Bioclear courses
- ✓ Meet our team of Bioclear and Kuraray experts
- ✓ Order products
- ✓ Register for courses

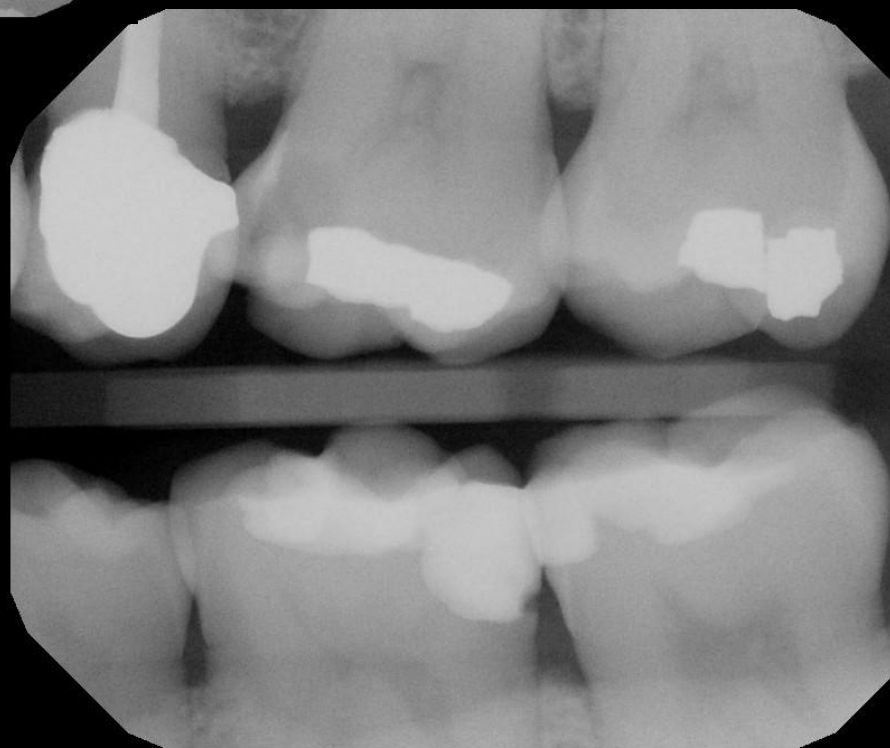
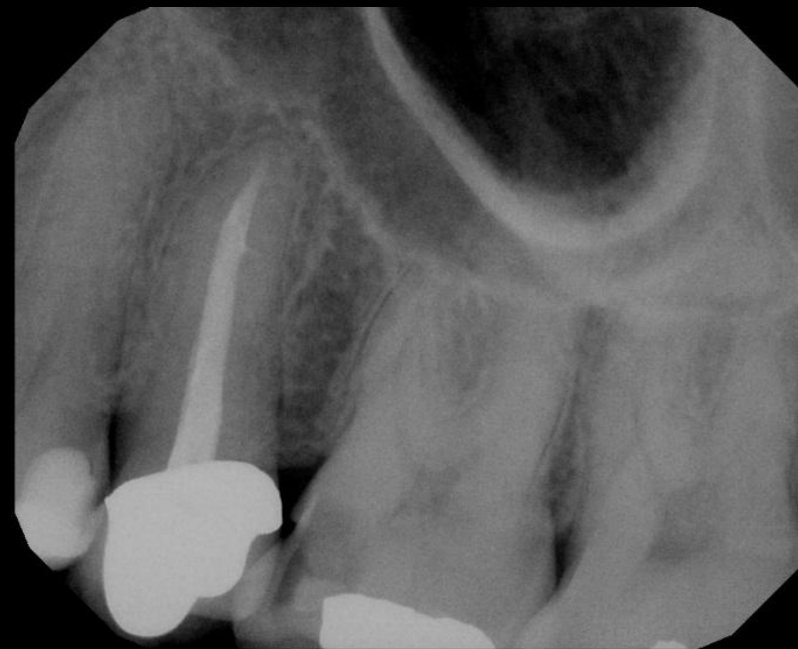




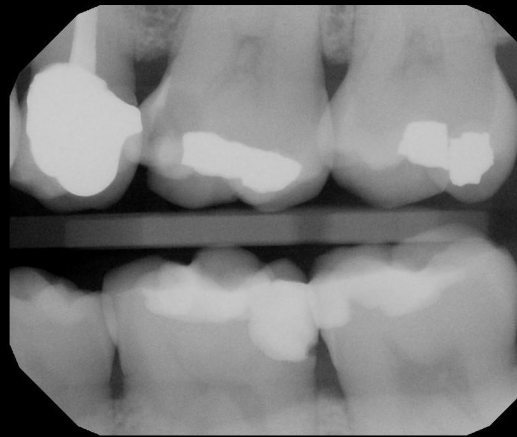
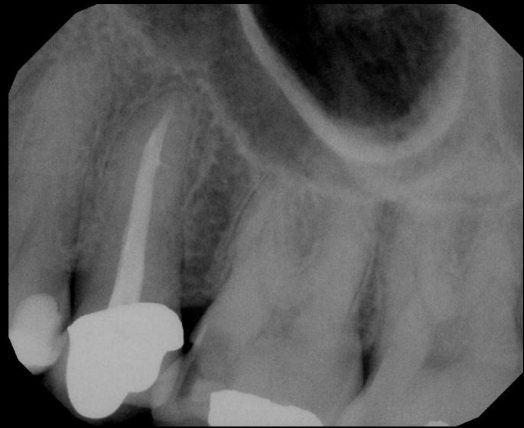
Dr. Rafael Bustamante
Full Faculty at the
Bioclear Learning center







- Selective Caries Removal
- Calla Lilly Compression Based Cavity Preparation for a Cracked Tooth
- Deep Margin Acquisition
- Dealing with a Furcation



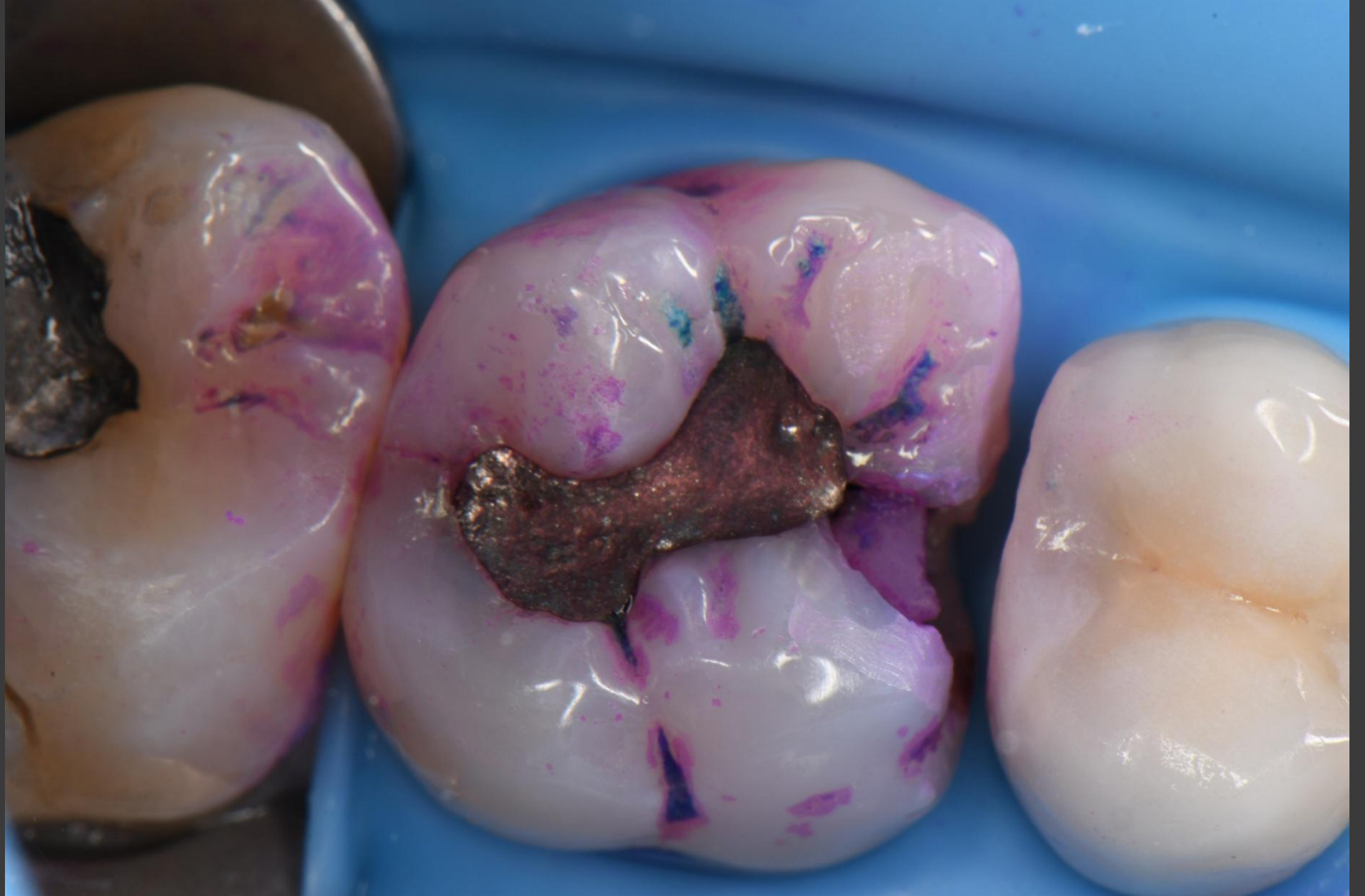
This is *Dr. Bustamante's* finger
BTW





What changed between pre and post rubber dam photos?



















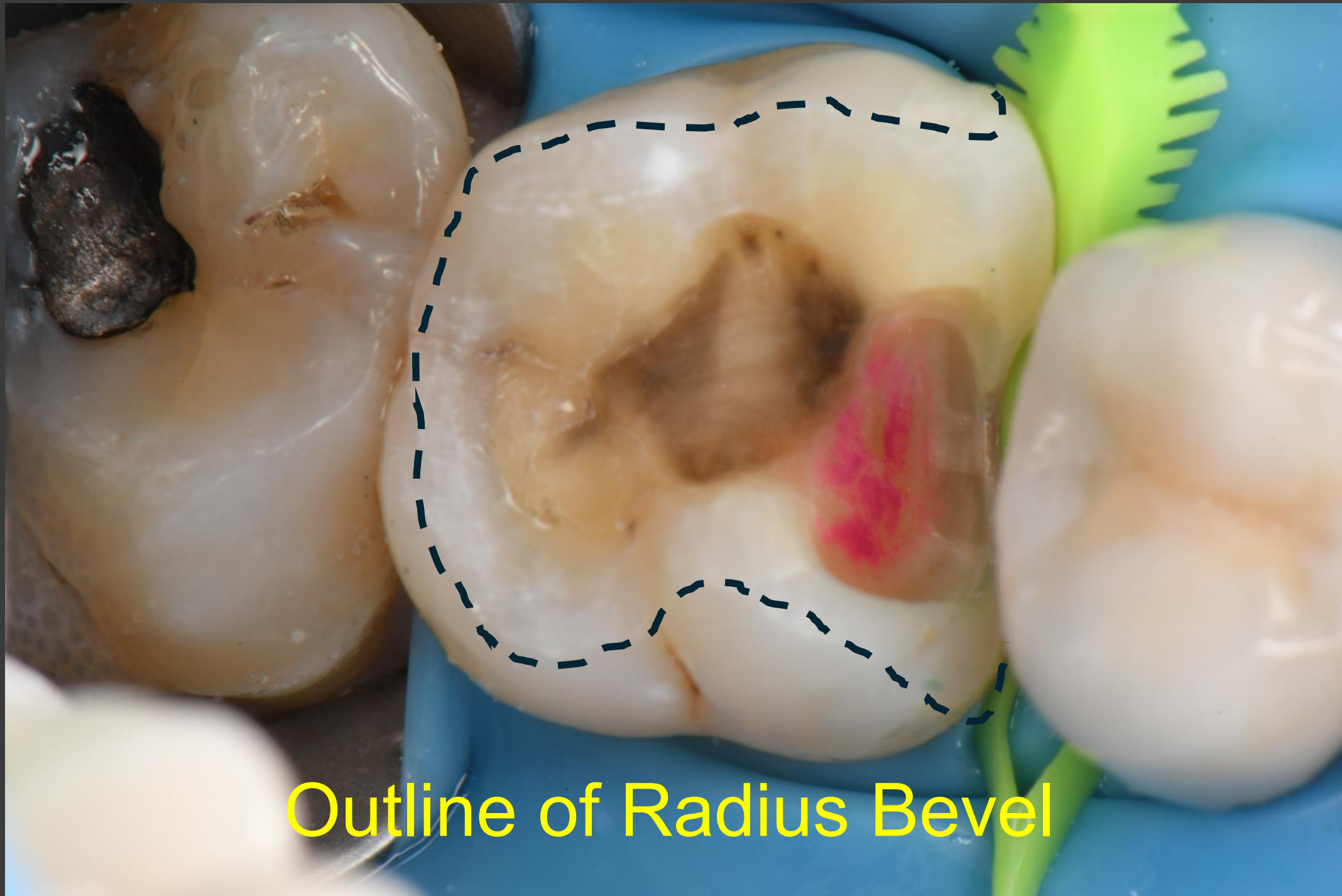
The new “Long Diamond Wedge” Available
in all five Diamond Wedge shapes



Long (Double-Hump) Furcal Wedge







Outline of Radius Bevel

Before Blasting

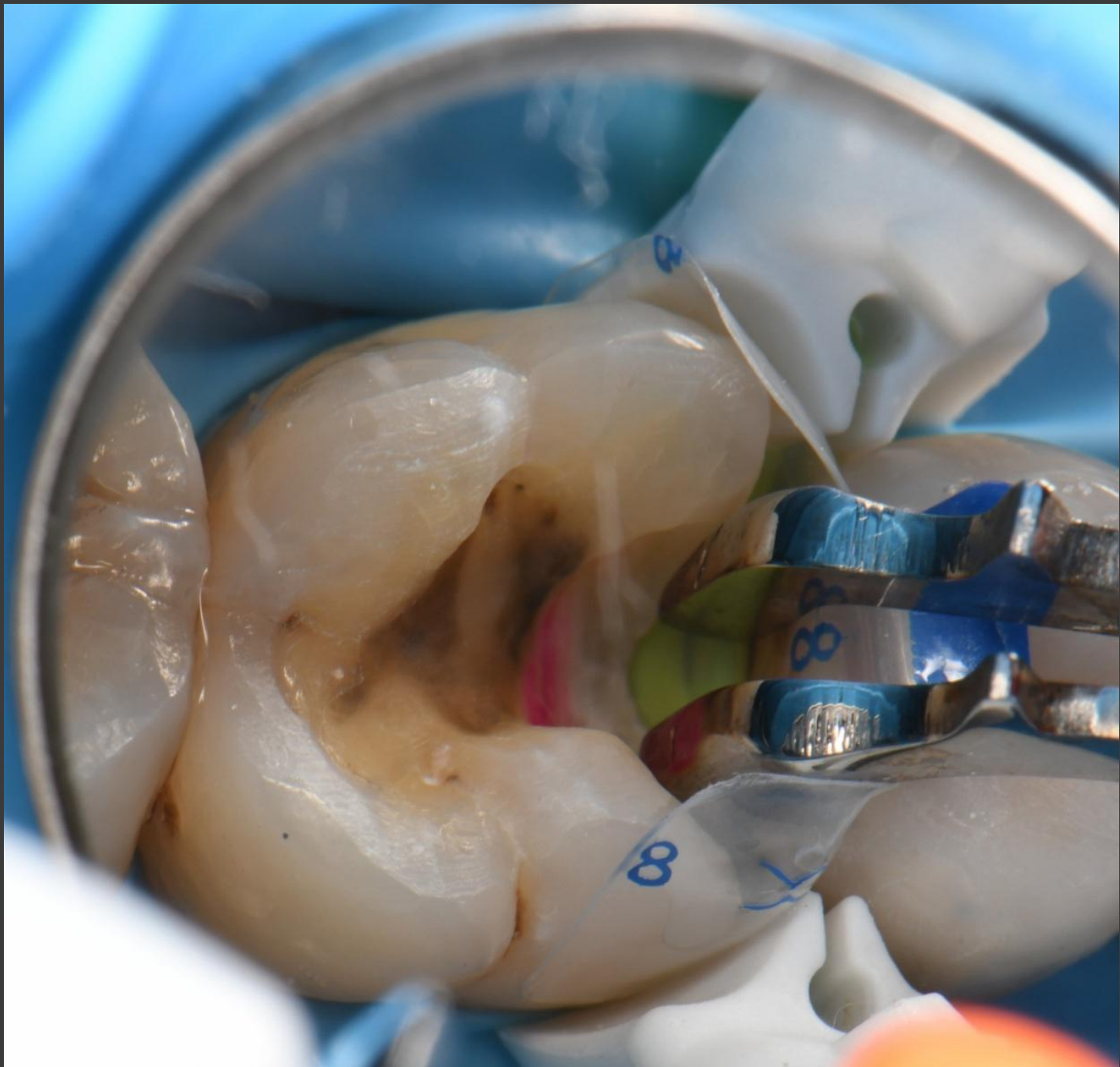


After Blasting and Final
Radius Beveling



















Miles ahead of everybody else for Bulk Fills

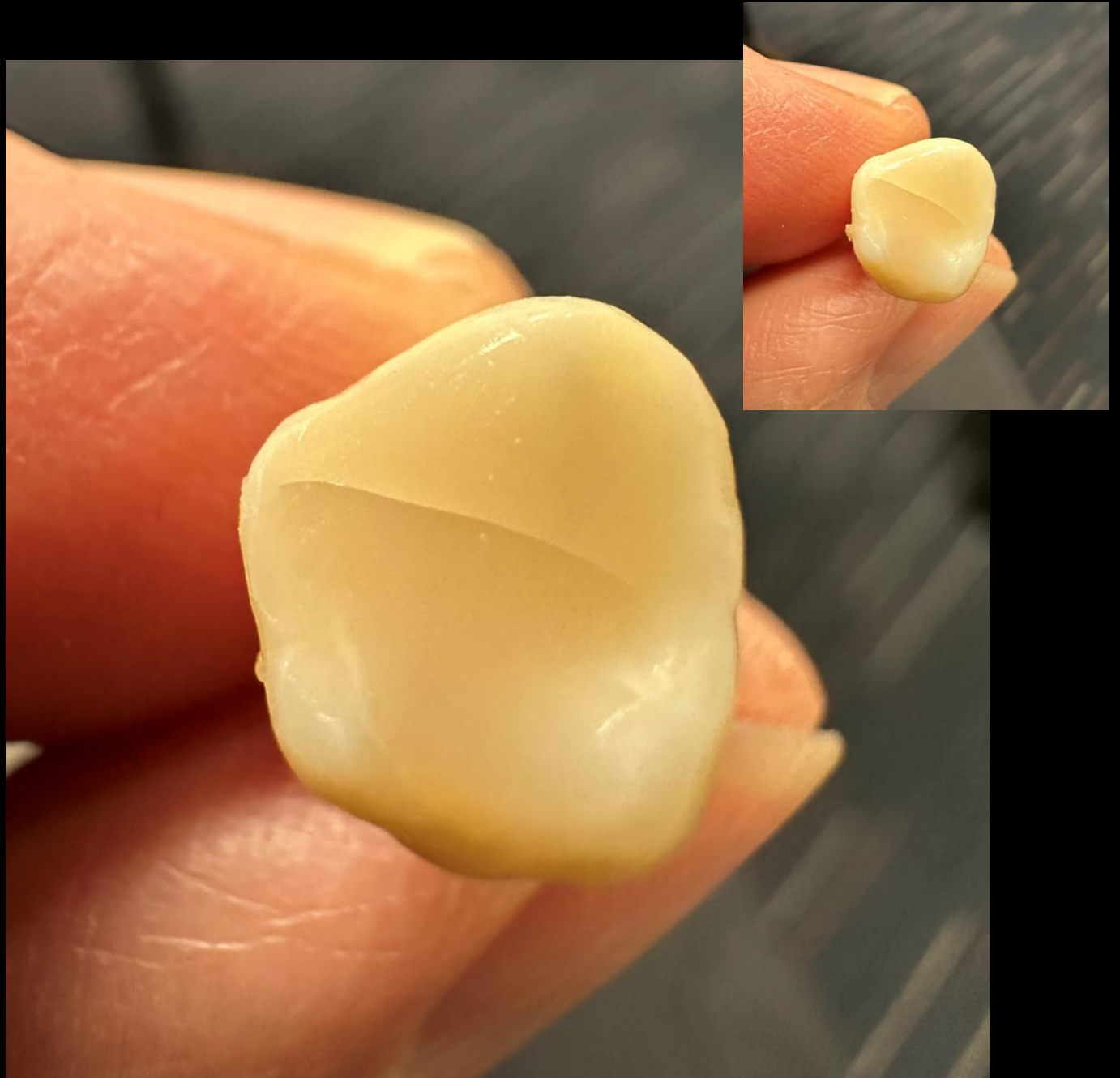




YIKES!!

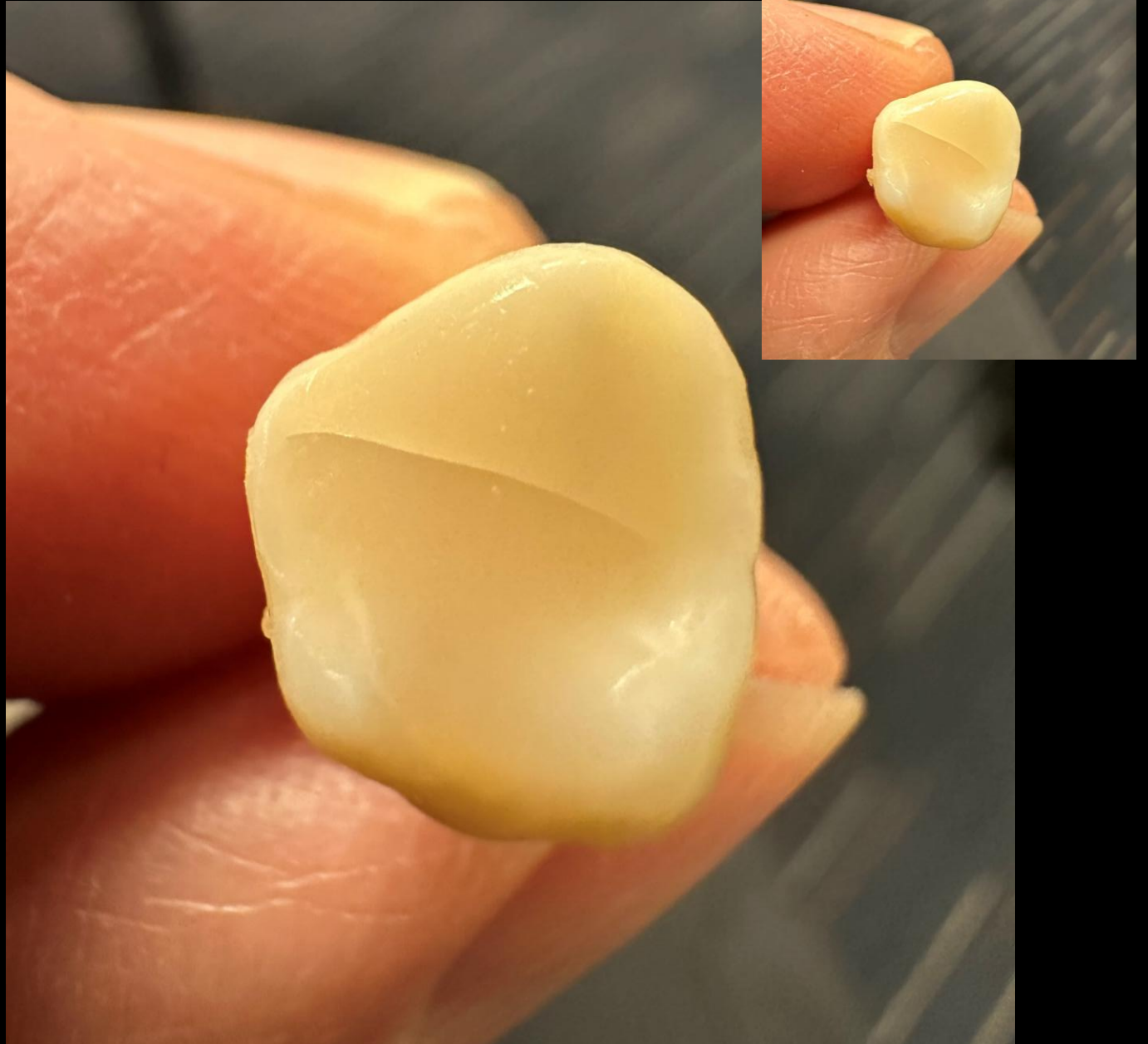
GC “Bulk Injectable”

Discussion:
Polymerization
shrinkage stress and
cuspal deflection is
very real but
challenging to
explain



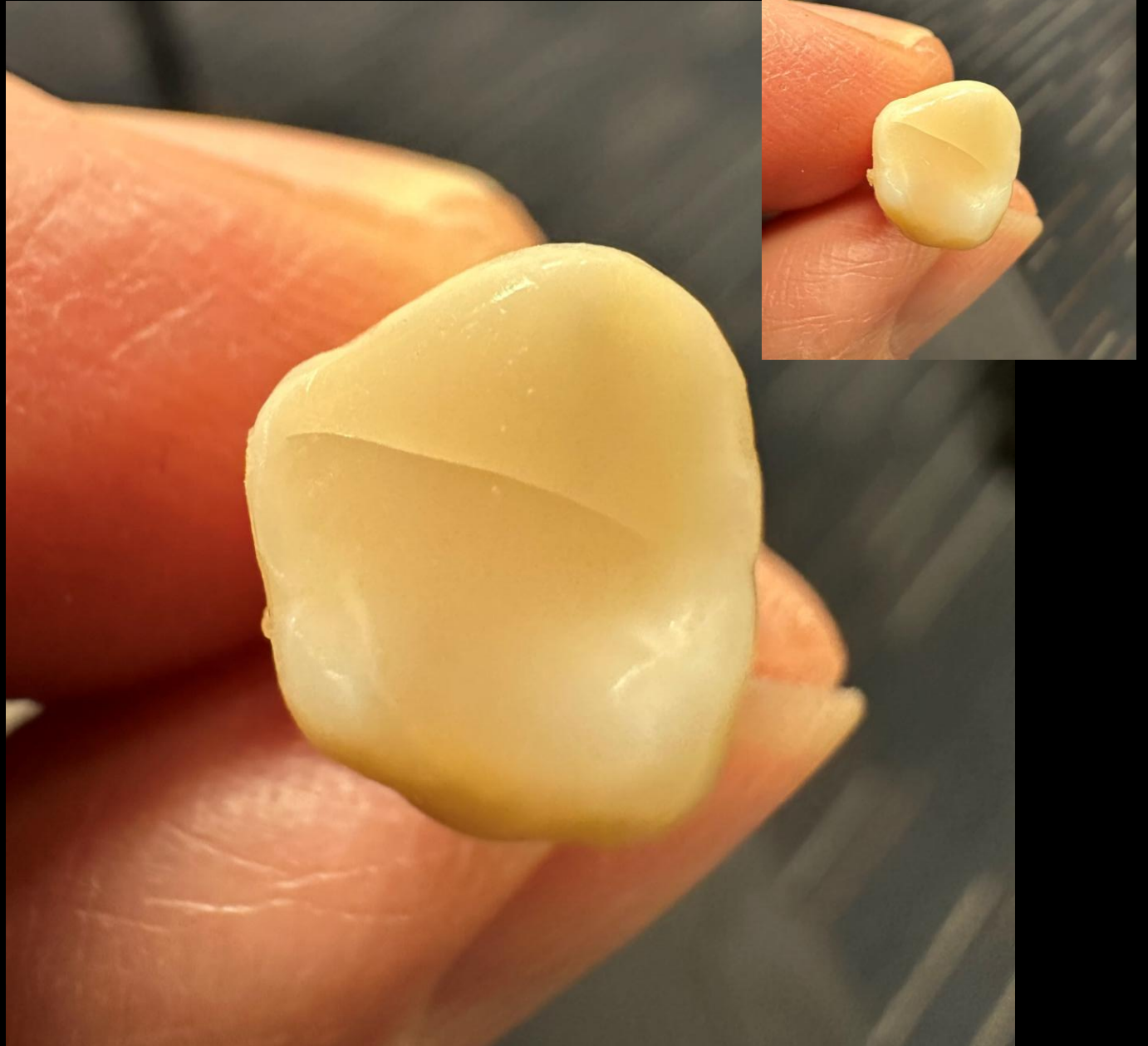
Discussion:

The volume of composite, and residual strength of the tooth are key players. If half of tooth is missing, ie there is a good sized hole in the occlusal or interproximal, we are recommending Filtek One (bulk fill paste) plus GC bulk flow or Filtek bulk flow.



Discussion:

If you we have a fair amount of dentin removed, we need Filtek One



Miles ahead of everybody else for Bulk Fills





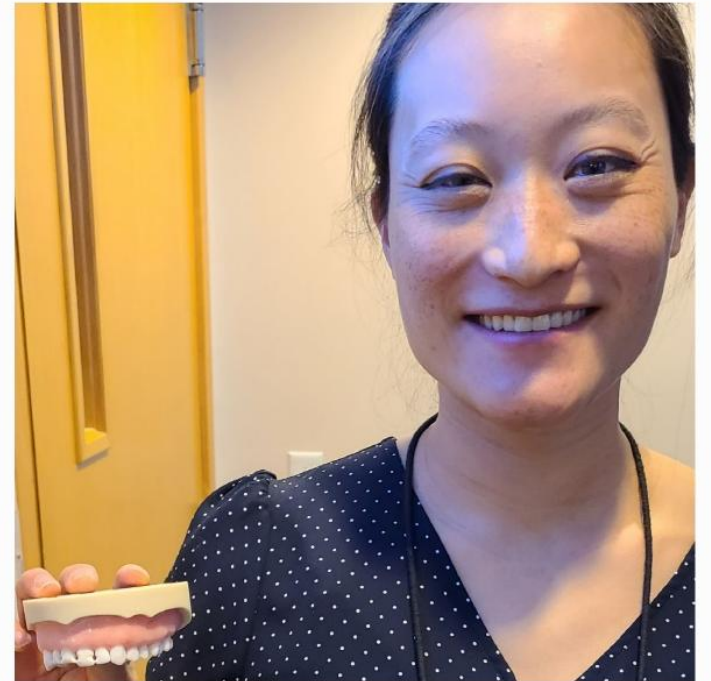
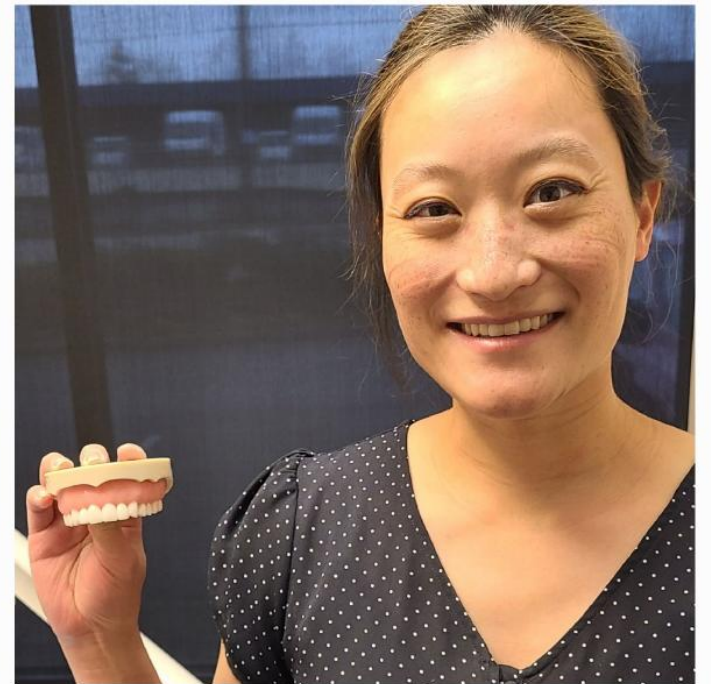
DC BIOCLEAR LEARNING CENTER

Tacoma USA · Solihull UK
Varberg Sweden · Cairo Egypt
Syracuse Italy · Taubate Brazil
Livermore CA (Bioclear pediatrics)
Seoul Korea · Madrid/Barcelona
Sydney Australia · Baghdad Iraq









Last week's attendees at the certification course





∞ BIOCLEAR

Stop by convention

booth # 827

to...

- ✓ Hear more about Bioclear courses
- ✓ Meet our team of Bioclear and Kuraray experts
- ✓ Order products
- ✓ Register for courses



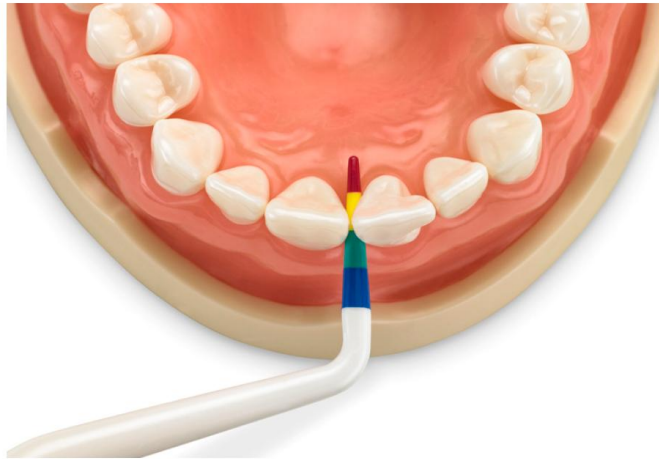
Treat yourself to a weekend with  BIOCLEAR

BLACK TRIANGLE

CERTIFICATION COURSE

18 CE CREDITS

This three-part live hands-on certification course will teach you how to treat black triangles, gingival recession, root abrasions, and perform confident restorations. In becoming a certified Bioclear black triangle doctor, you'll increase your overall skill and knowledge of Bioclear and learn to market your new skills to patients.



Upcoming Dates:

Denver

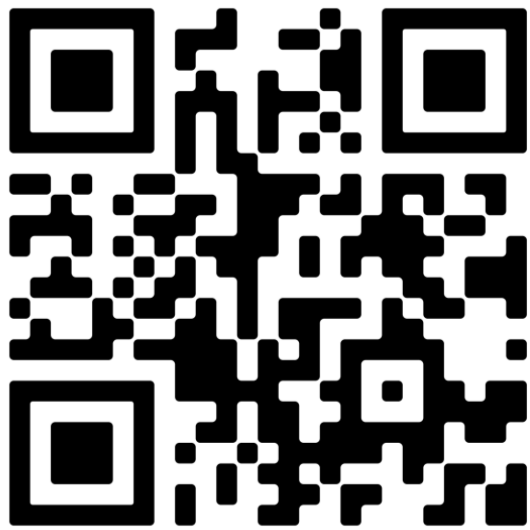
October 9th 2026

Walnut Creek

August 21st 2026

Limited spots available!

Scan to learn more
& sign up for your
local BT Course!



www.bioclearmatrix.com/live-courses/



BEFORE



AFTER



BEFORE



AFTER

2026 Certification Courses



- Core Anterior + Core Posterior • Complex Cases & Problem Solving
- Smile Design & Comprehensive Anterior Rejuvenation • Bioclear Alumni Summit

January

S	M	T	W	T	F	S
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11	12	13	14	15	16	17
18	19	20	21	22	23	24
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February

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March

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June

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July

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September

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November

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December

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2027 Certification Courses



- Core Anterior + Core Posterior • Complex Cases & Problem Solving
- Smile Design & Comprehensive Anterior Rejuvenation

JANUARY

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FEBRUARY

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MAY

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JUNE

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JULY

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AUGUST

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22	23	24	25	26	27	28
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SEPTEMBER

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OCTOBER

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NOVEMBER

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DECEMBER

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