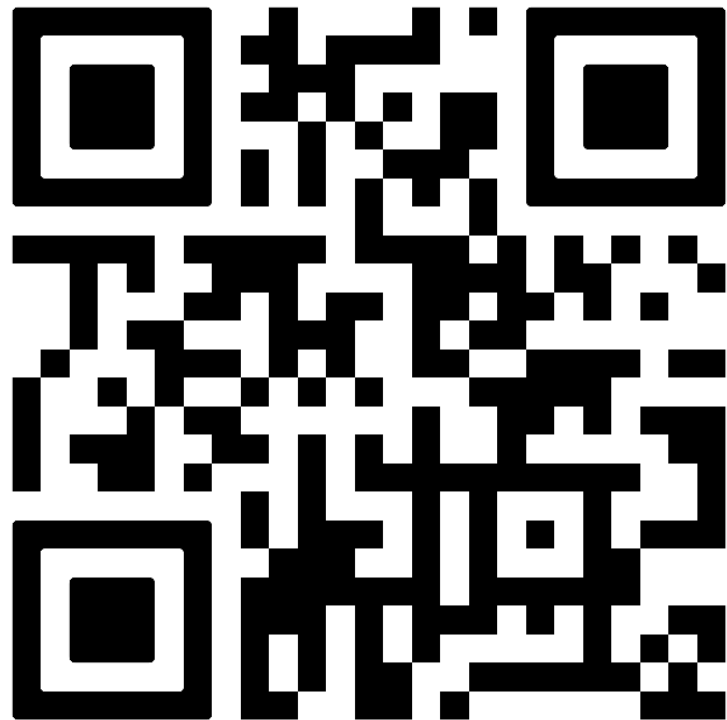




# The Great Tooth Killer: Epidemic of Cracked Teeth, the Science of Strong Teeth

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



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.



# 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.



# DC BIOCLEAR LEARNING CENTER

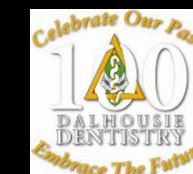
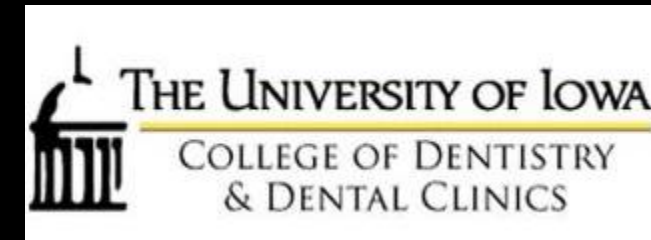
Tacoma USA · Solihull UK  
Varberg Sweden · Cairo Egypt  
Syracuse Italy · Taubate Brazil  
Livermore CA (Bioclear pediatrics)  
Seoul Korea · Madrid/Barcelona  
Sydney Australia · Baghdad Iraq



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**.



# Dental schools/GPR integrating the Bioclear Method



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 a dark, brownish-yellow pulp chamber. The surrounding gingival tissue 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

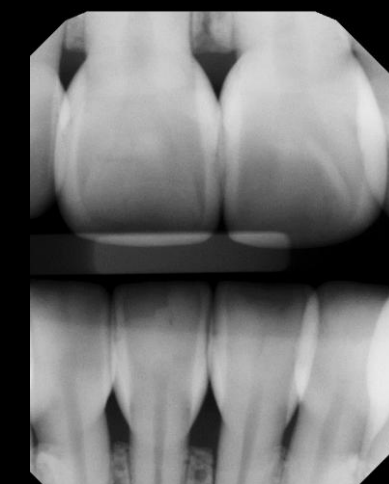
- Why things break...
- Modern cavity preparations
- Injection Overmolding as a 3<sup>rd</sup> option
- FEA of loading of teeth & composite
- Long term outcomes & case studies of composite overlays for cracked teeth
- When to endo, when to extract.

# Modern Approach to Composite Restorations

Posterior  
Restoration



Black Triangle



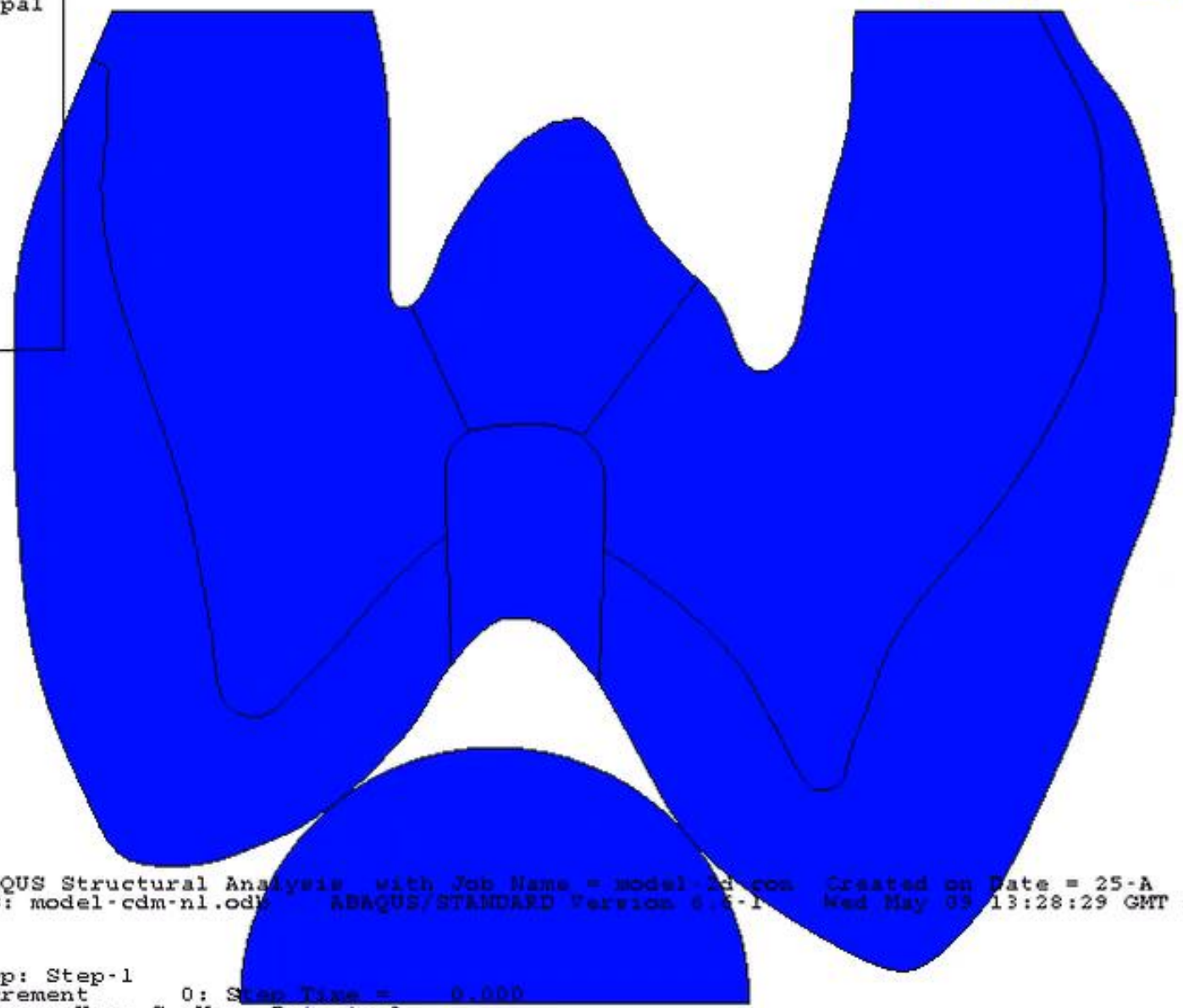
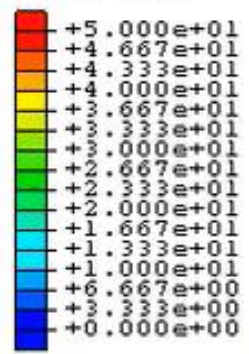
# Glossary

- 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  
ABAQUS/STANDARD Version 6.5-1 Wed May 03 13:28:29 GMT Daylight

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

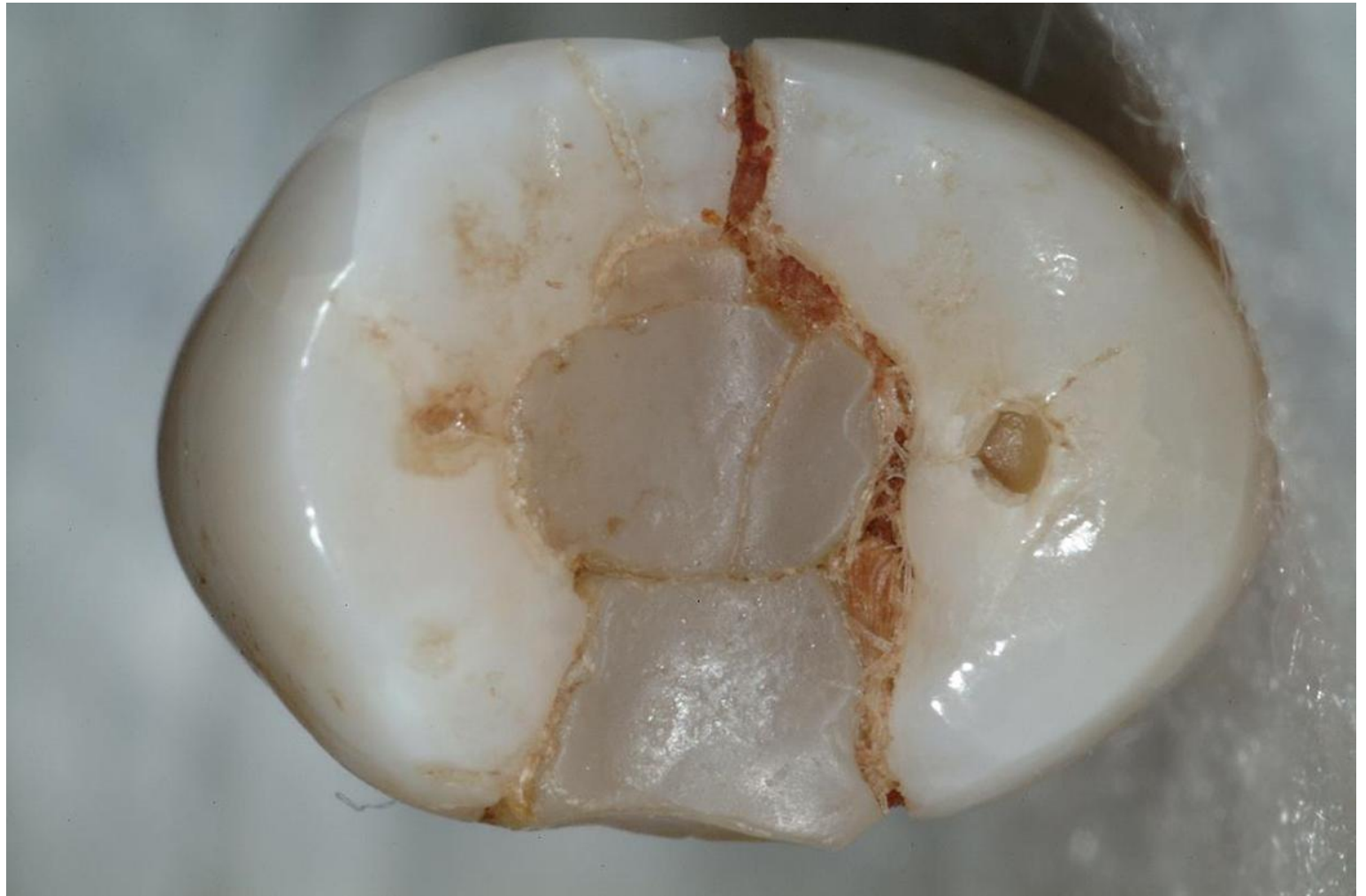


2021: Catastrophic fracture tooth #5. Virgin  
Tooth



# 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

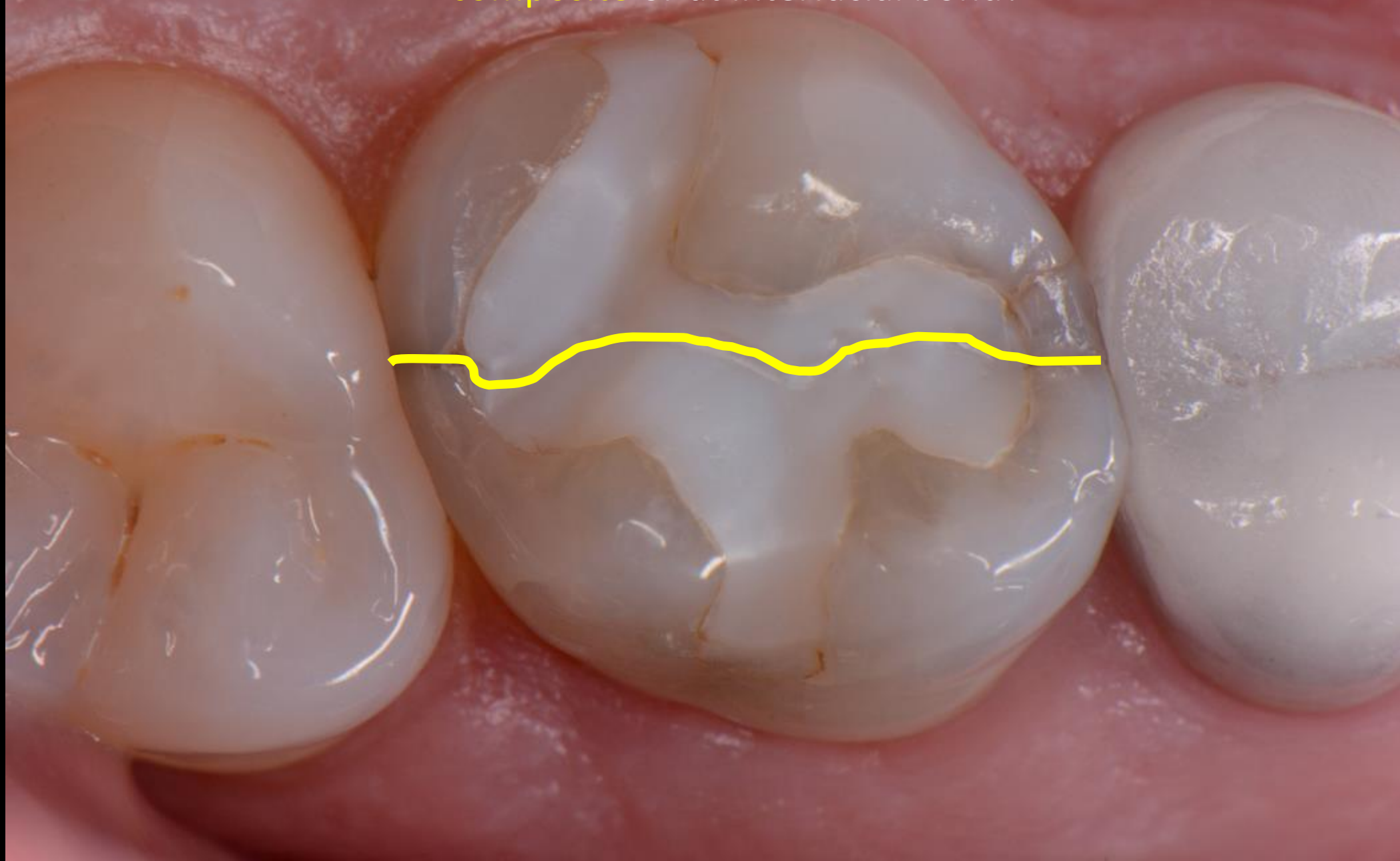
**When the tooth fractures:** Crack initiates at the central groove of composite or at interfacial bond.



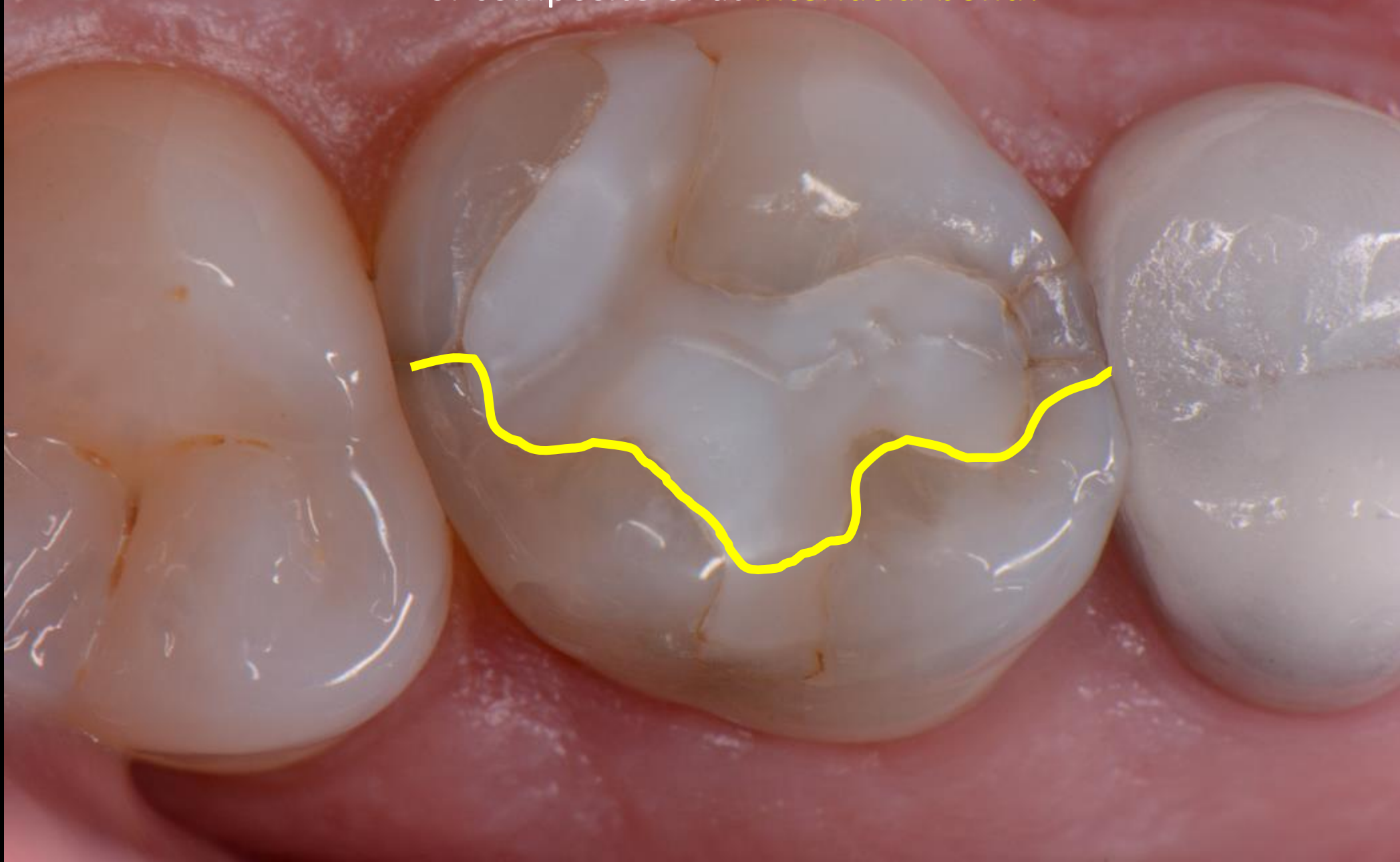
***When*** the tooth fractures: Crack initiates through the central groove of composite or at interfacial bond?



*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 significant damage. The tooth is cracked, with several visible fissures extending across its surface. The color of the tooth is uneven, with a prominent grayish discoloration in the central area, indicating internal damage or decay. The surrounding gum tissue is pink and appears slightly inflamed. The text "If the tooth is gray, the tooth is cracked" is overlaid in white, bold, sans-serif font across the center of the image.

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 in enamel)



# 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

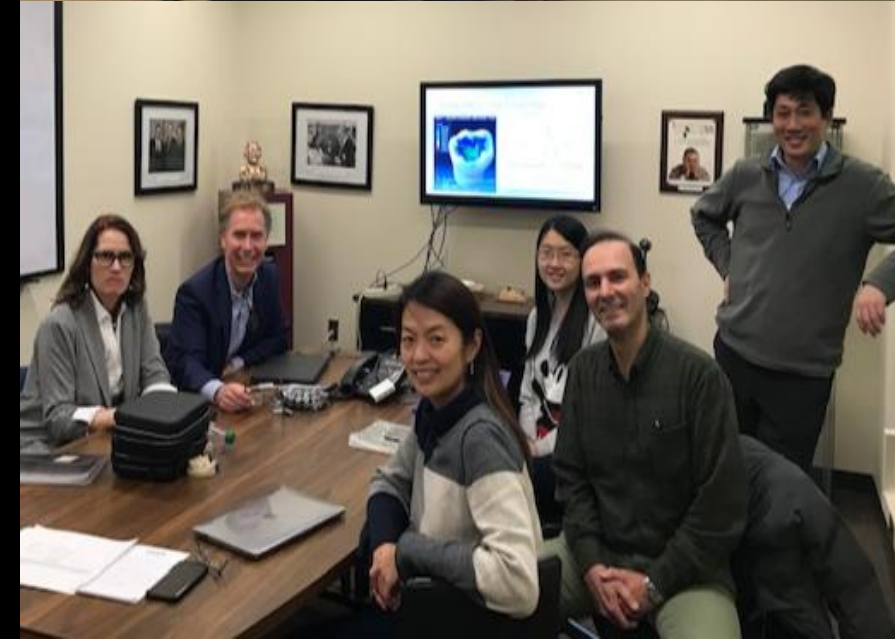
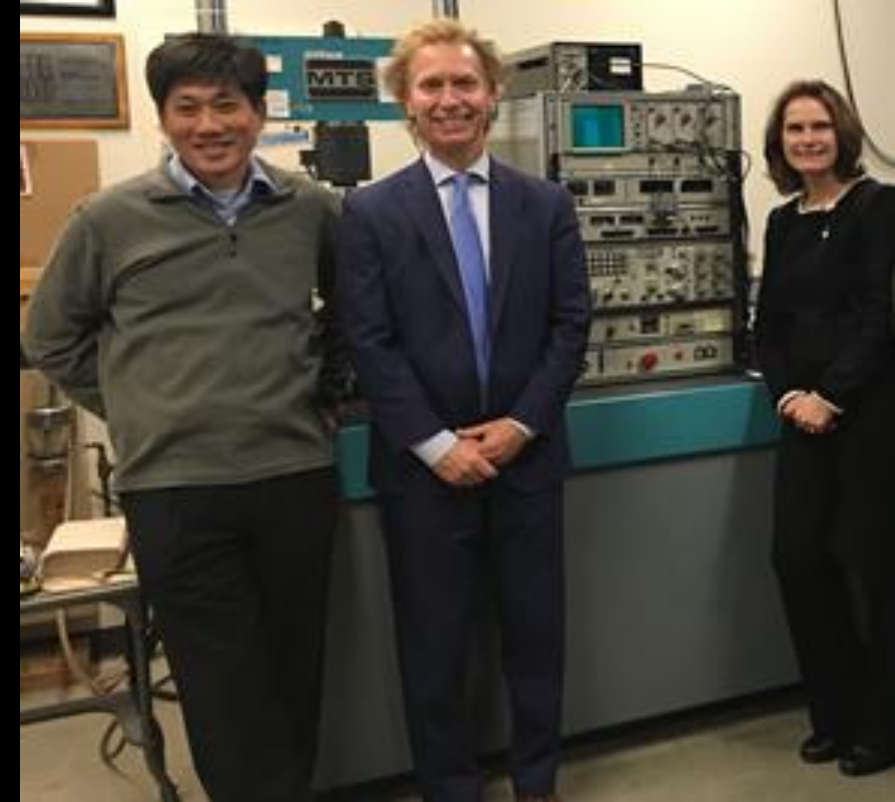
Assistant professor, Division Director of Operative Dentistry and Biomaterials, UNC School of Dentistry

- 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

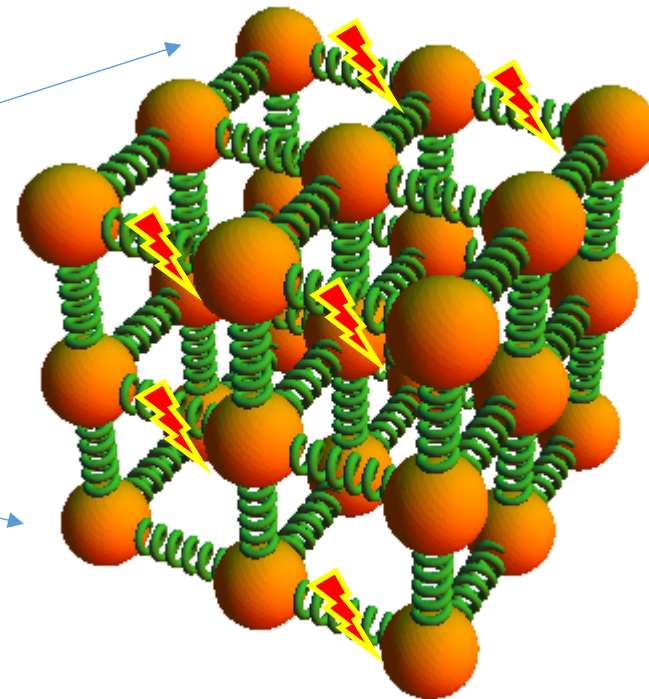
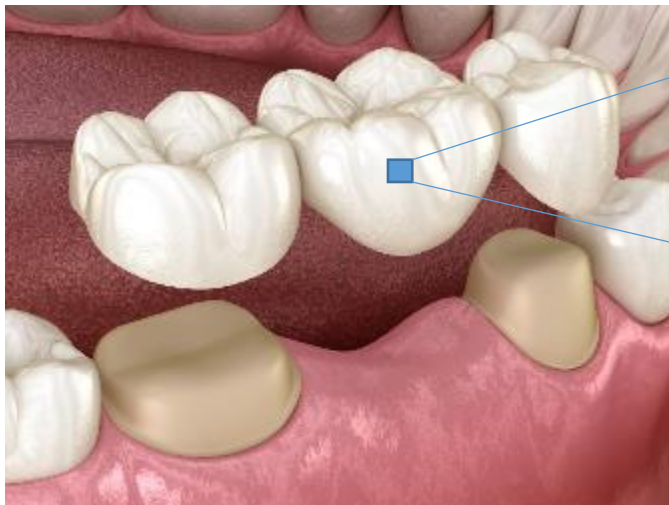
Sabrina F. Sochacki, DDS, MS, PhD

Indiana University School of Dentistry

# Basics of Solid Mechanics

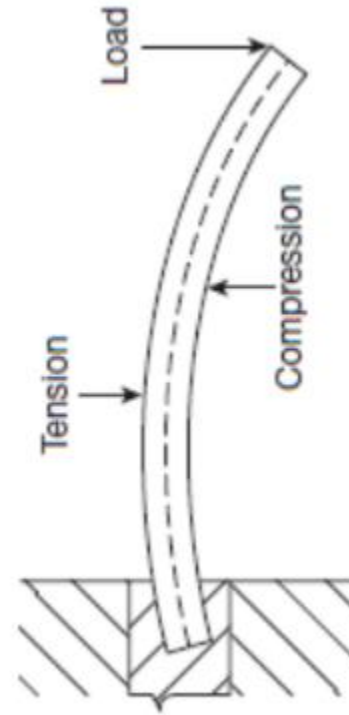
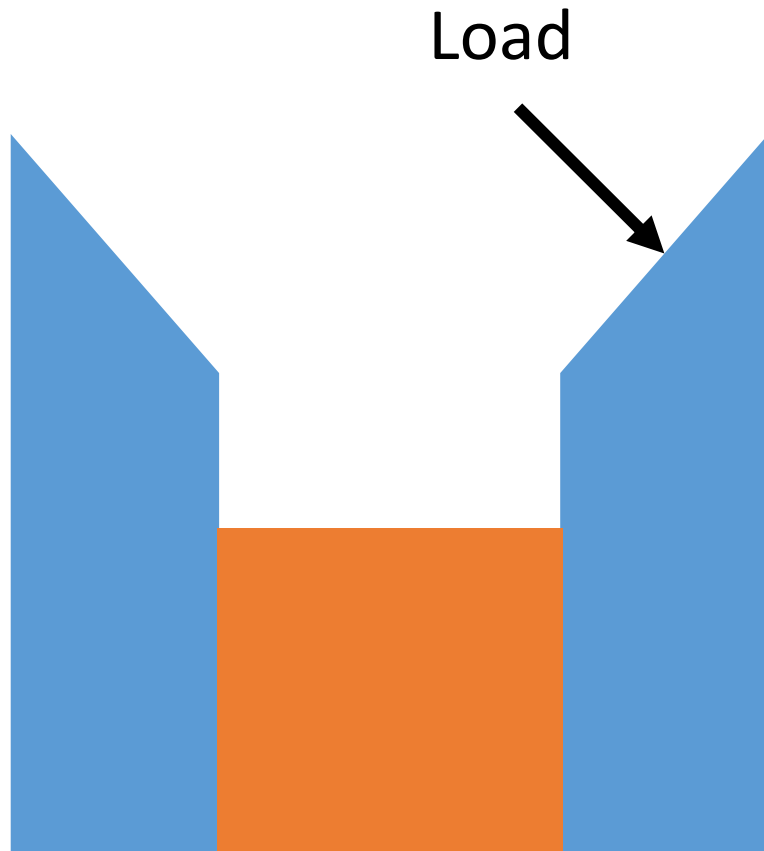


All solid structures can be considered as an assembly of many interconnected springs.



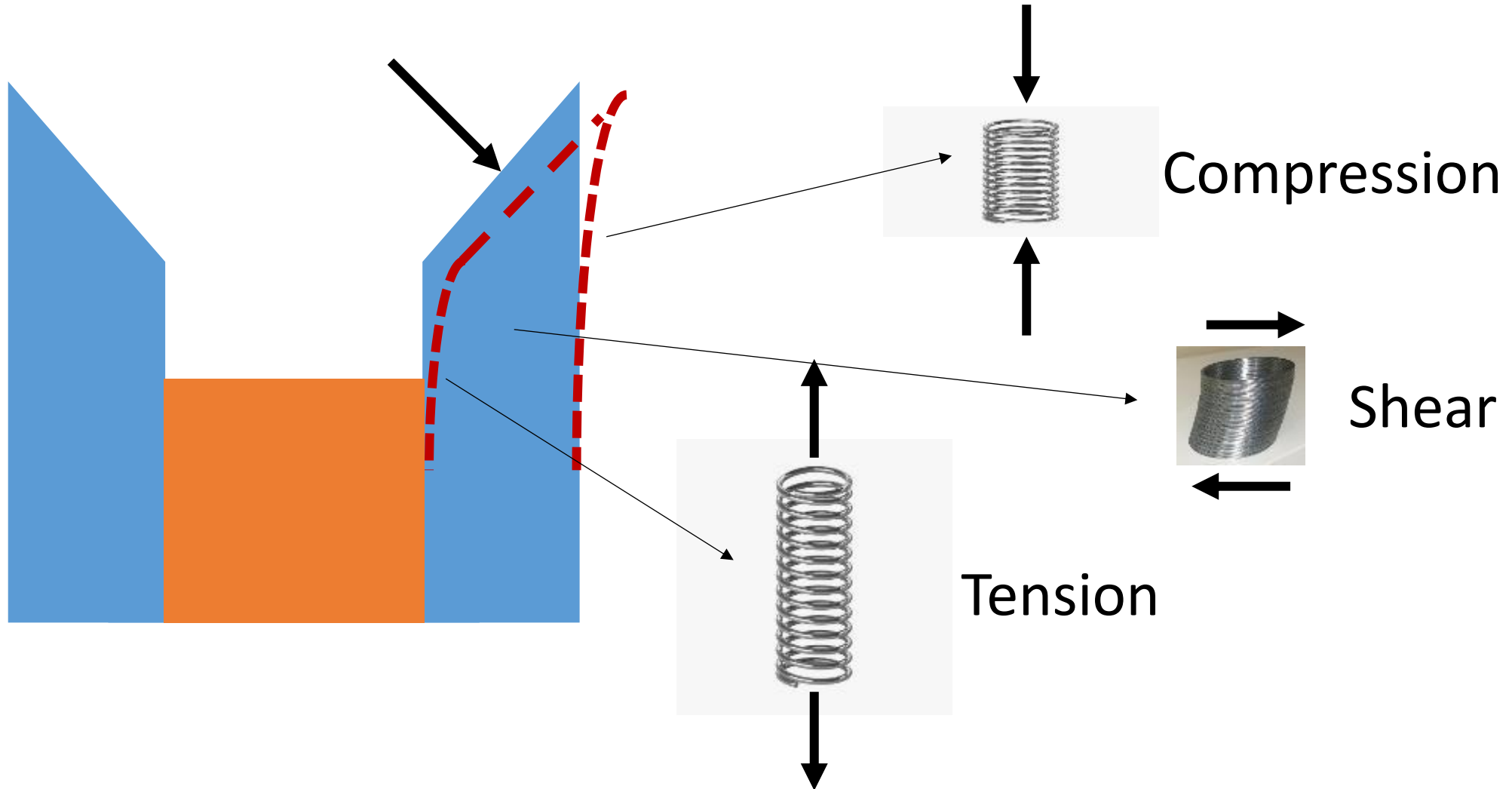


# Prepared tooth under load – structural deformation

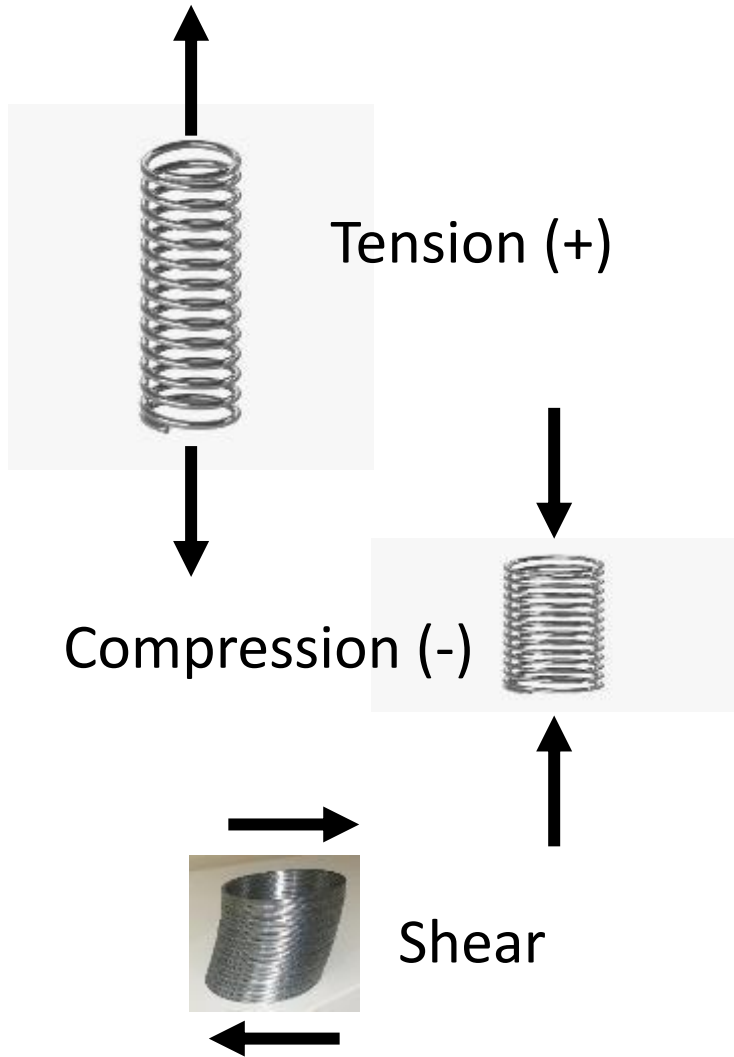


Cavity wall is under cantilever bending

# Prepared tooth under load – elemental deformation



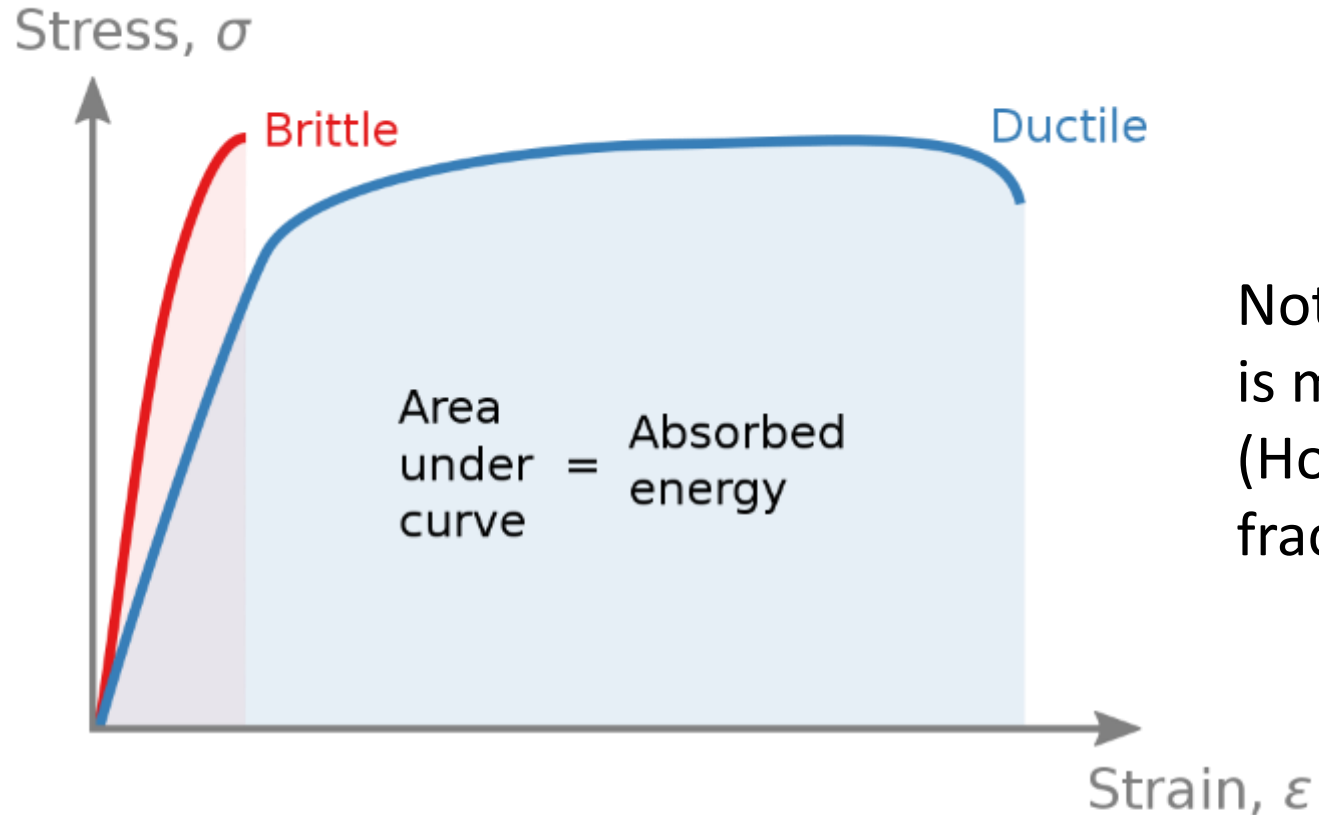
# Stresses and Strains



Stress is force (F) per unit area (A) =  $\frac{F}{A}$

Strain is displacement ( $\delta$ ) per unit length (L) =  $\frac{\delta}{L}$

# Stress-strain curves



Note that, for brittle materials, stress is more or less proportional to strain (Hooke's law) right up to the point of fracture.



# Brittle materials are stronger in compression/shear than in tension

The stones in an arch bridge are under compression.

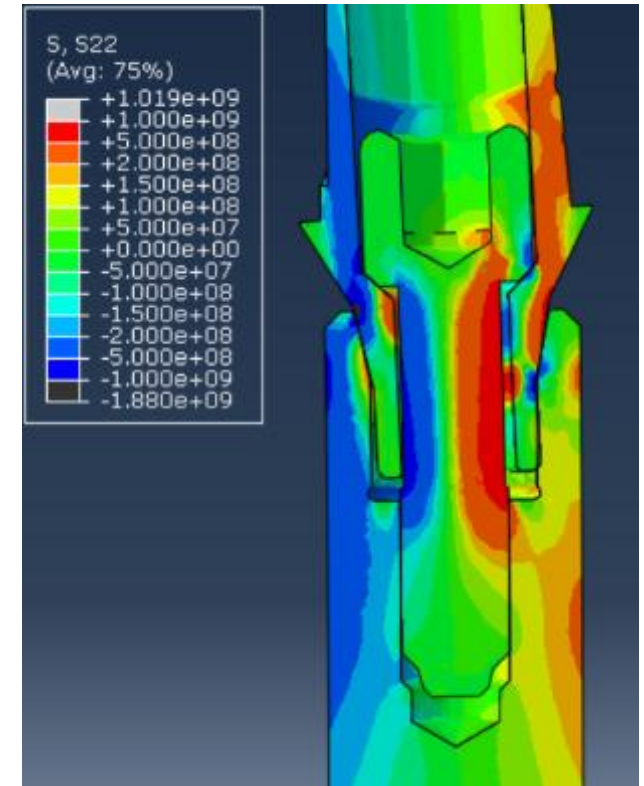
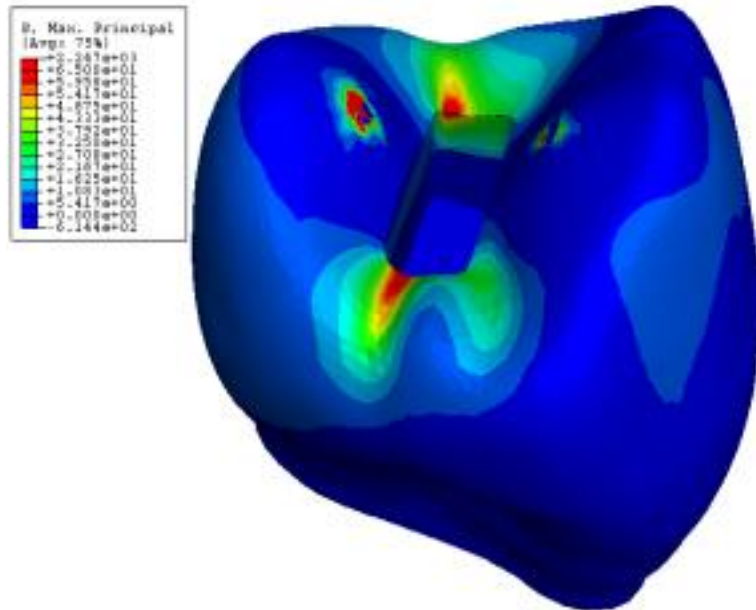


It is easier to lift a carpet (tension) than to pull it along the floor (shear).

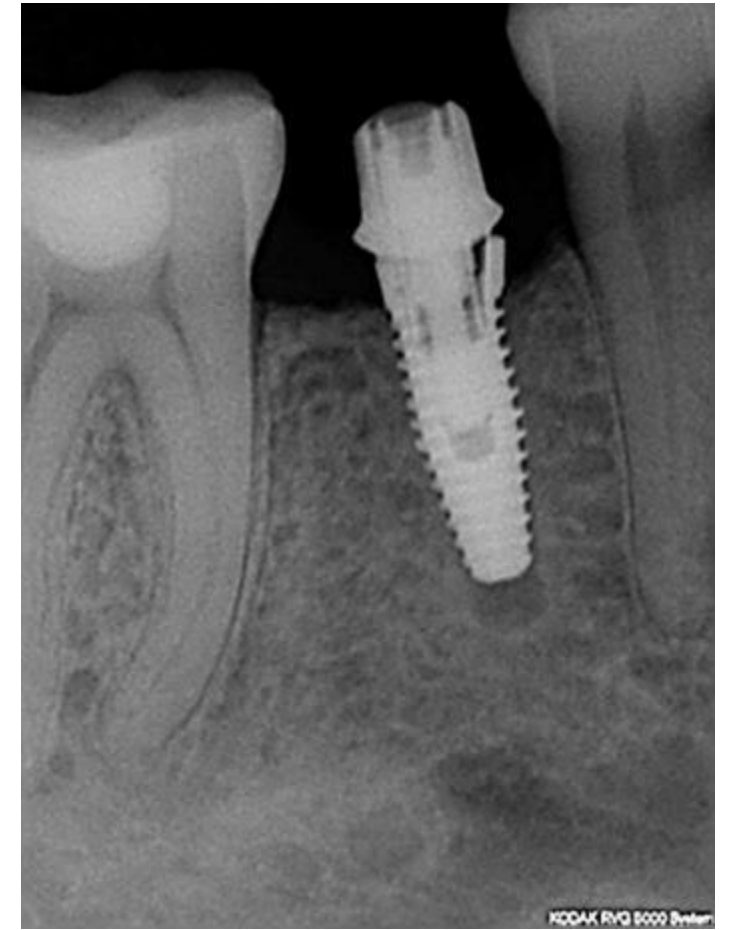
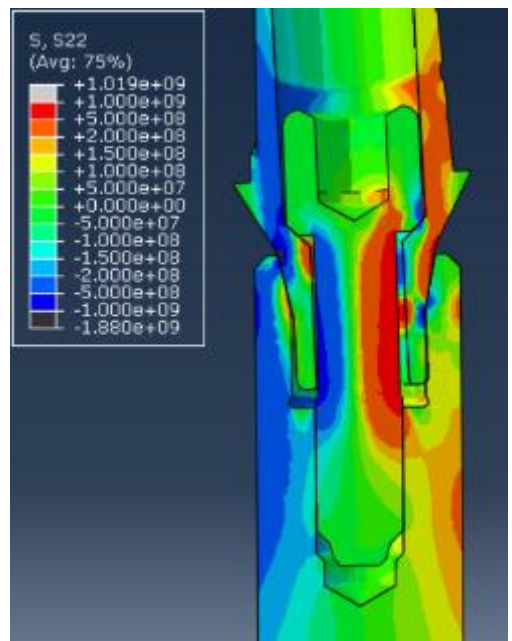
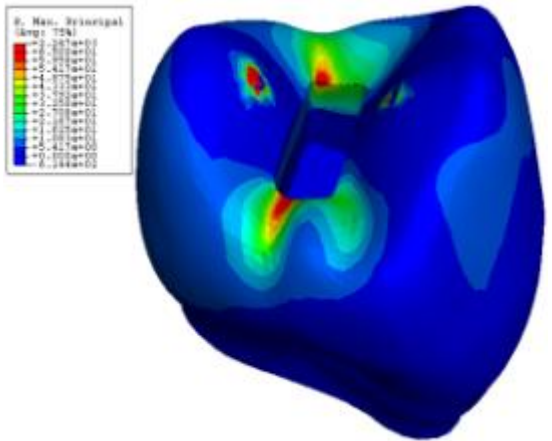
# Stress/strain concentration

This occurs at

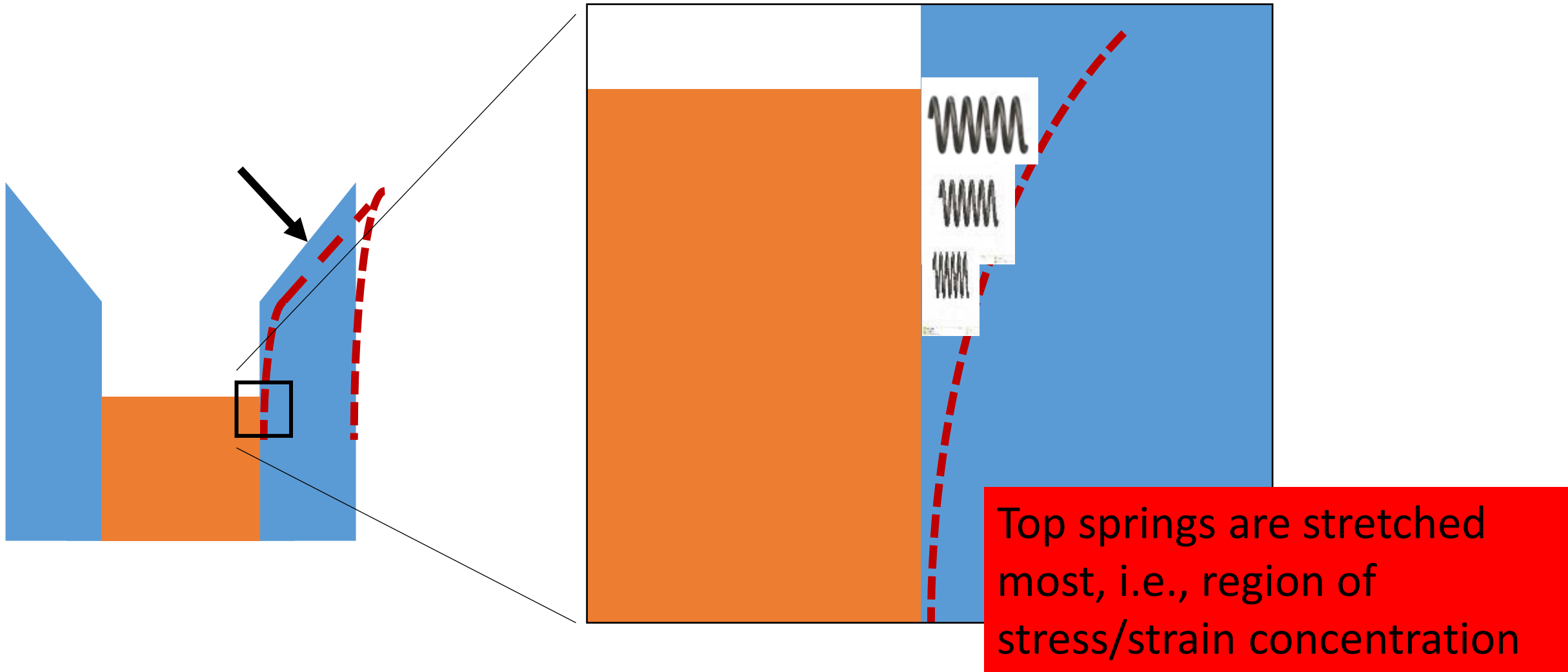
- Abrupt changes in geometry
- Mismatches in mechanical properties
- Concentrated loads



# Regions of stress concentration are often origins of failure



# Stress/strain concentration – line angle



# Enamel vs. Resin Composite



Enamel rods?

Resin composite



# Impact of materials on design of structures



The discovery of metals has allowed us to build bigger and stronger structures ...



# Impact of materials on design of structures



... and literally turns many structures on their heads.



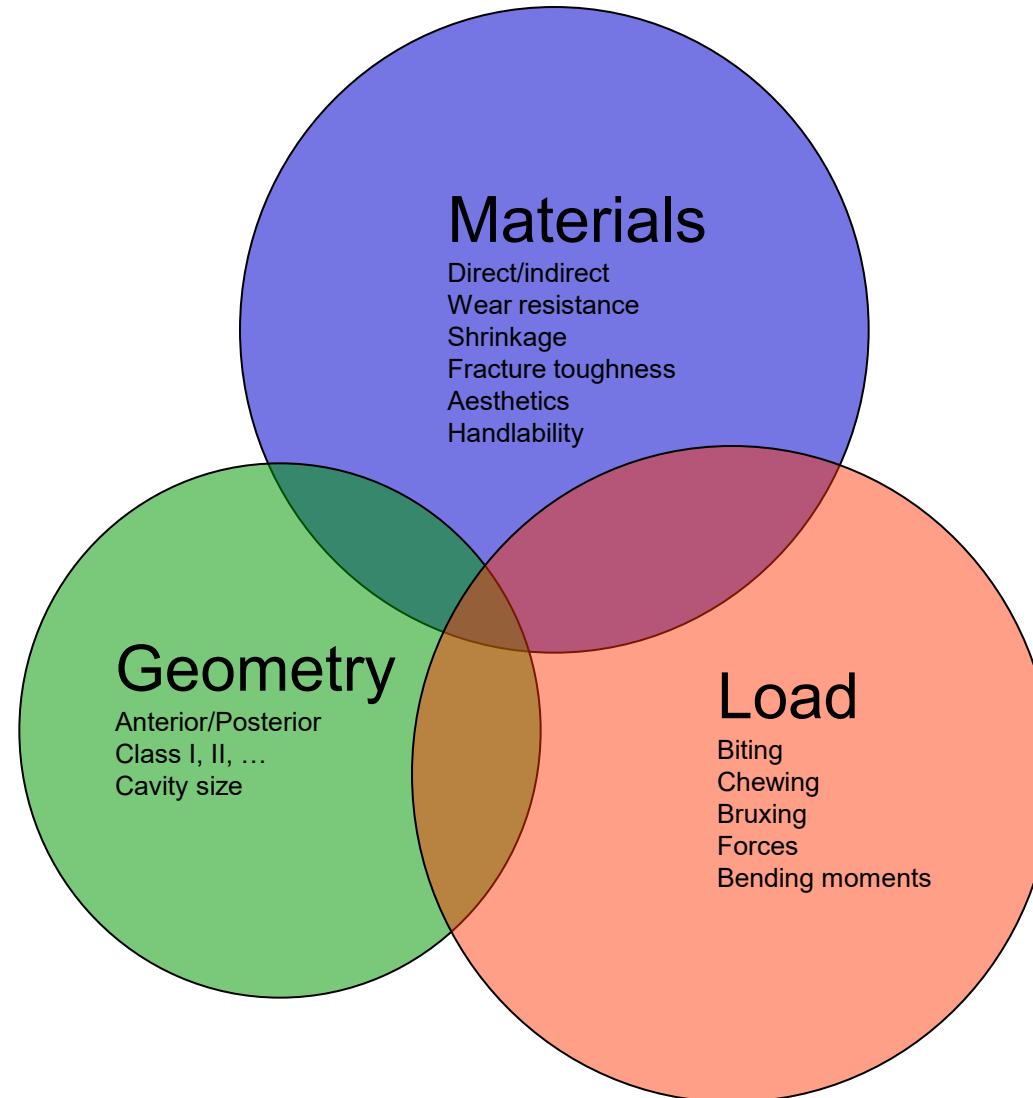
# Impact of materials on design of structures



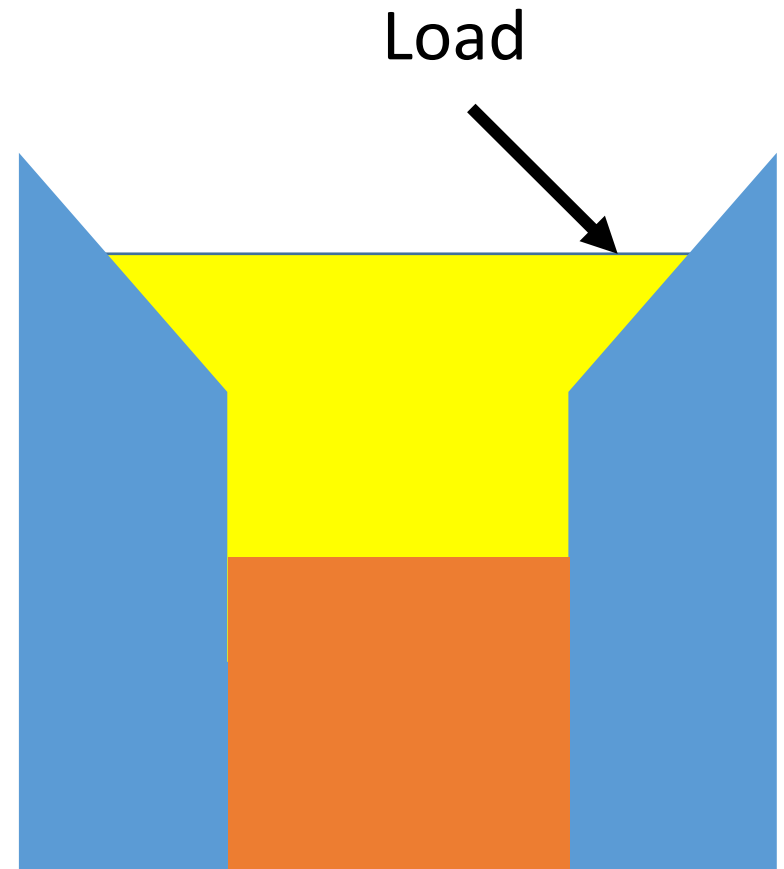
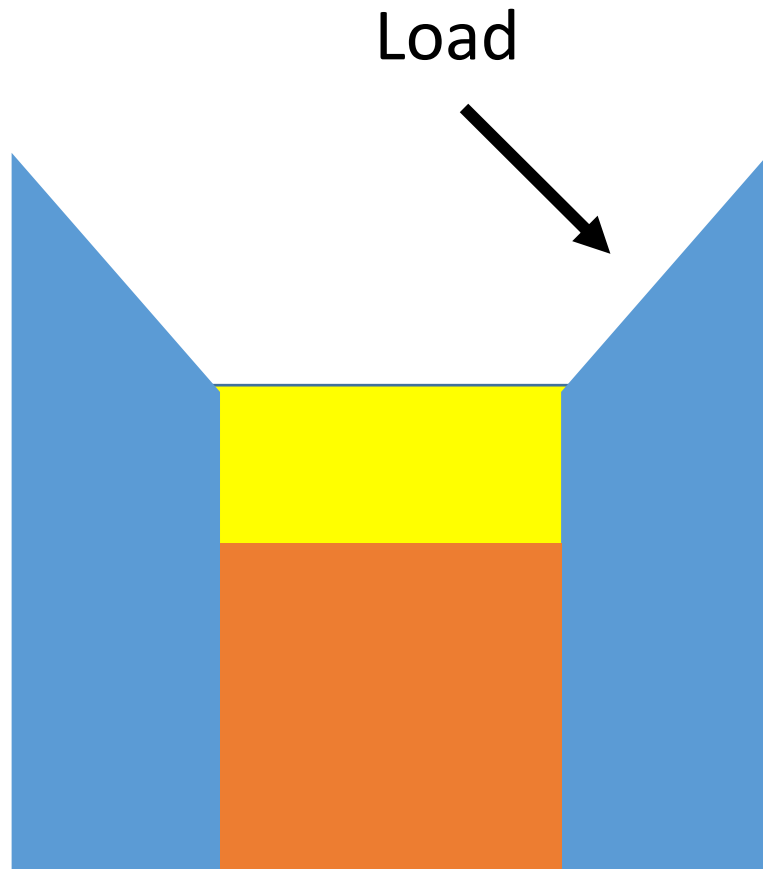
In contrast, to improve esthetics, restorative dentistry is moving away from metals ...

# Design $\Delta$ - Tooth Restoration

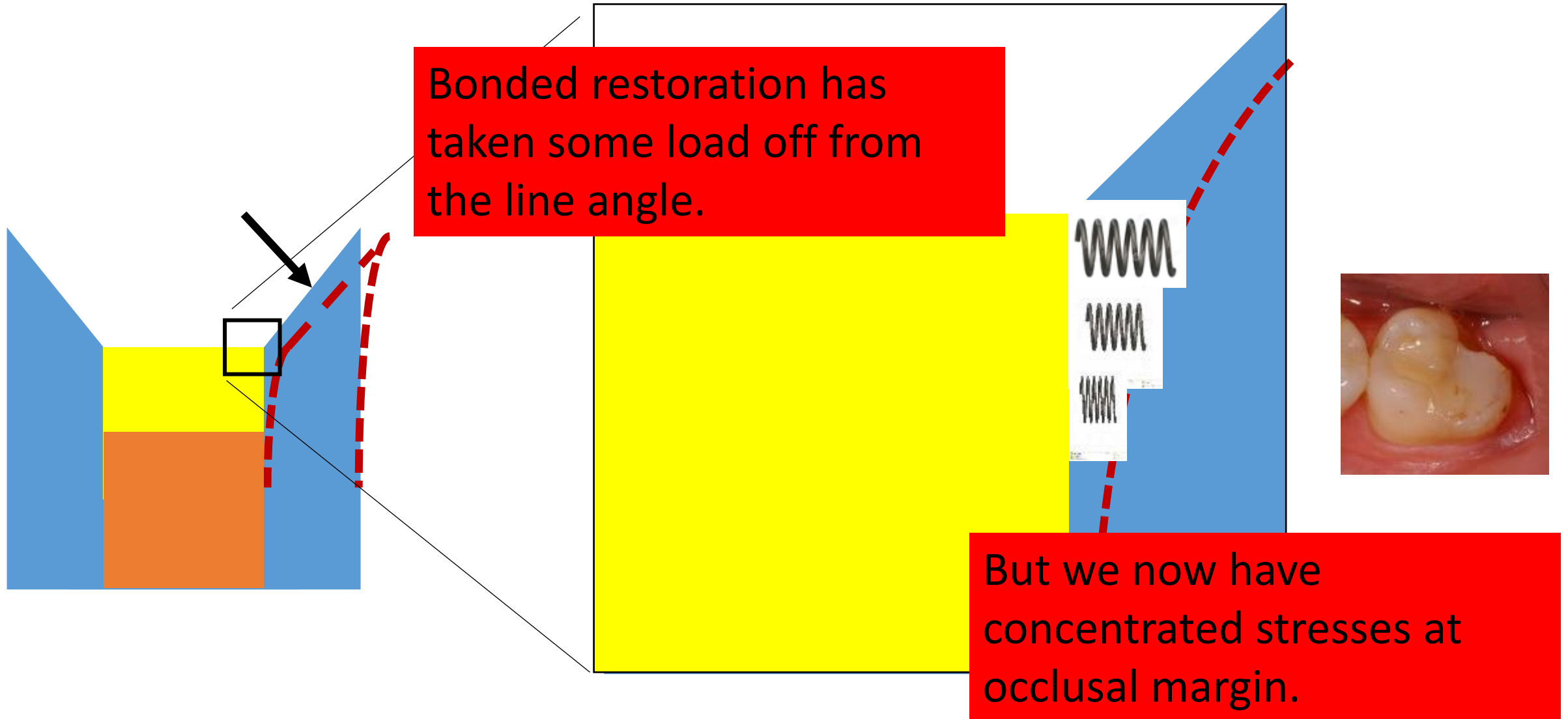
The three components of structural design/analysis, i.e. material, geometry and loading, interact with and affect one another.



# Butt joint vs. bevel joint

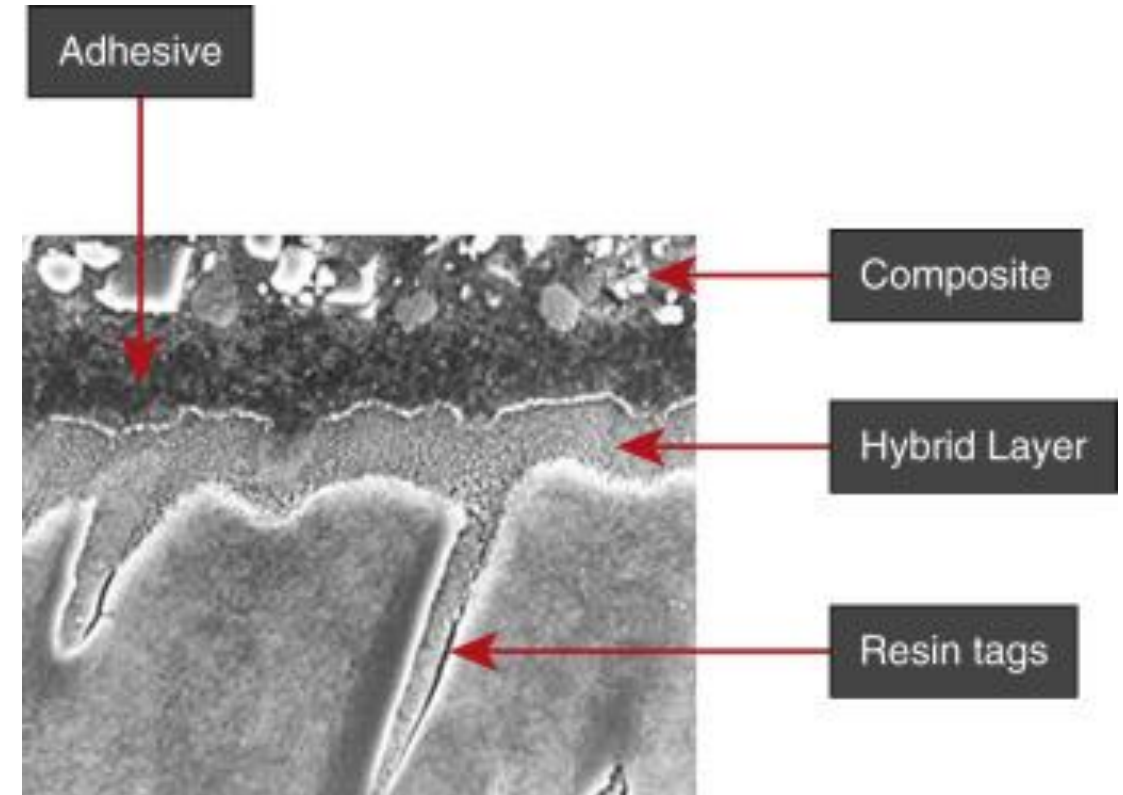
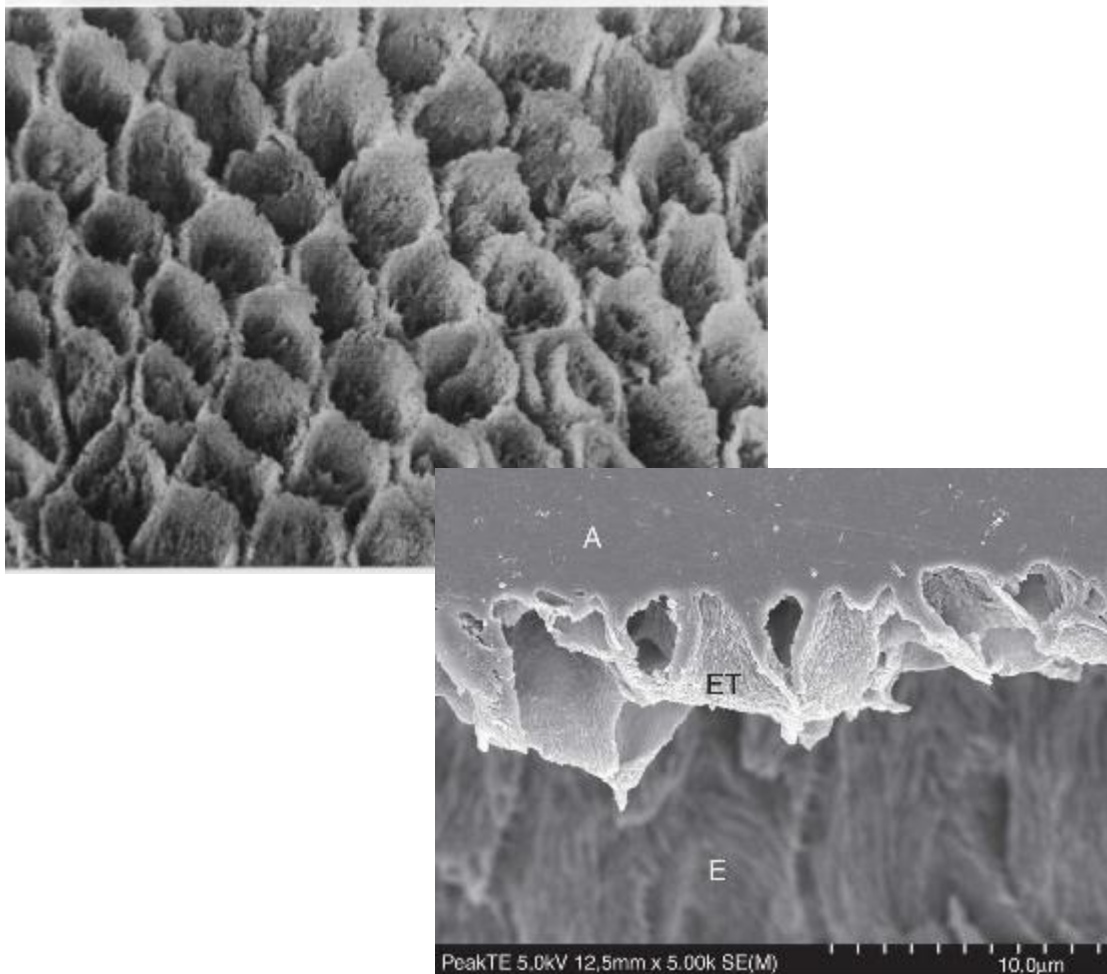


# Stress/strain concentration – occlusal margin



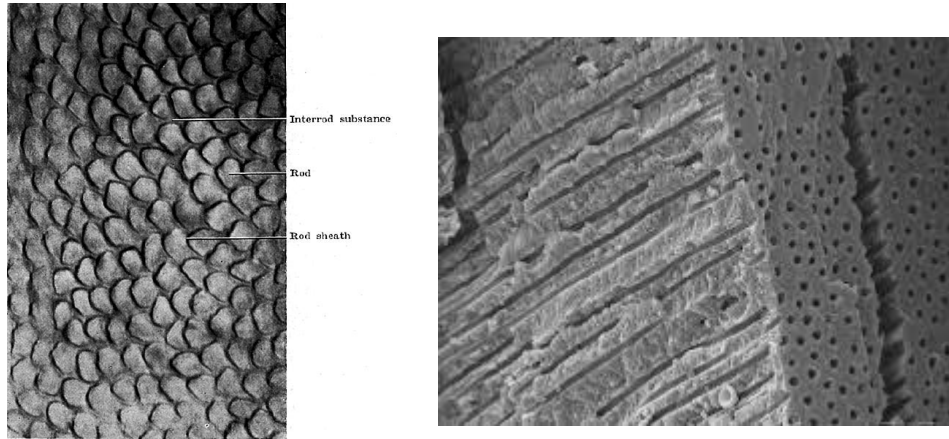
# Enamel vs. Dentin Bonding

Bonding to enamel is mostly micromechanical.

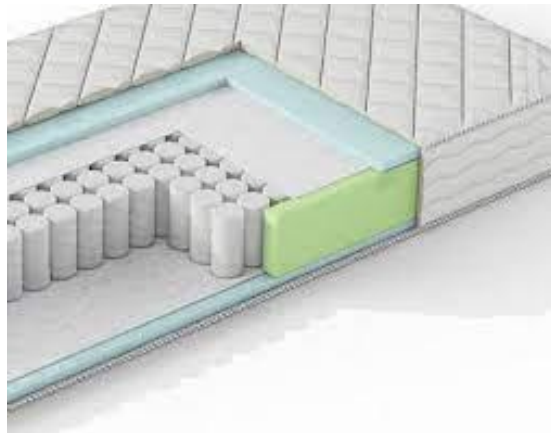


Bonding to dentin is more complicated, involving a hybrid layer and exposed collagen that are prone to enzymatic attack.

# Anisotropy : tooth tissues

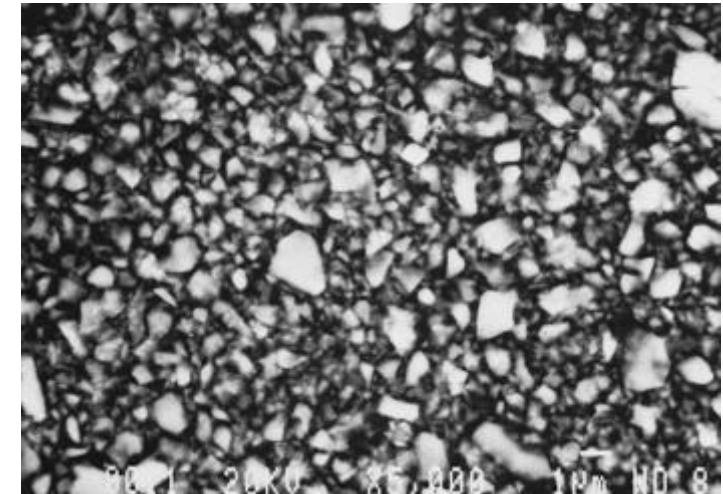


From Orban (1949) Oral Histology and Embriology, St. Louis: C.V. Mosby.



No bending stresses

# Isotropy: resin composite



VS.



# JOURNAL OF ESTHETIC AND RESTORATIVE DENTISTRY

Official Publication of the American Academy of Esthetic Dentistry,  
Japan Academy of Esthetic Dentistry, International Federation of Esthetic Dentistry,  
American Academy of Cosmetic and Adhesive Dentistry,  
Belgian 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\*  
GERRYL H. 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 dissemination to 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 limitation 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  
†Governator Dentist, Newport Coast Oral Facial Institute, Newport Beach, CA, dental professor,  
Restorative Dentistry, USC School of Dentistry, Los Angeles, CA, USA  
‡Governator 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

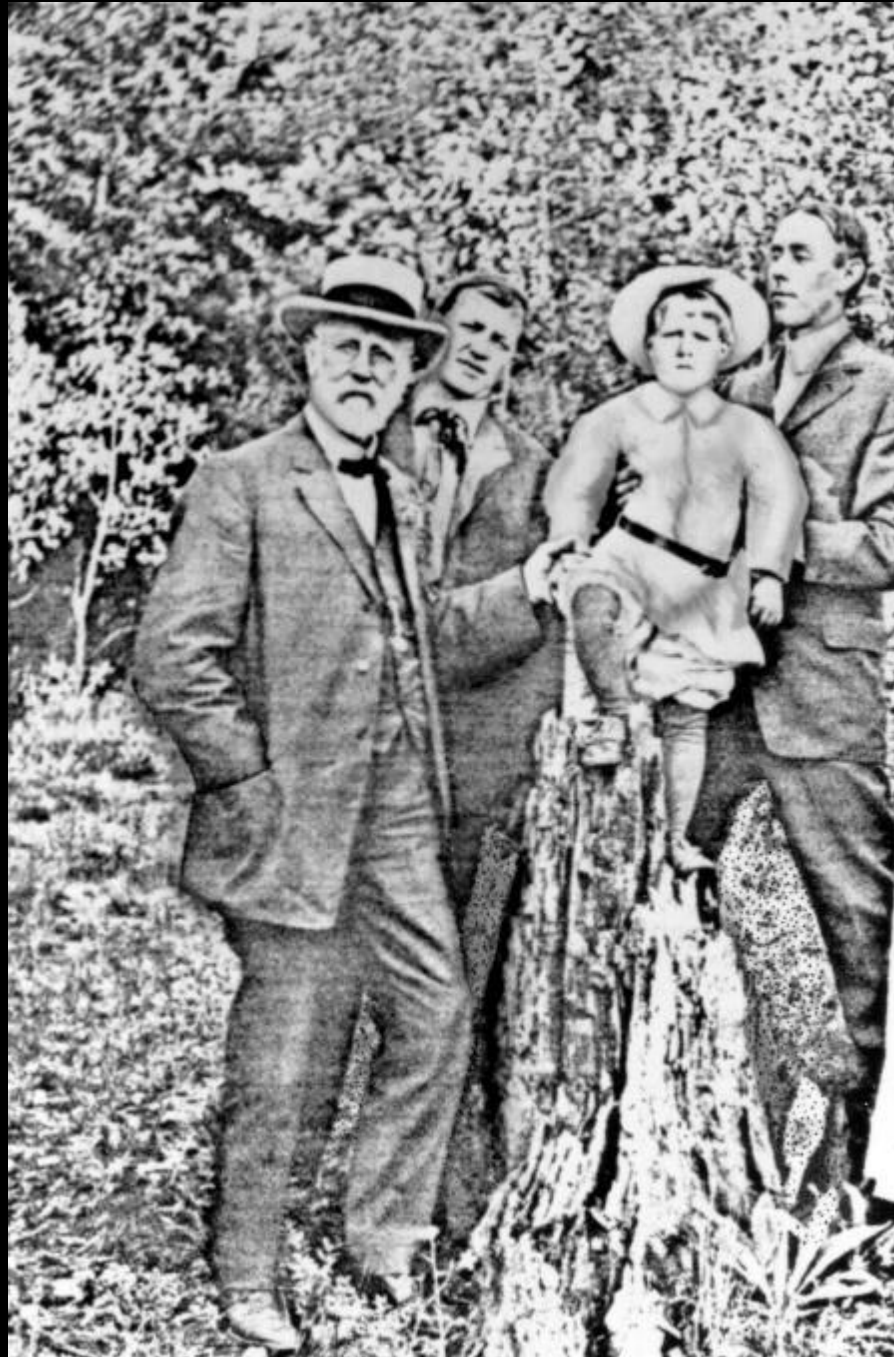
## Type III: Have high risk of underlying pathology

- 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**

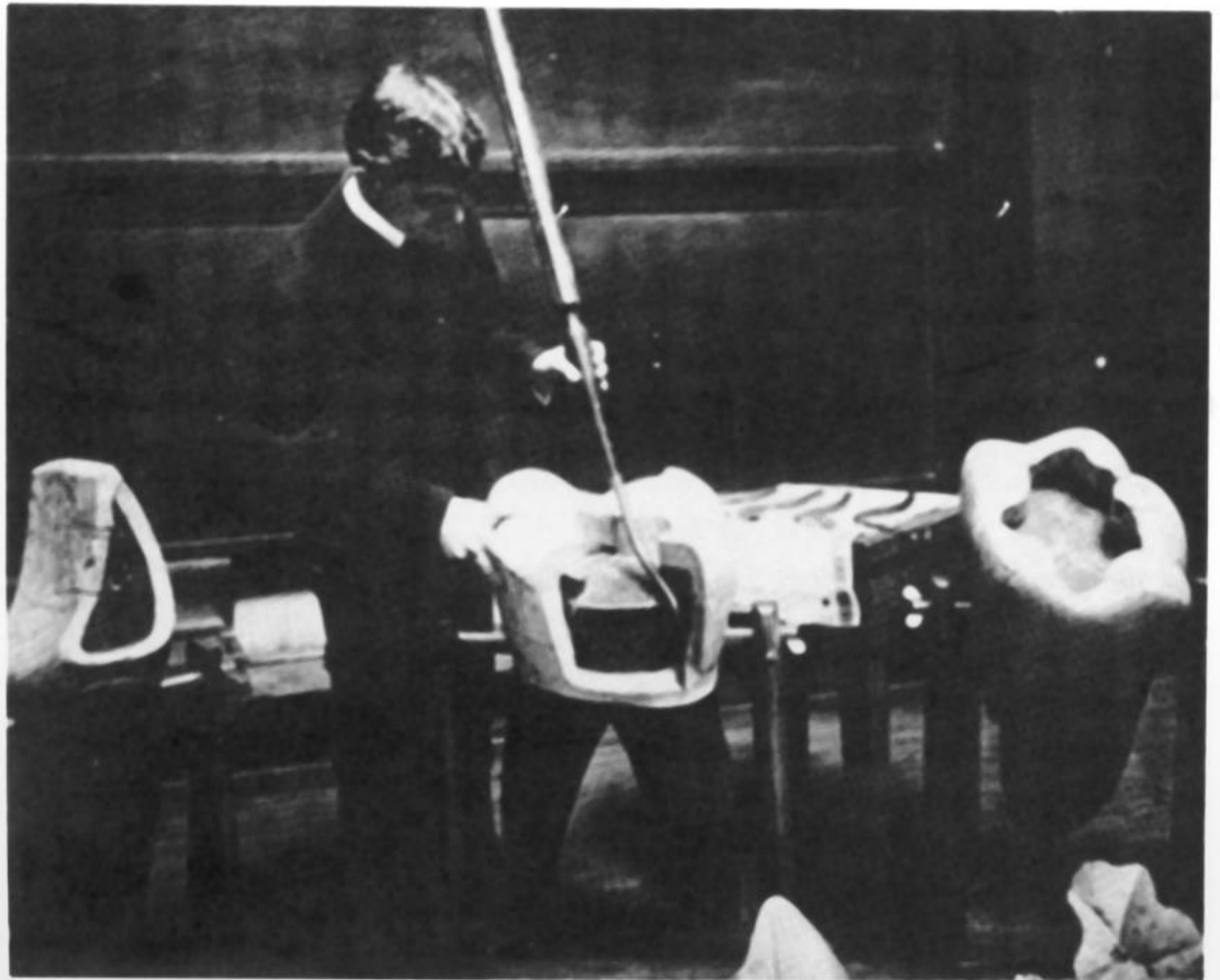
**WHERE ARE WE WITH  
CAVITY SHAPES?**

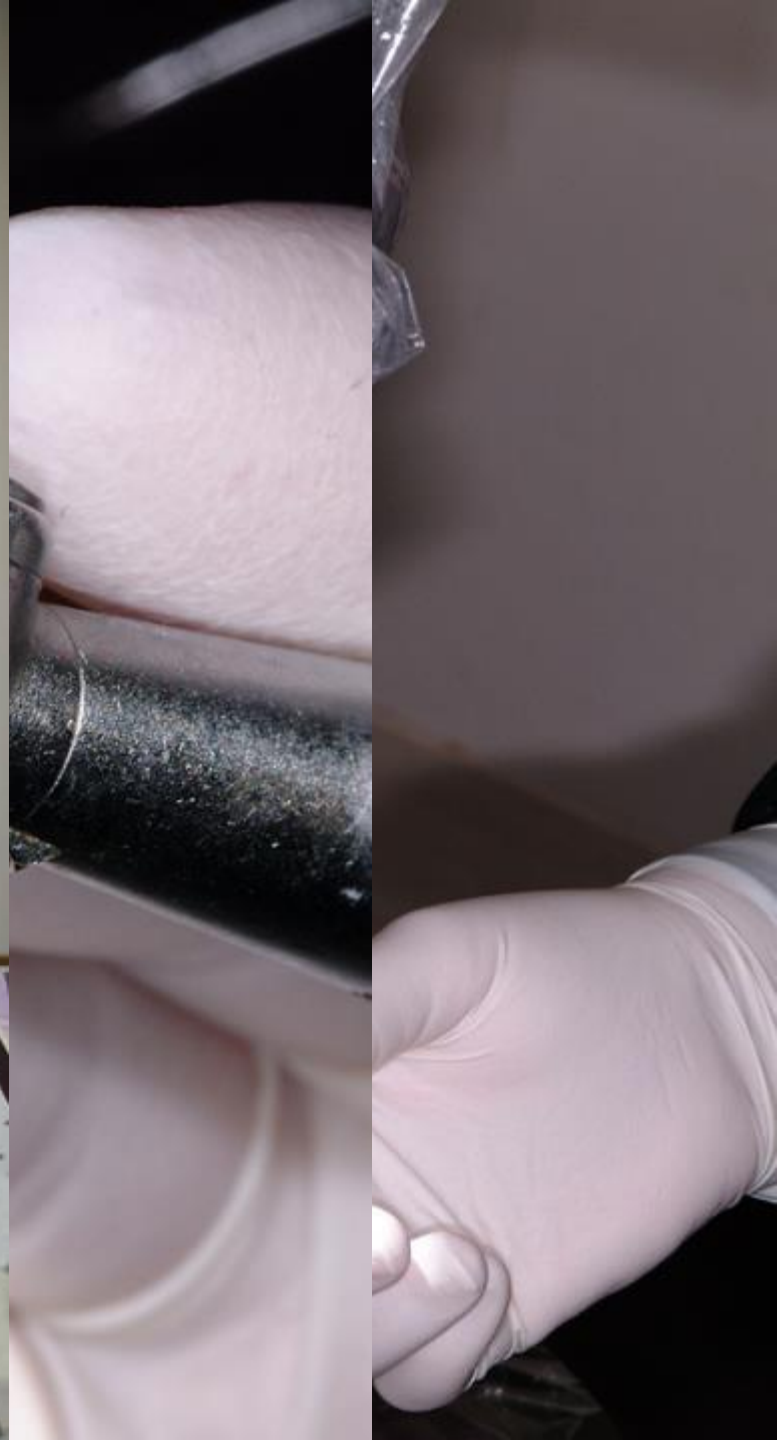
1890

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



**MORTICE AND  
TENON JOINTS  
NECESSARY FOR  
MECHANICAL  
RETENTION OF  
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THE JOURNAL OF MULTIDISCIPLINARY CARE

# Decisions™ IN DENTISTRY

## CONSERVATIVE APPROACH TO DEEP CARRIES LESIONS

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

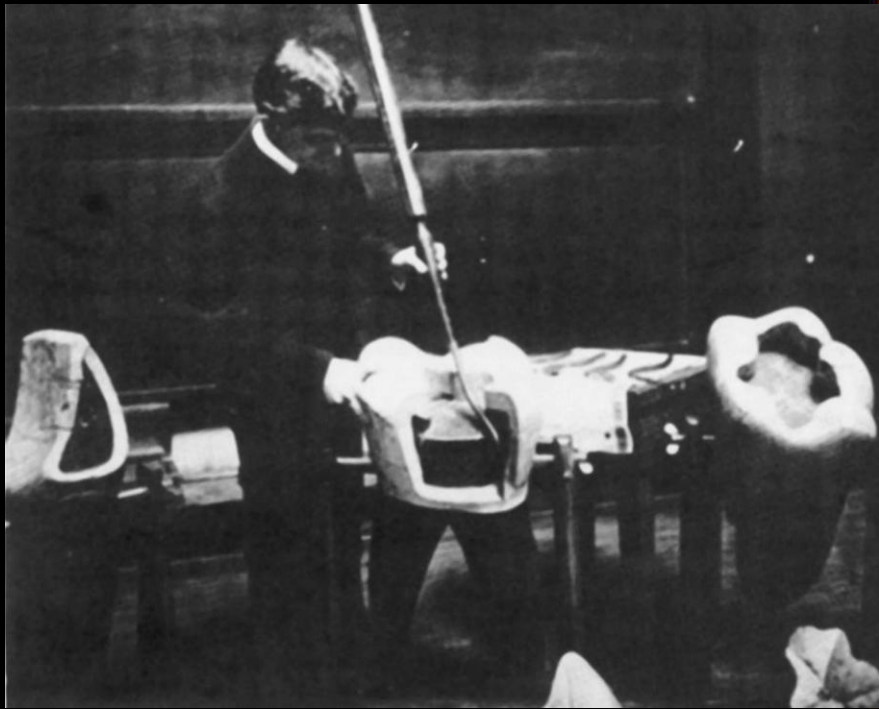
RISK FACTORS IN  
ORAL CANCER  
SCREENING  
SARAH GLASS, DDS

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

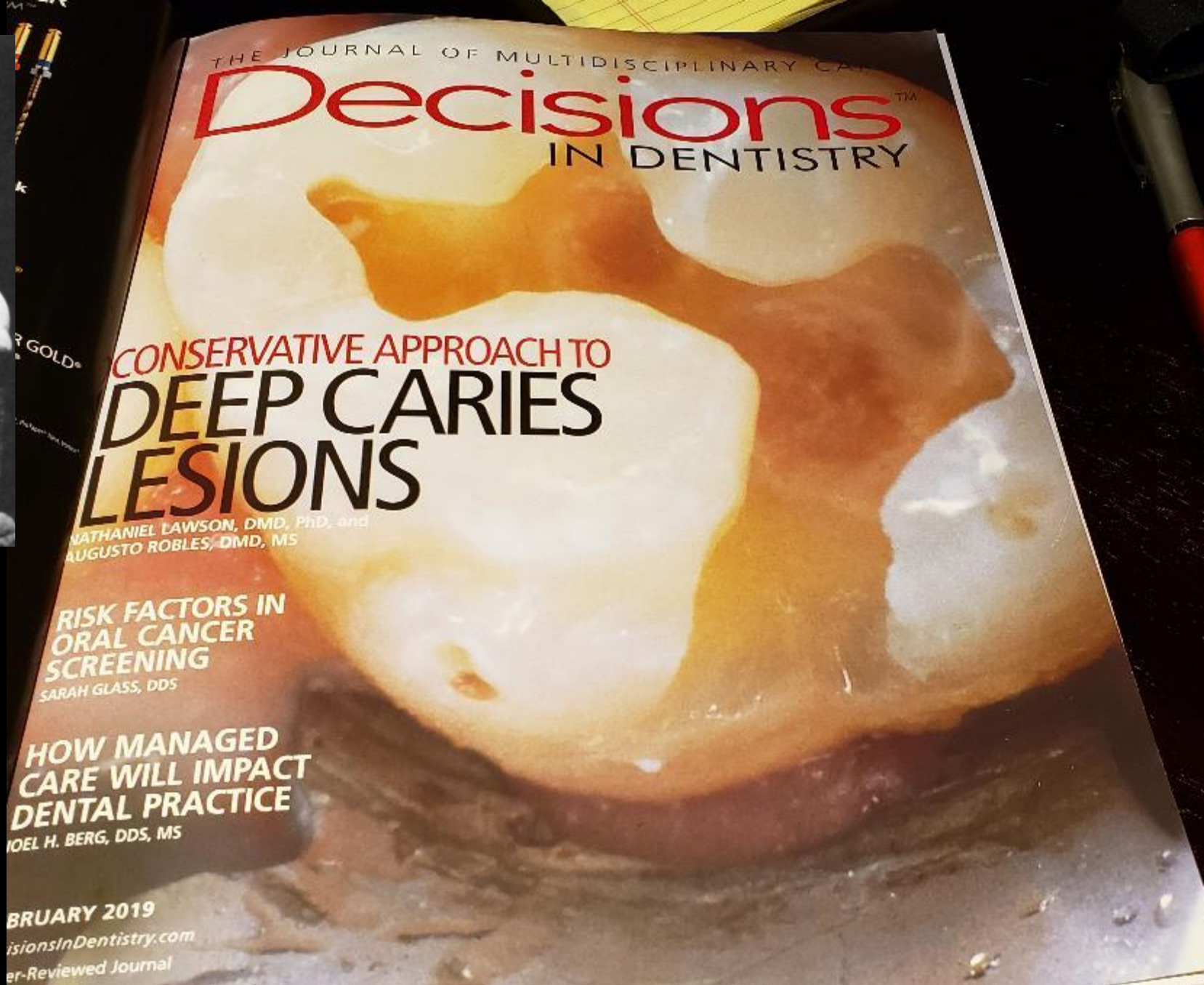
FEBRUARY 2019

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A Peer-Reviewed Journal

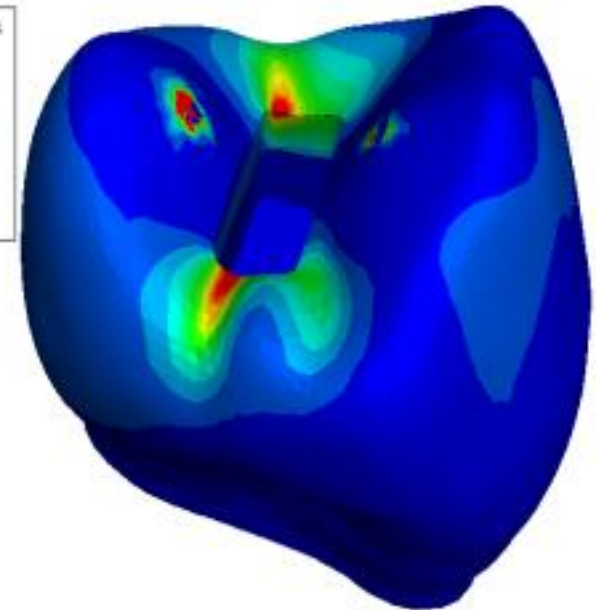
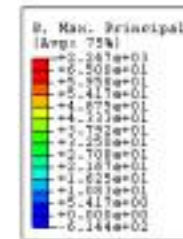
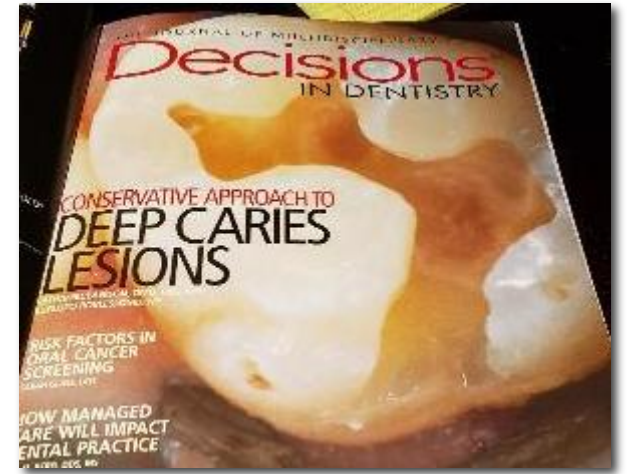


Is this the  
year 2026  
or 1890?



# Stress/Strain Concentration

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

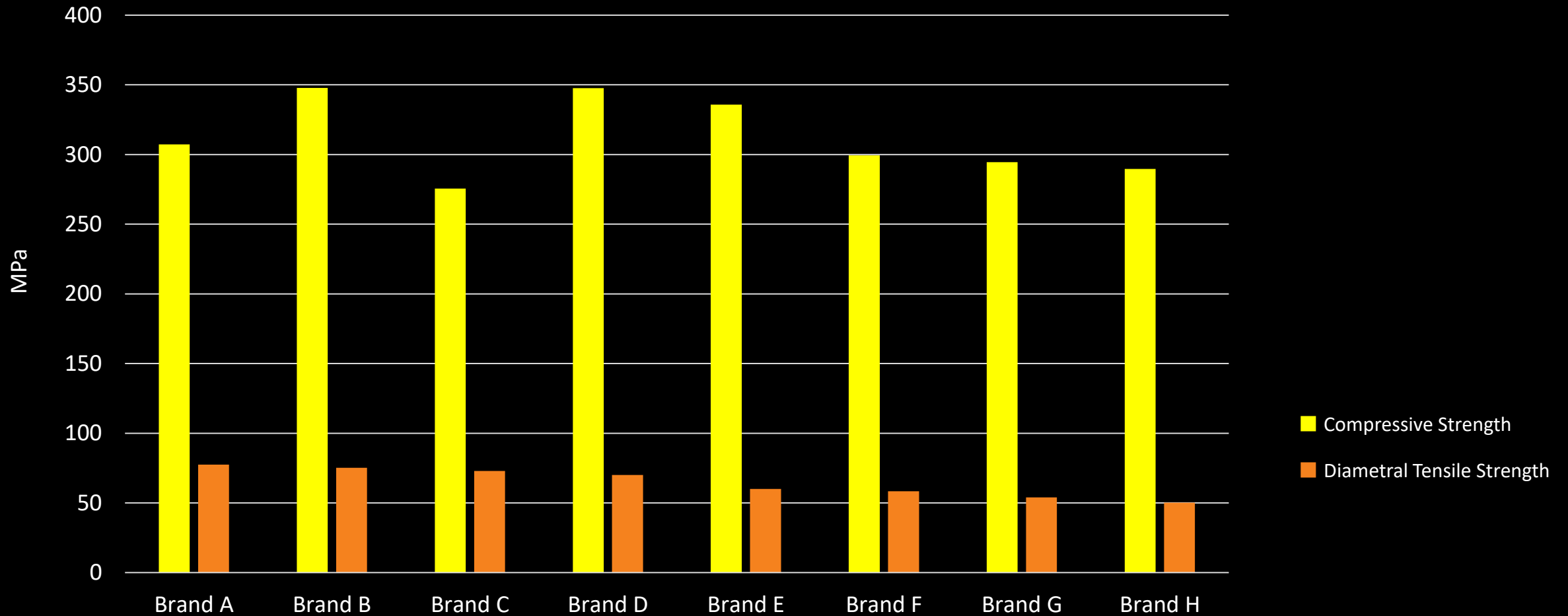


# Epidemic of Cracked Teeth...Why?

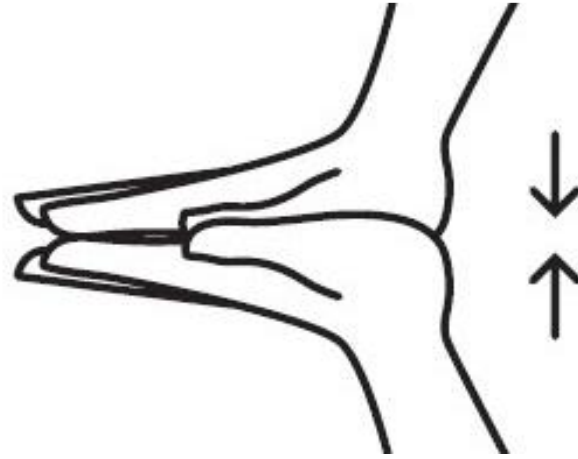
**Brittle Materials with  
Tension joints**

# Composite Resin Material Properties

## Compressive vs Diametral Tensile Strength



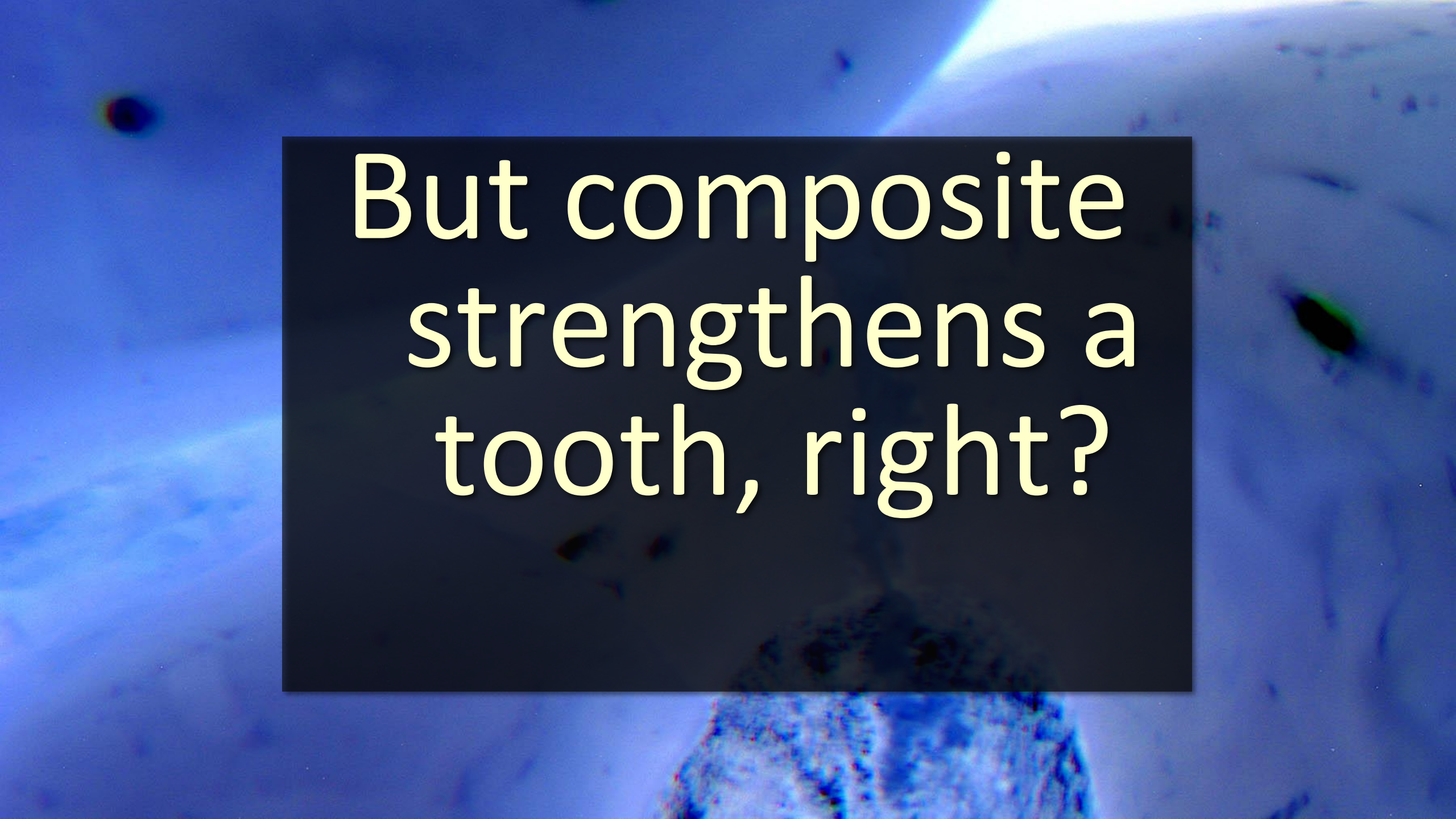
# Compression vs. Tension is “Engineering 101”



compression



tension

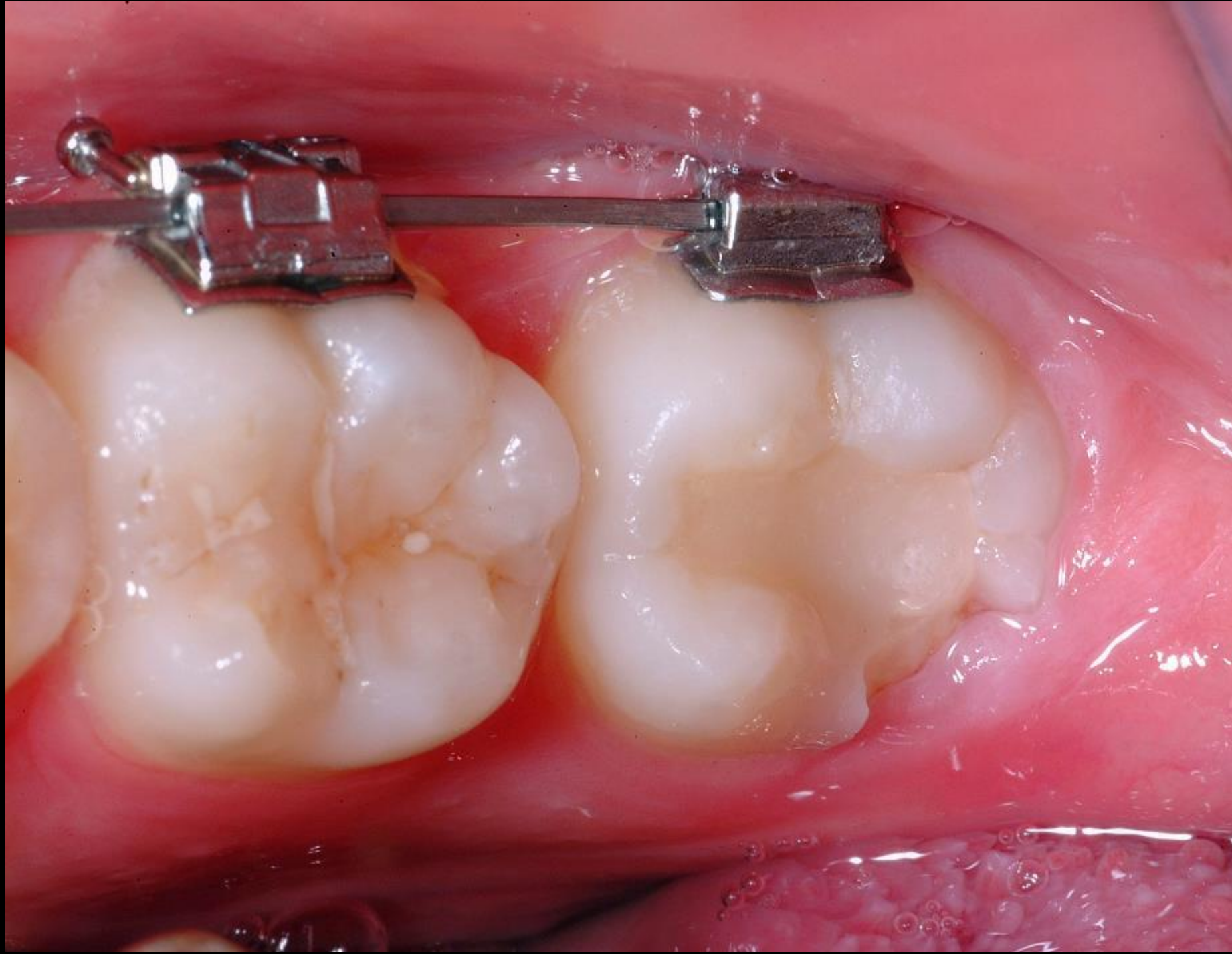
A microscopic view of a tooth with a composite filling. The background is a light blue, textured surface representing the tooth's enamel. A dark, irregularly shaped area at the bottom center represents the composite filling. The text is overlaid on a dark blue rectangular background in the center of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

But composite  
strengthens a  
tooth, right?

Does composite strengthen the tooth?

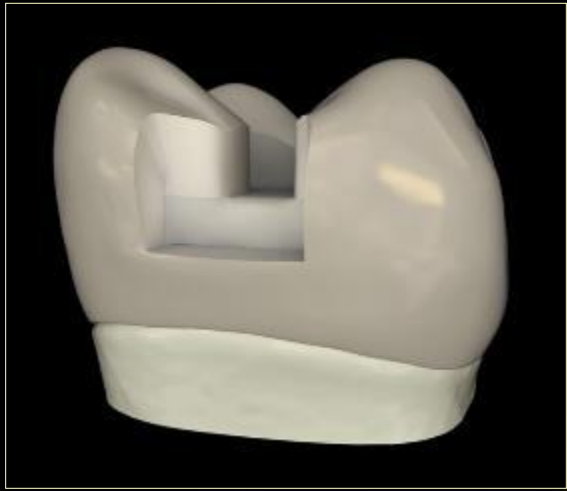
# No more than does amalgam

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)





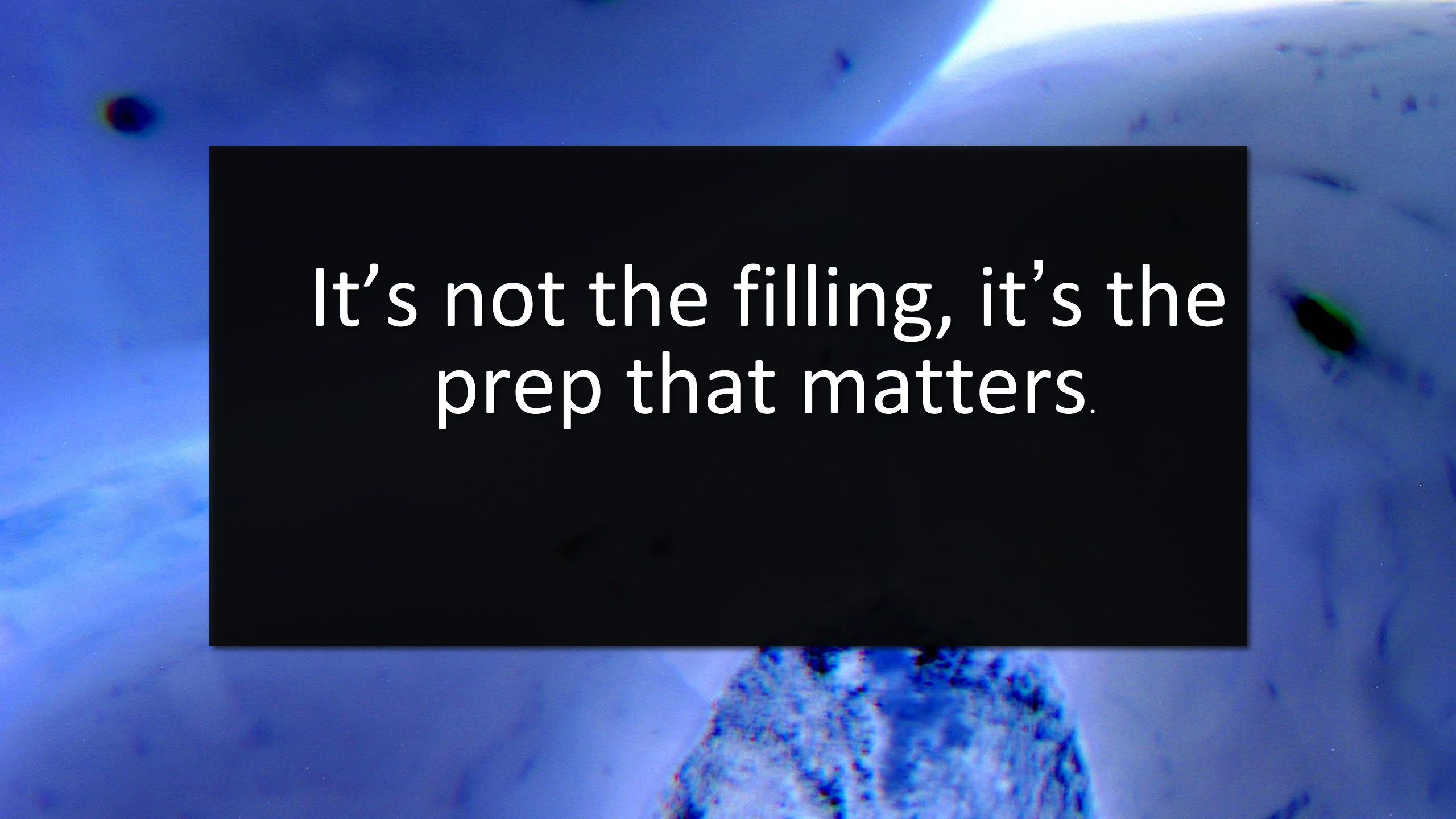




Boxes are bad.

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.

# The New Science of Strong Materials

## or Why You Don't Fall through the Floor

### J. E. Gordon



## The Epidemic of Cracked and Fracturing Teeth



### MAGNIFICATION

**T**ooth and endodontic failure are on the rise. A study of 100,000 teeth in the United States found that 10% of teeth have root fractures. The rise in root fractures is linked to the use of restorative procedures and endodontics. Root fractures are most common in the mandible, but they can occur in the maxilla as well. Root fractures are most common in the mandible, but they can occur in the maxilla as well. Root fractures are most common in the mandible, but they can occur in the maxilla as well.

**REVERSE CAUSATION AND PREVENTION**  
The reverse causation of root fractures is the use of restorative procedures and endodontics. The reverse causation of root fractures is the use of restorative procedures and endodontics.

Table 1. How Can We Minimize Tooth Fracture?			
Factor 1: Restorative procedures	Factor 2: Endodontic procedures	Factor 3: Occlusal factors	Factor 4: Parafunctional habits
Factor 5: Patient education	Factor 6: Restorative materials	Factor 7: Endodontic techniques	Factor 8: Occlusal appliances

- 1) Root fracture prevention: Use of restorative procedures and endodontics.
- 2) Occlusal factors: Use of occlusal appliances.
- 3) Parafunctional habits: Use of occlusal appliances.
- 4) Patient education: Use of restorative procedures and endodontics.
- 5) Restorative materials: Use of restorative procedures and endodontics.
- 6) Endodontic techniques: Use of restorative procedures and endodontics.
- 7) Occlusal appliances: Use of restorative procedures and endodontics.



Figure 1. A root fracture of a tooth. The fracture line extends down the length of the root.

### RESTORATIVE

## Fracture Resistant Endodontic and Restorative Preparations



Figure 1. Root fractures of teeth. The fractures extend down the length of the root.



**INTRODUCTION**  
The use of restorative procedures and endodontics has increased significantly in recent years. The use of restorative procedures and endodontics has increased significantly in recent years.

The use of restorative procedures and endodontics has increased significantly in recent years. The use of restorative procedures and endodontics has increased significantly in recent years.

**THE SCIENCE OF STRONG MATERIALS**  
The use of restorative procedures and endodontics has increased significantly in recent years. The use of restorative procedures and endodontics has increased significantly in recent years.

## **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

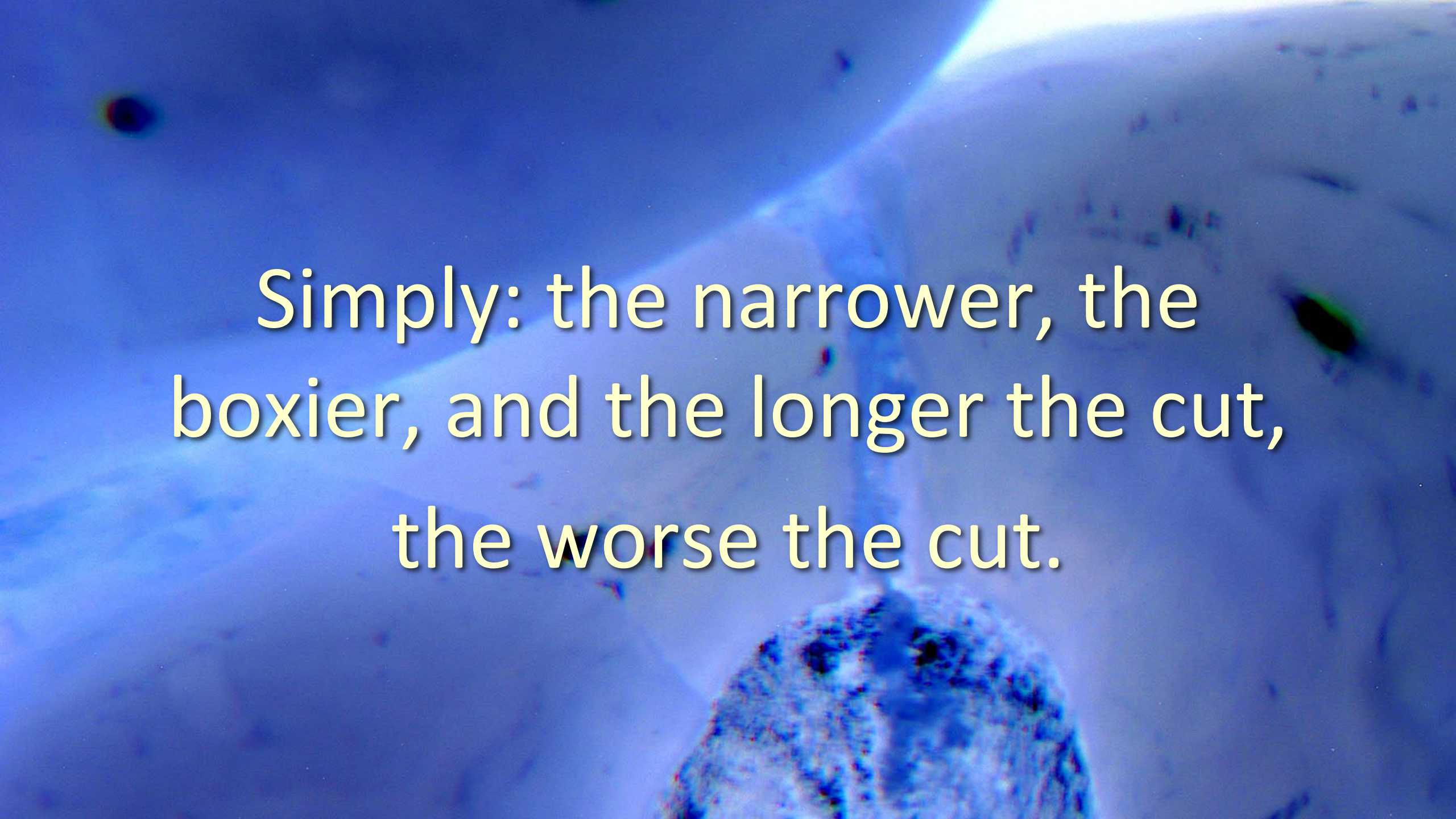
A microscopic image of a metal surface showing a sharp notch. The notch is a deep, narrow cut in the metal. The surface is highly reflective, and the notch is the central focus. The background is a bright, slightly textured metal surface. The text is overlaid on the image in a white, sans-serif font.

The formula for stress concentration in a cavity is

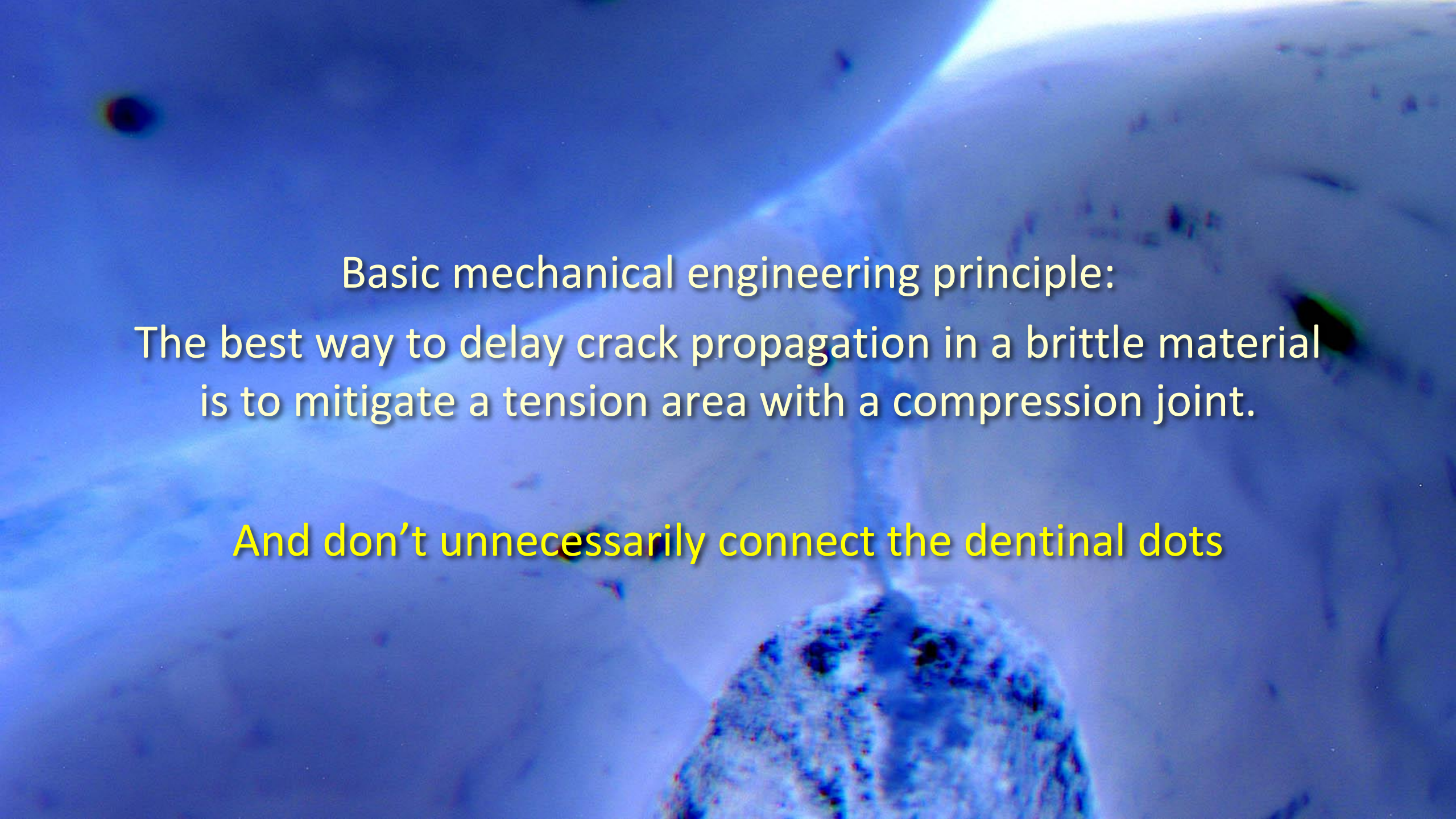
$$1 + 2 \sqrt{L/R}$$

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 showing a material surface with a crack. A compression joint is visible, which is a localized area of high pressure that counteracts the tension in the surrounding material, thereby delaying crack propagation. The crack is a dark line running through the material, and the compression joint is a darker, more textured area where the crack has been arrested or slowed down.

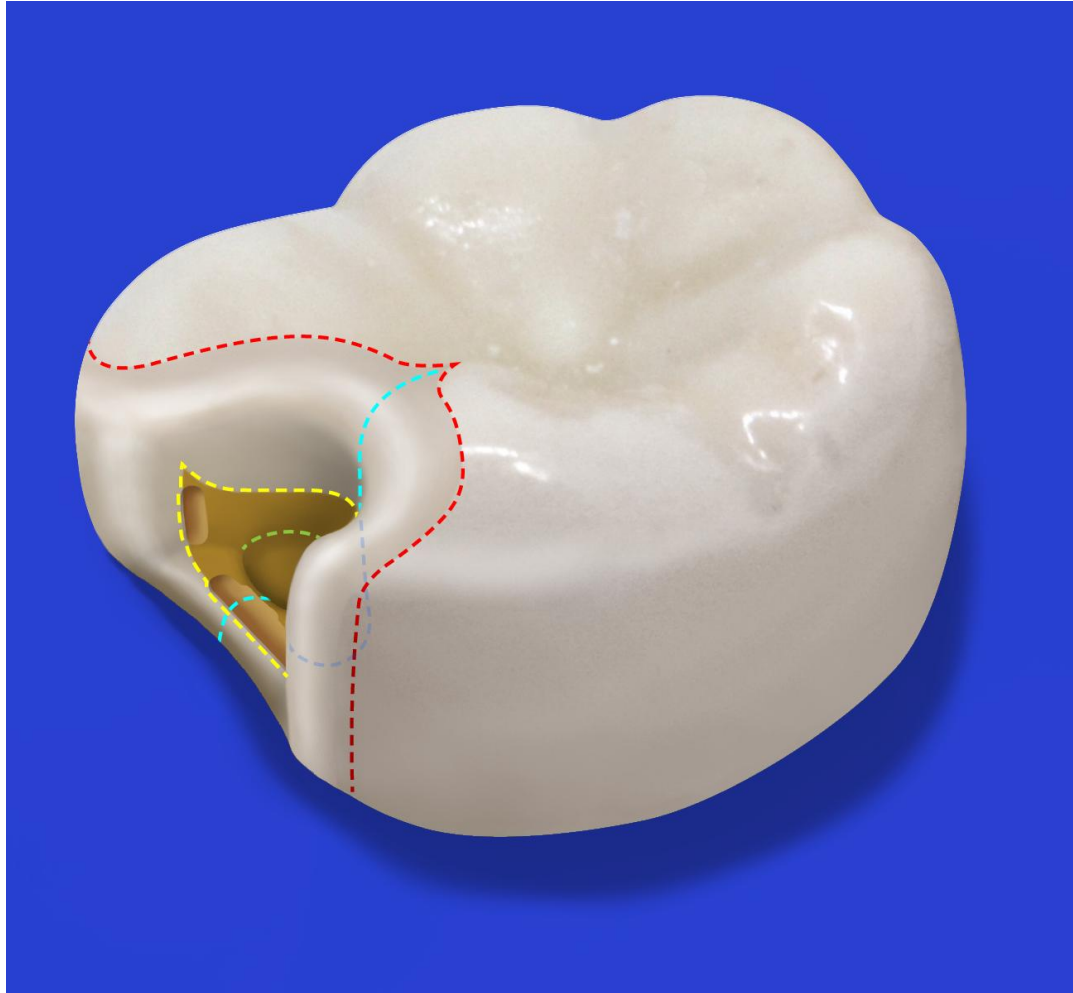
Basic mechanical engineering principle:  
The best way to delay crack propagation in a brittle material  
is to mitigate a tension area with a compression joint.

And don't unnecessarily connect the dentinal dots

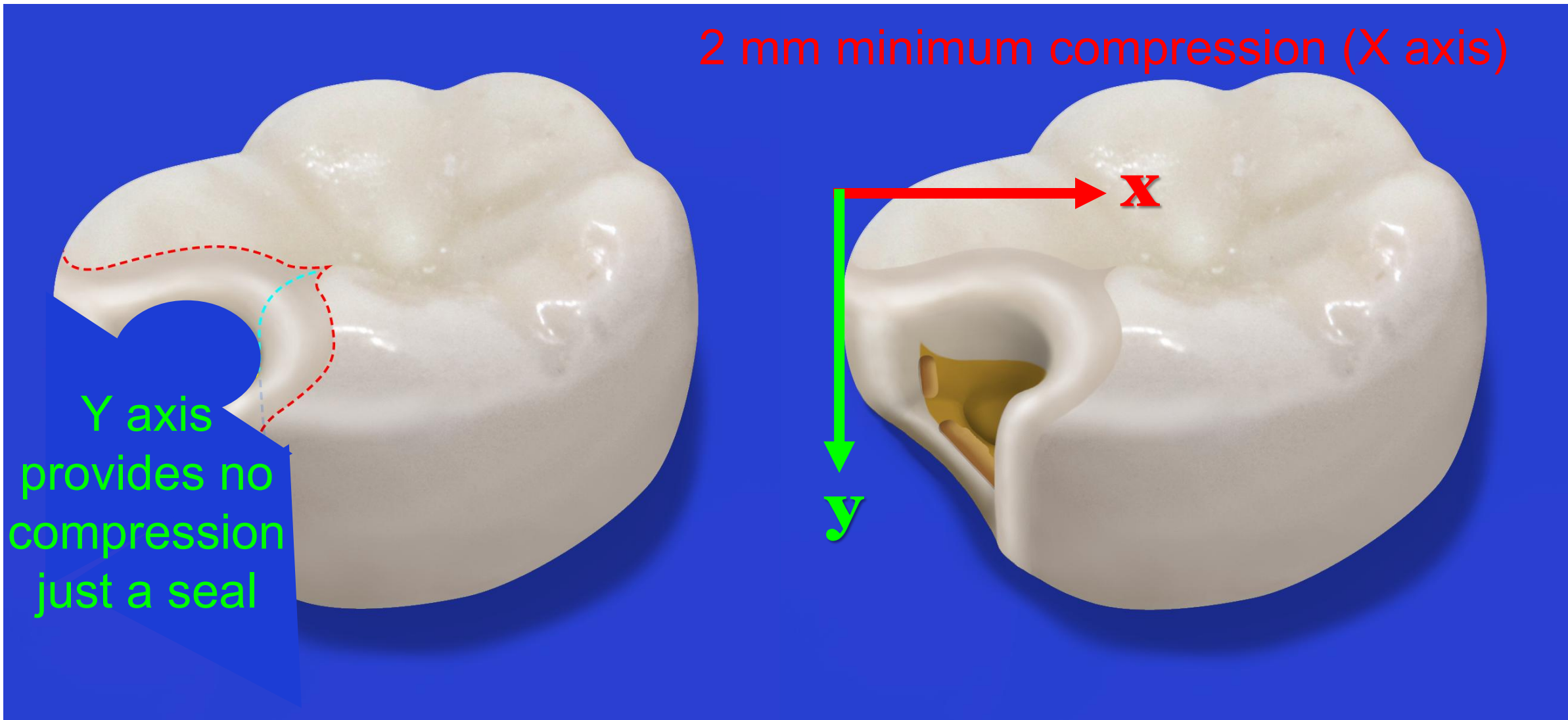
# The Prep?



# 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



# Clark Class II Prep Design



# Unique Aspects of the Clark Class II Prep Design



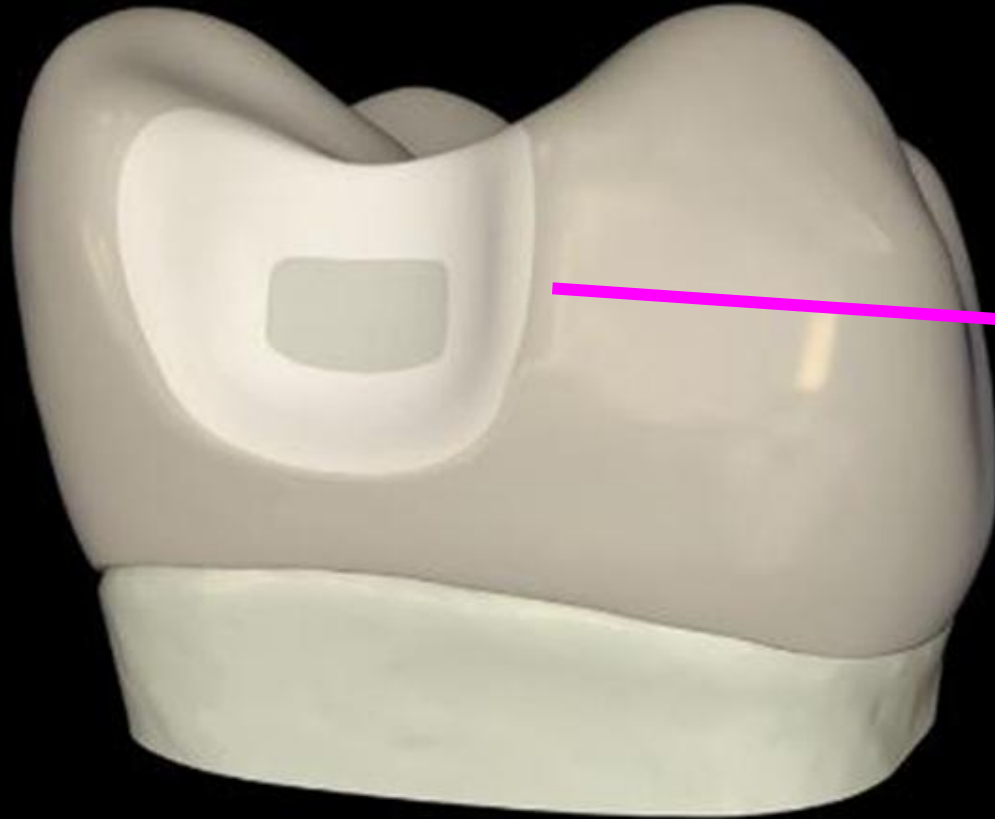
- Removal of biofilm

# 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

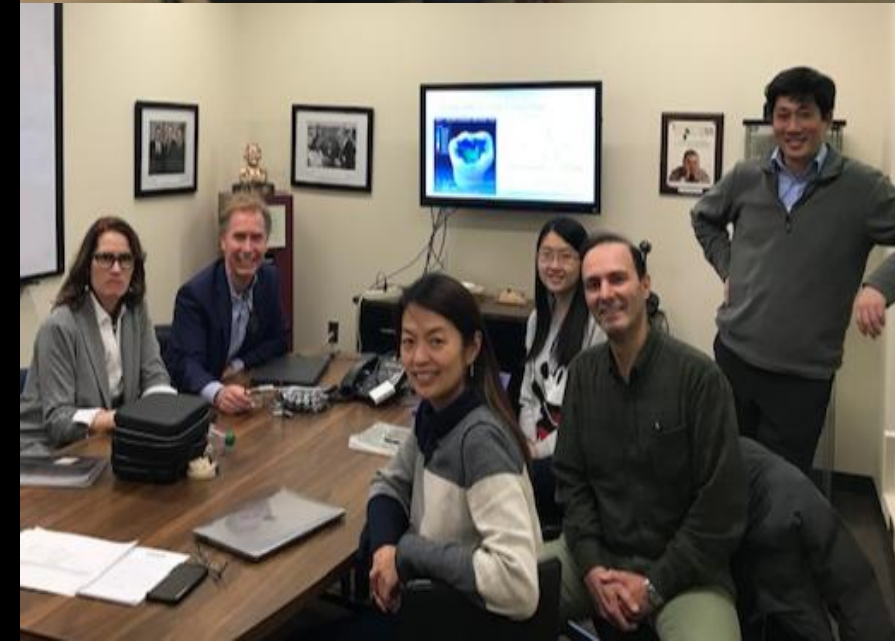
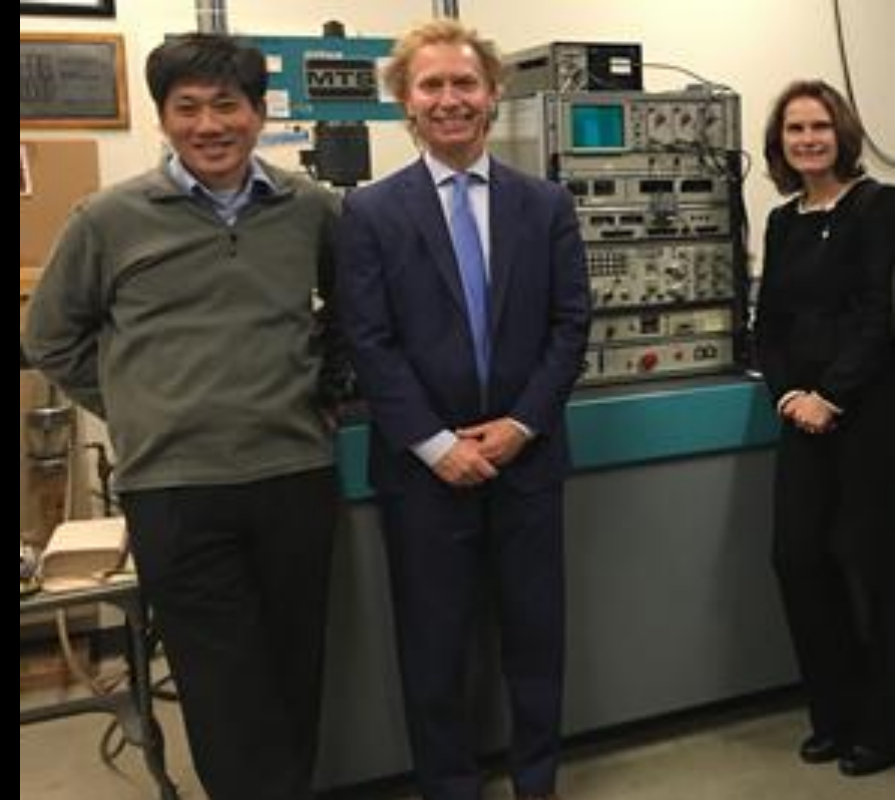
Assistant professor, Division Director of Operative Dentistry and Biomaterials, UNC School of Dentistry

- 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

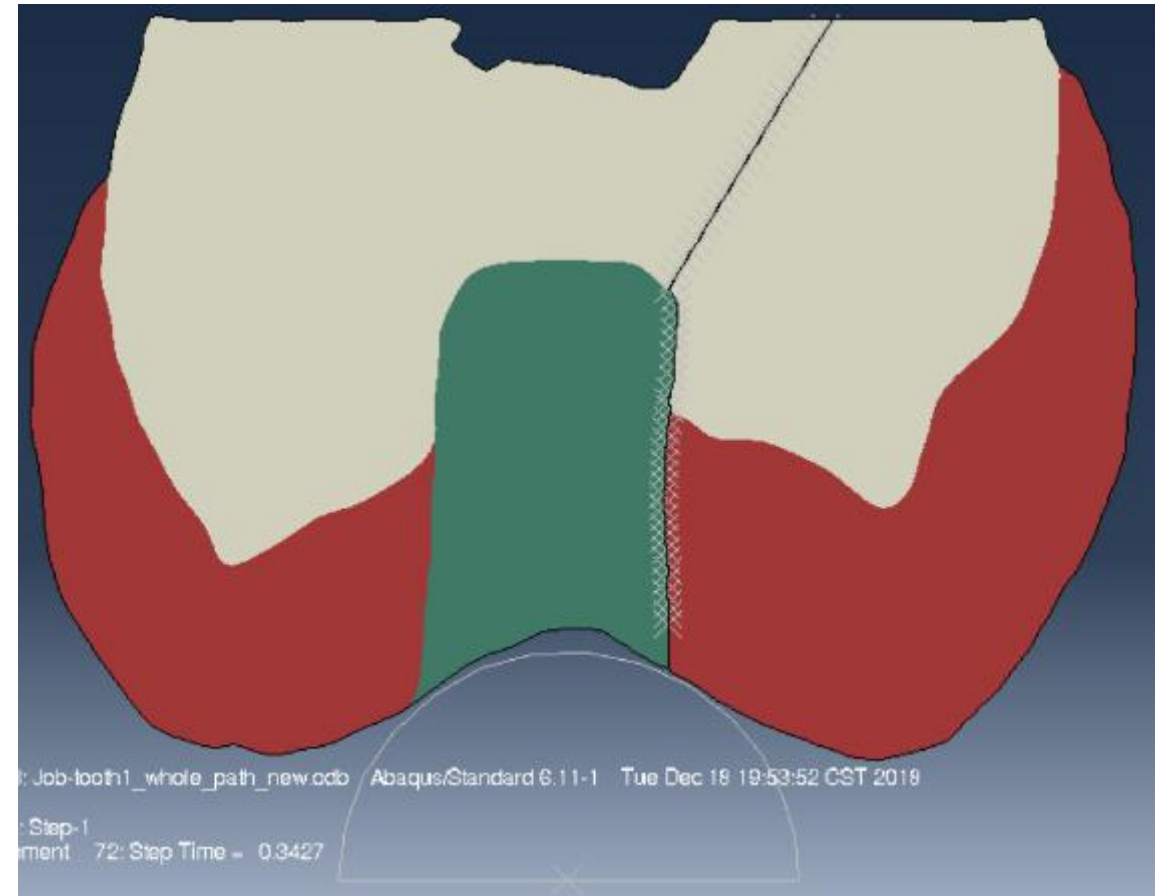
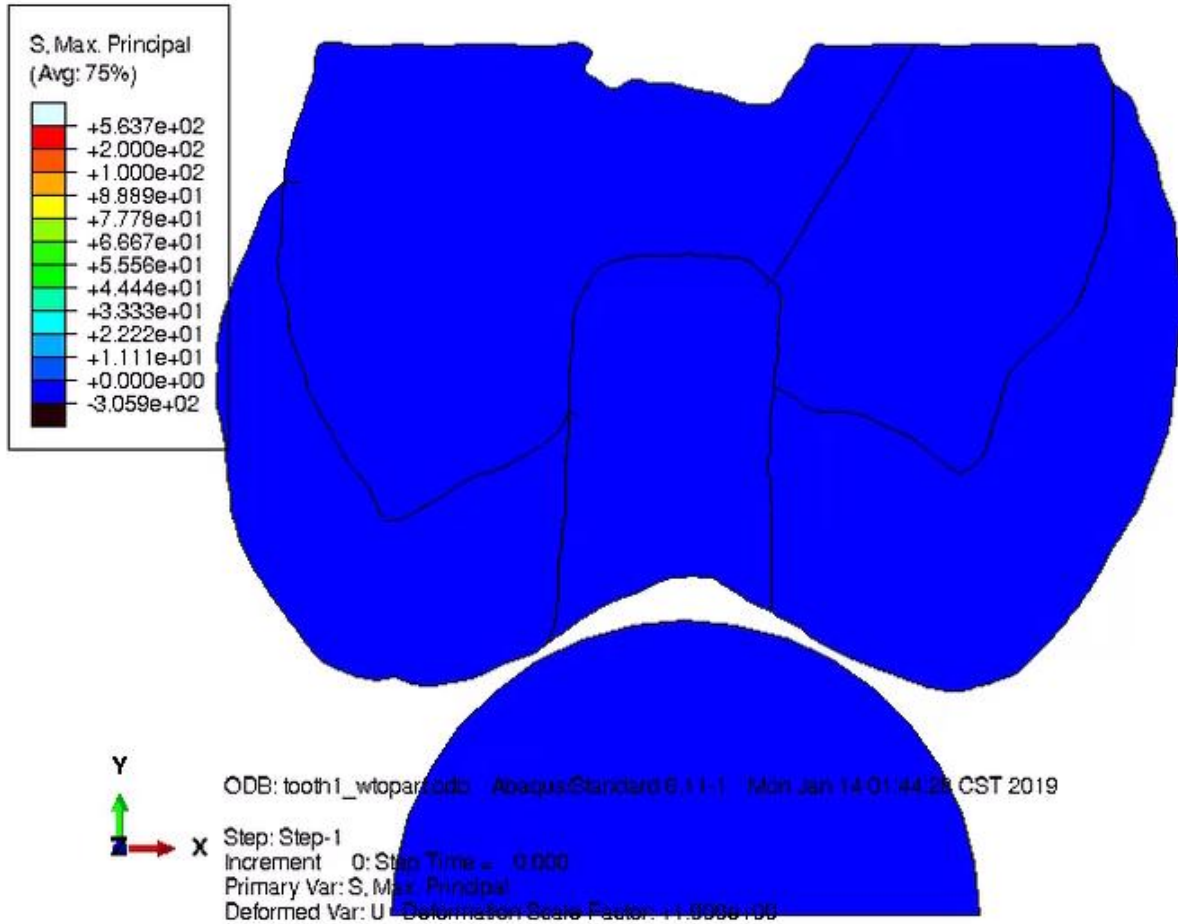
# Fracture Simulation of Class-I Restorations



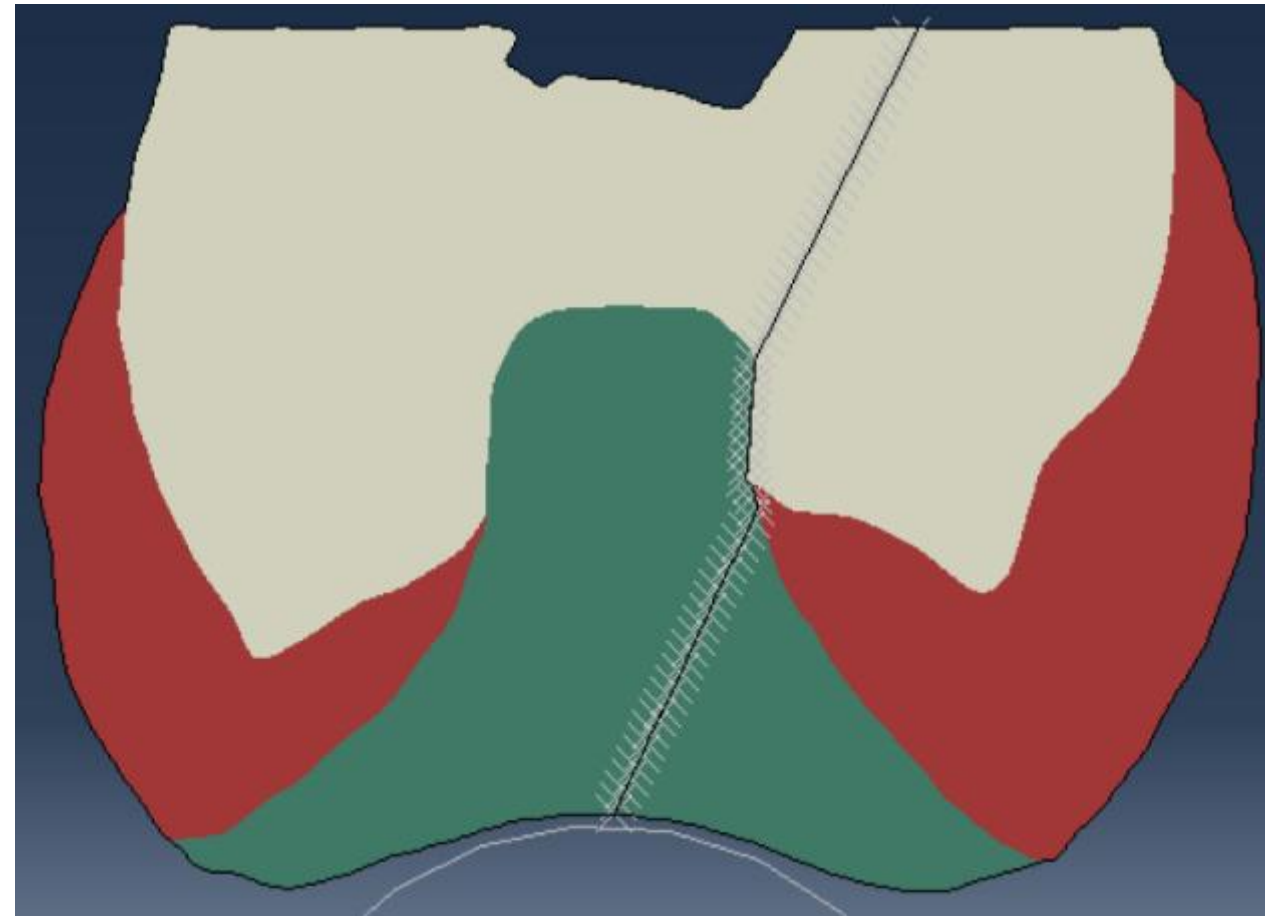
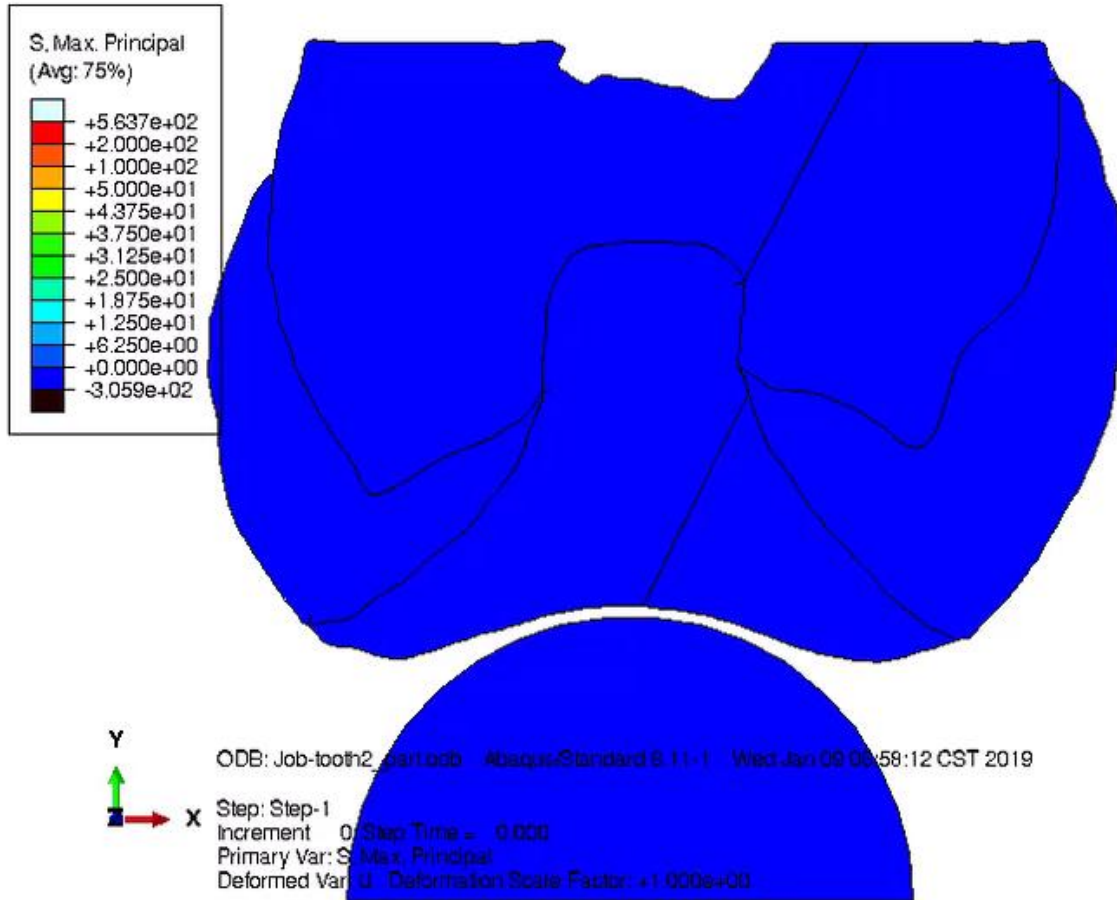
Prepared by: Ning Ye  
Date: 1/11/2019

Reference no. MDRRCBB-NY-JAN11-2019

# Traditional Class I Prep



# Calla Lily Class I Prep



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

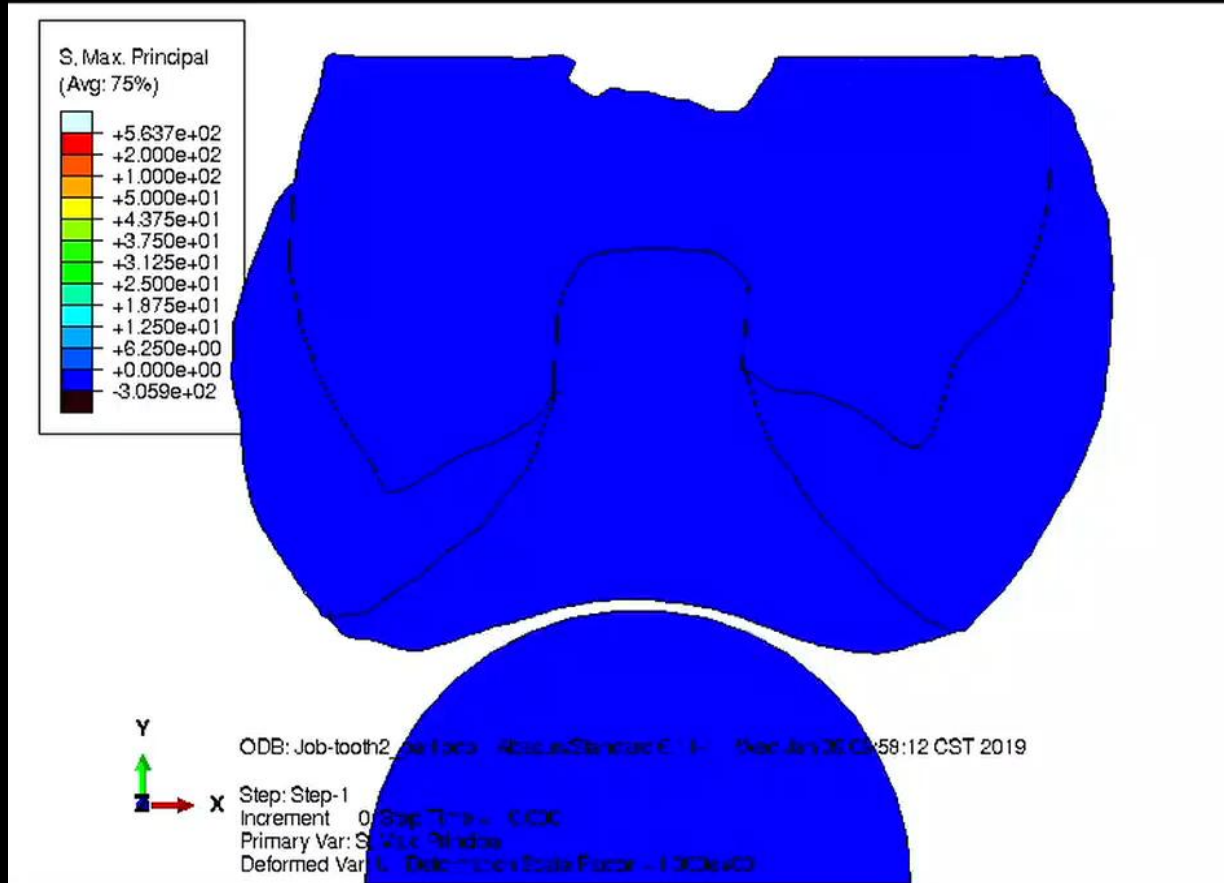
...if Restoration 1 has a fast fracture strength that is **10% higher than Restoration 2**, then its fatigue life is roughly 3 times as long.

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

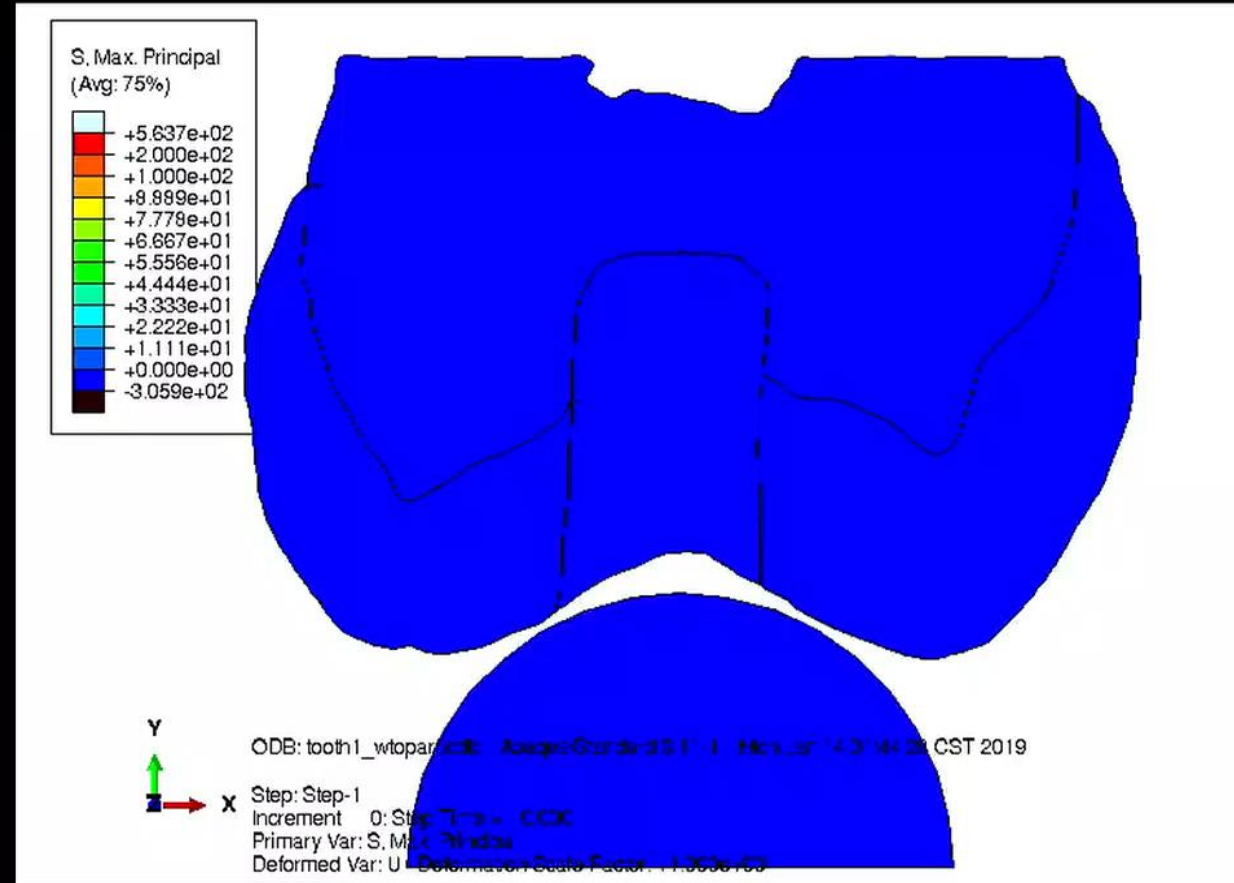
Alex Fok

Minnesota Dental Research Center  
for Biomaterials and Biomechanics

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

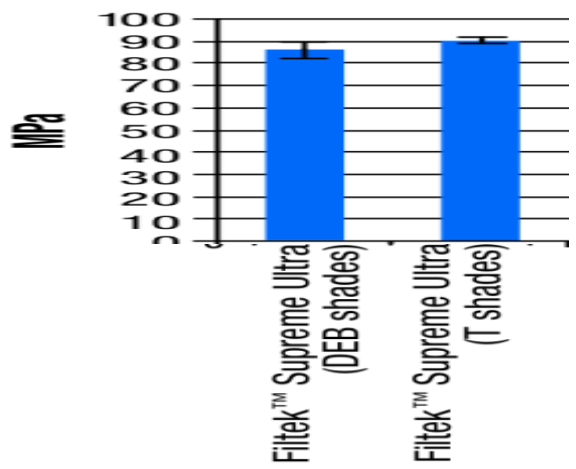


Traditional Class I filled with composite resin

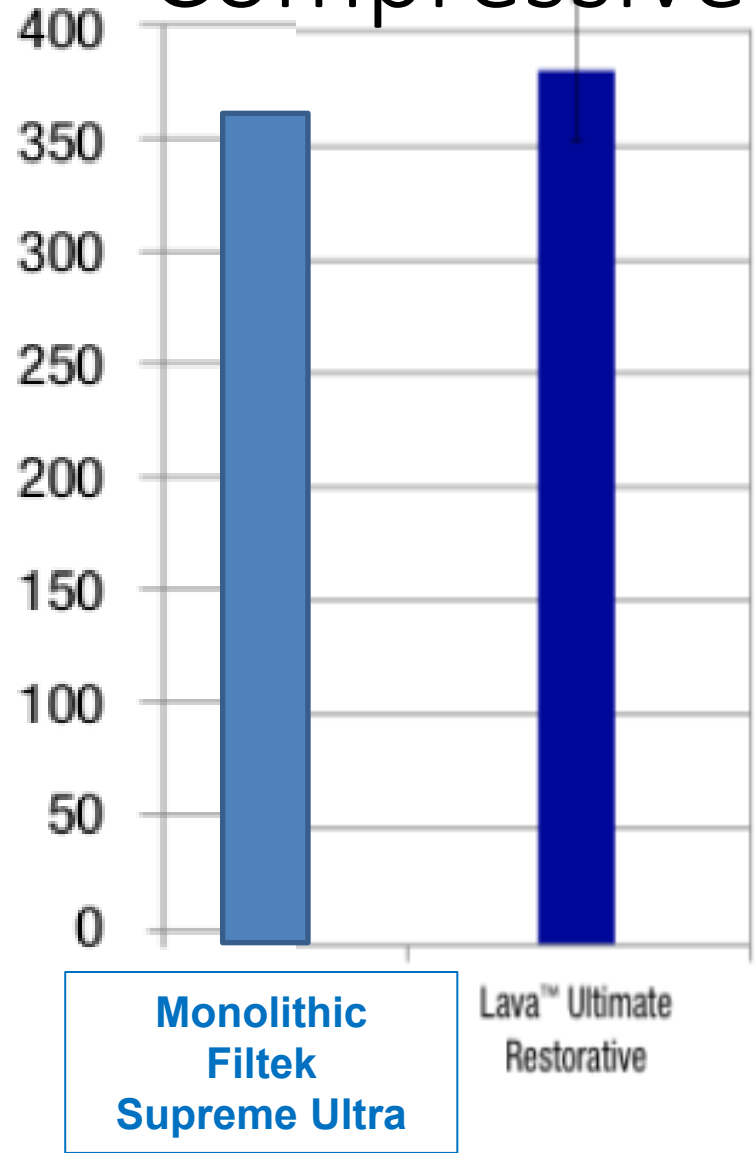


The compressive strength of composite is about 4x the diametral tensile strength.

## 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

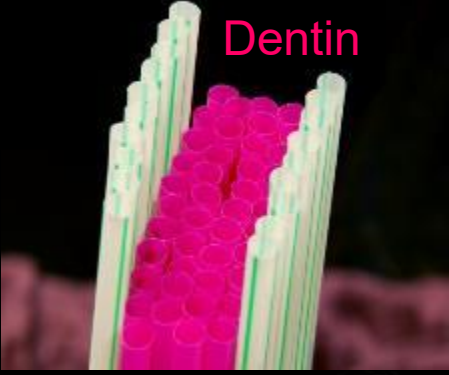
# Calla Lily Prep





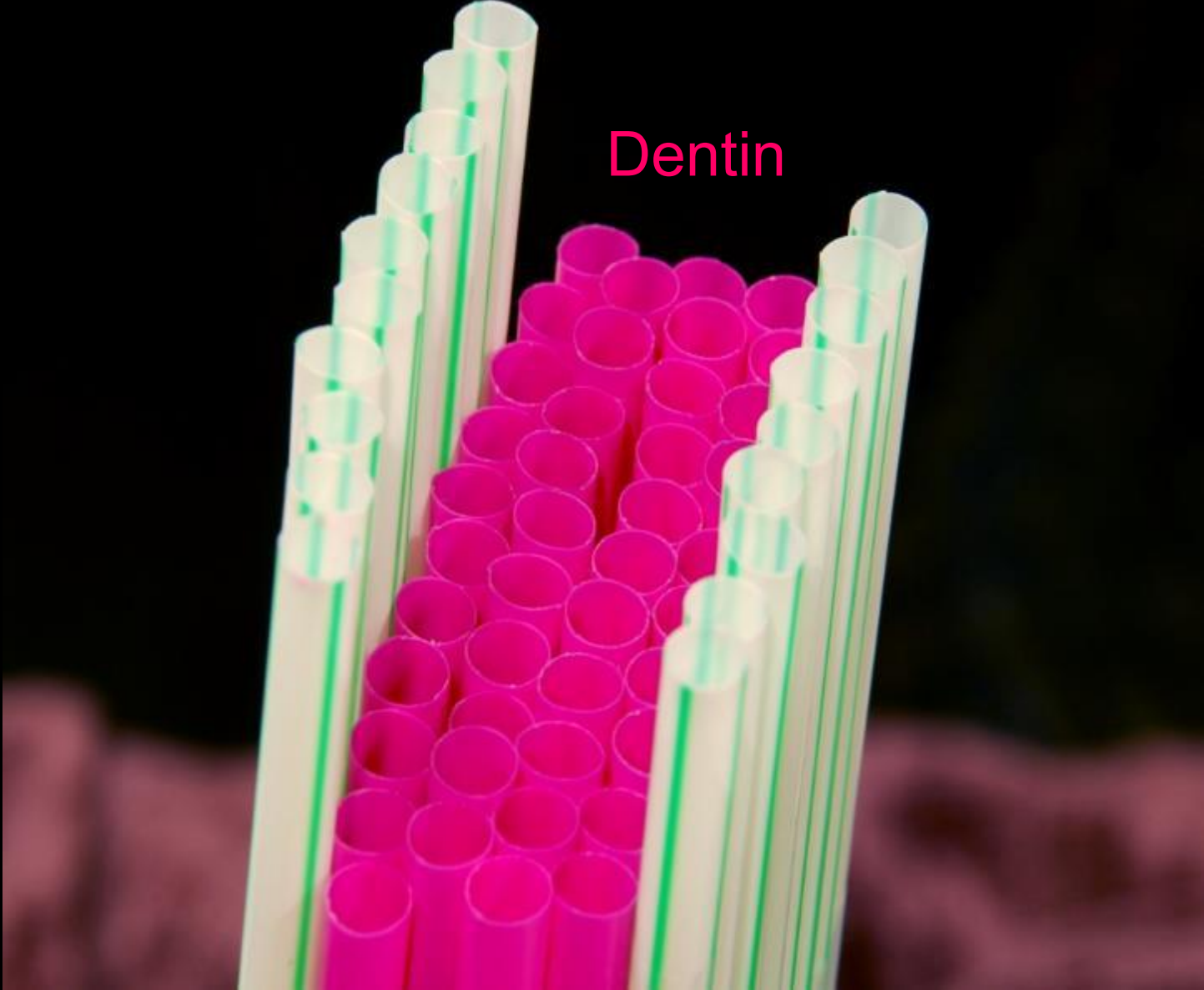
Enamel

Dentin



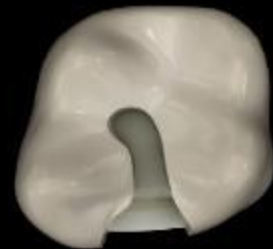
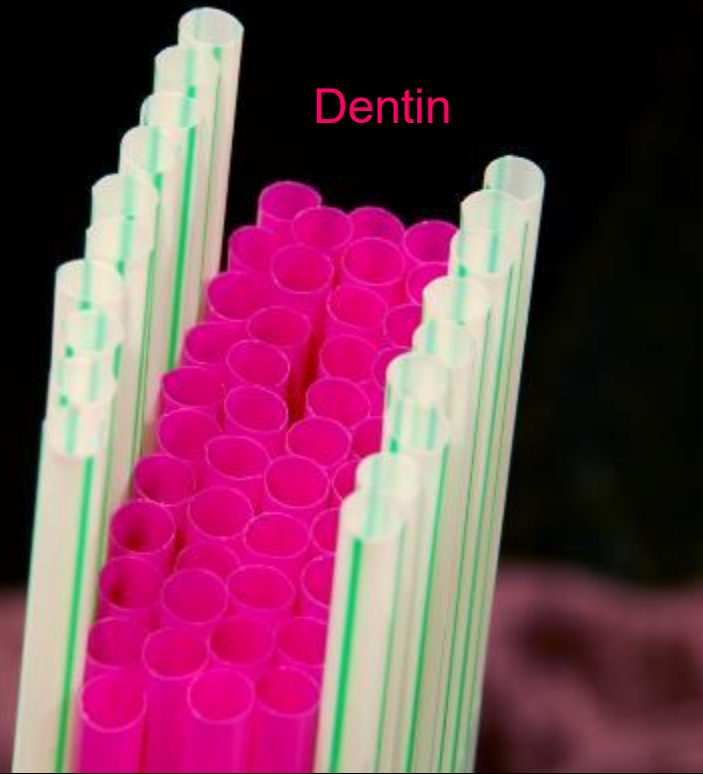
Enamel

Dentin

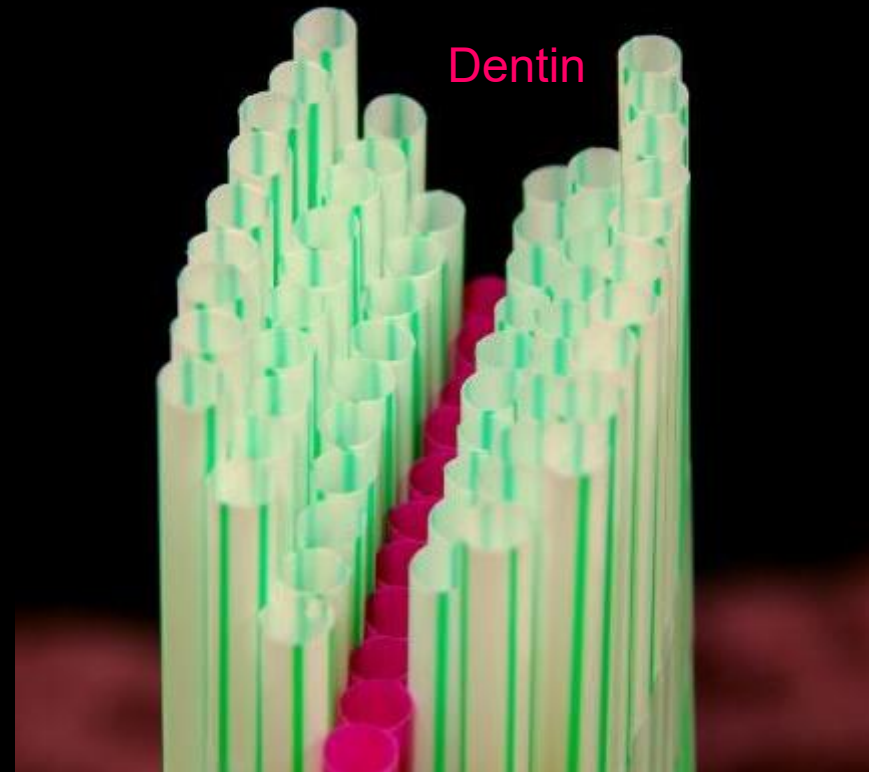


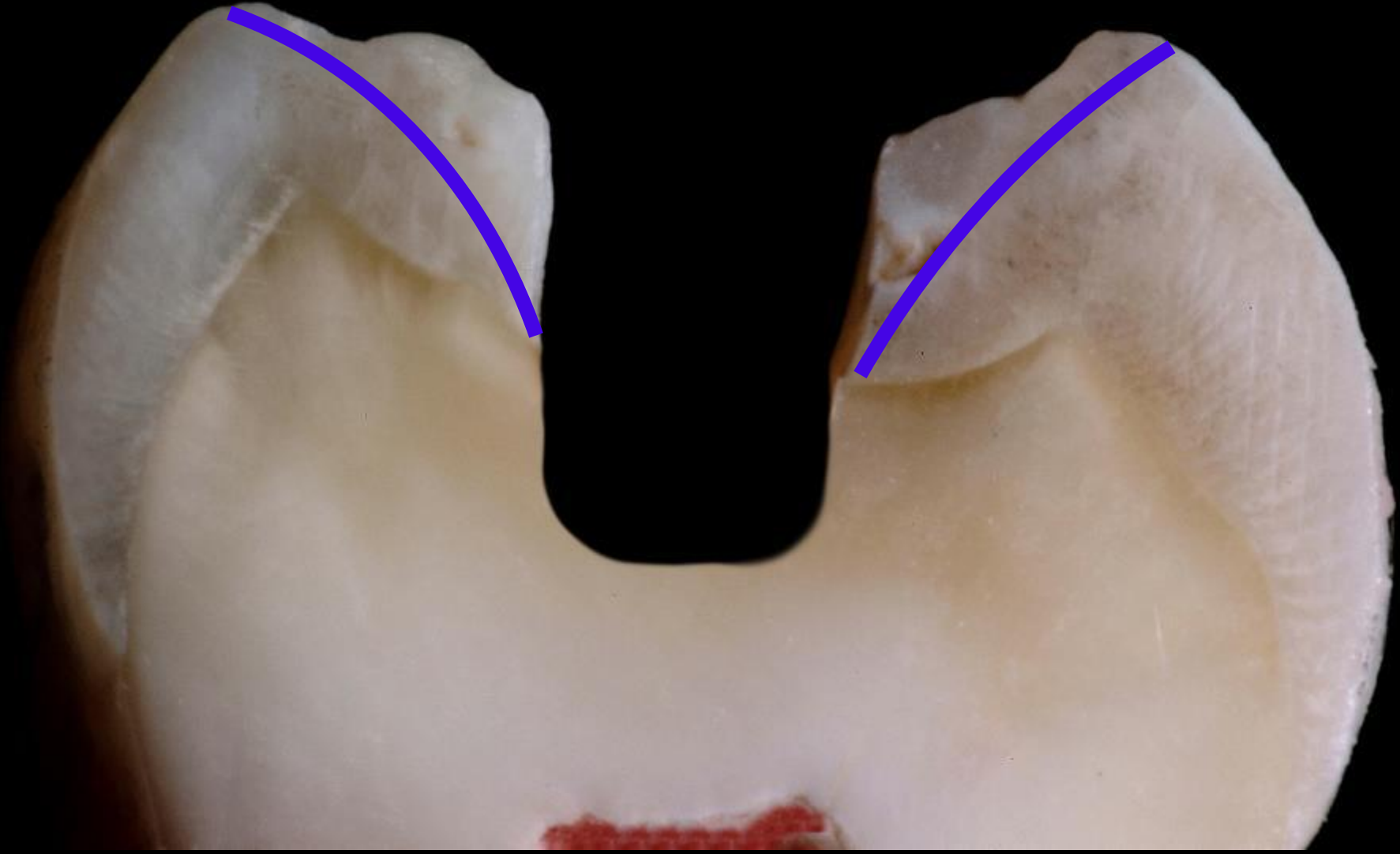
# Do you trust enamel bonding or **dentin bonding**?

Enamel

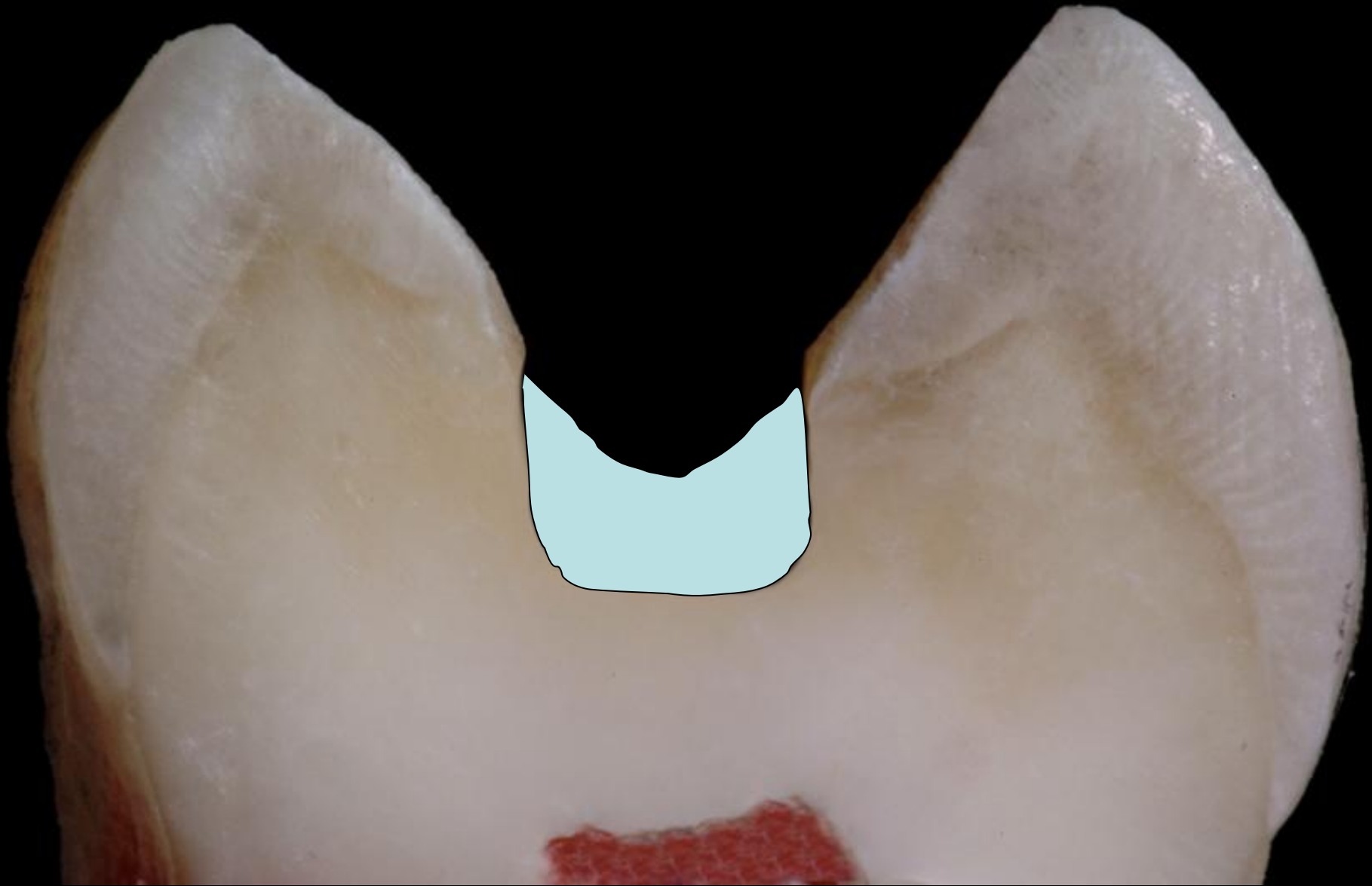


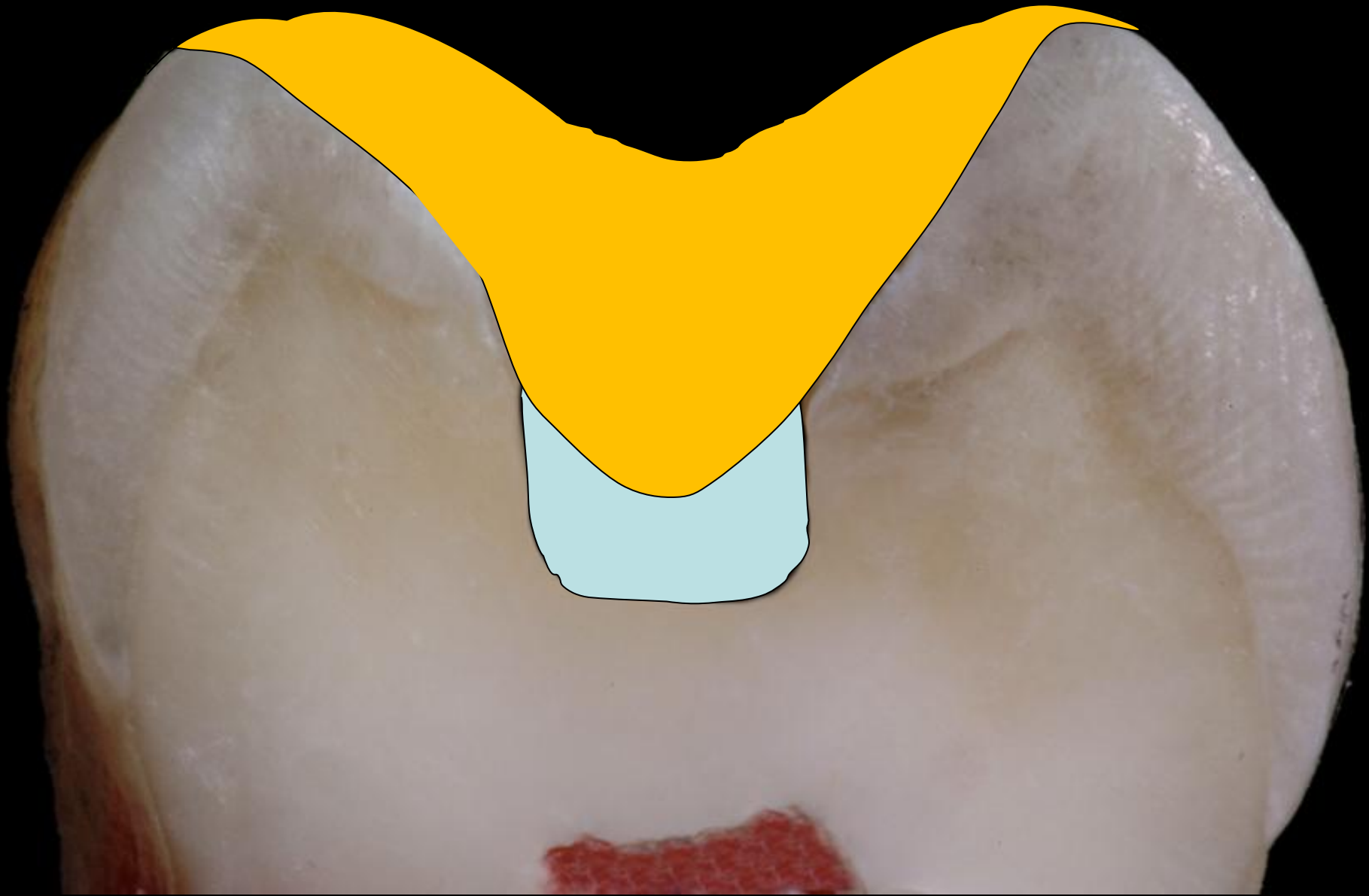
Enamel





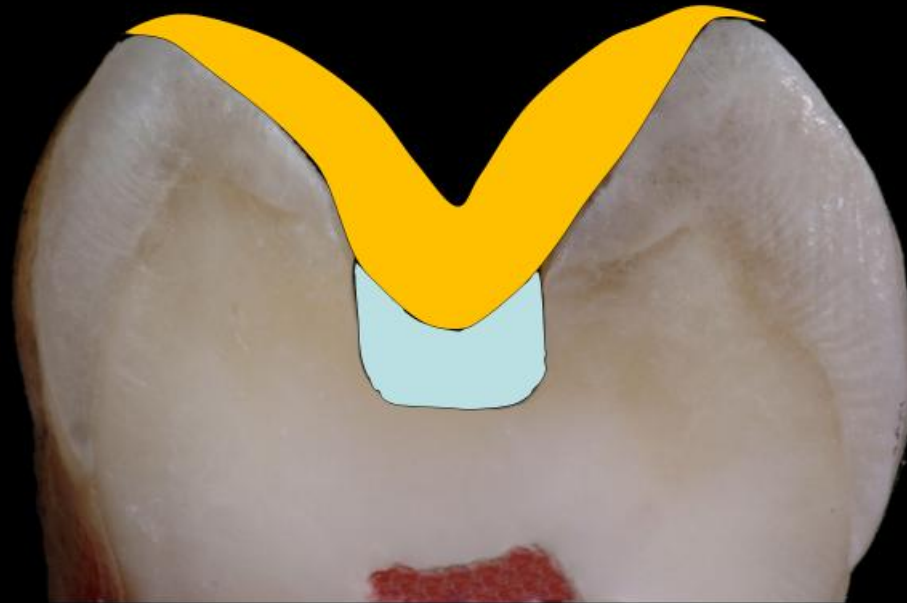








At what point will this tooth go from compression into tension, and vice versa?



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



Enamel vs. resin composite

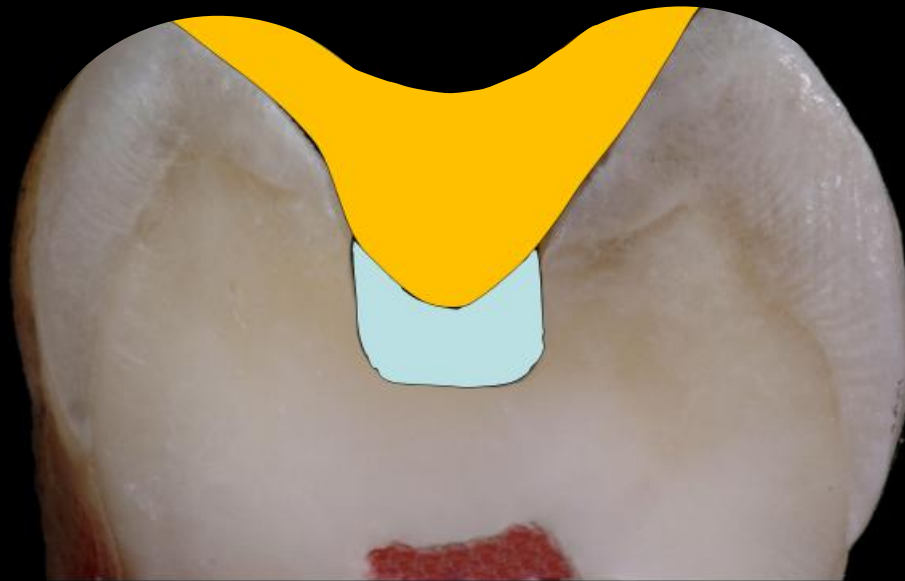


Enamel rods?

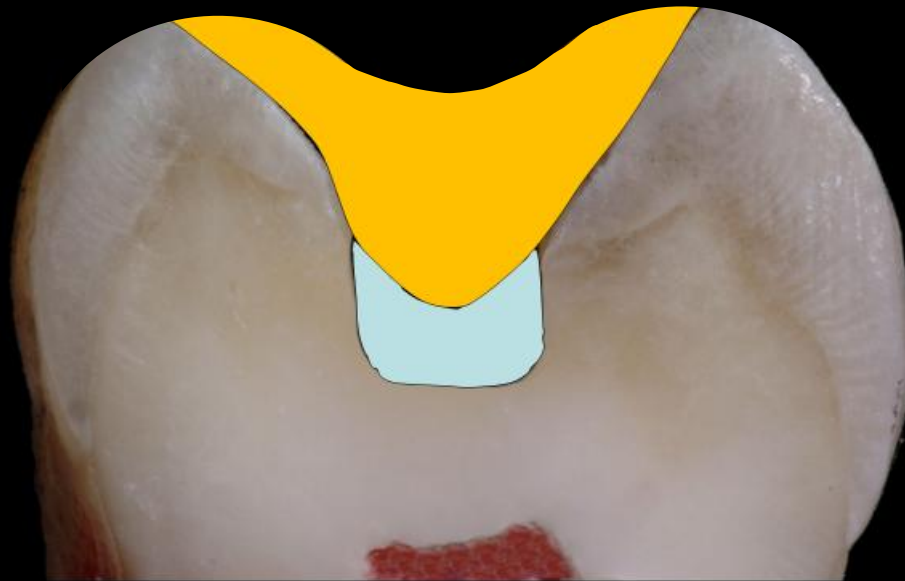
Resin composite



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

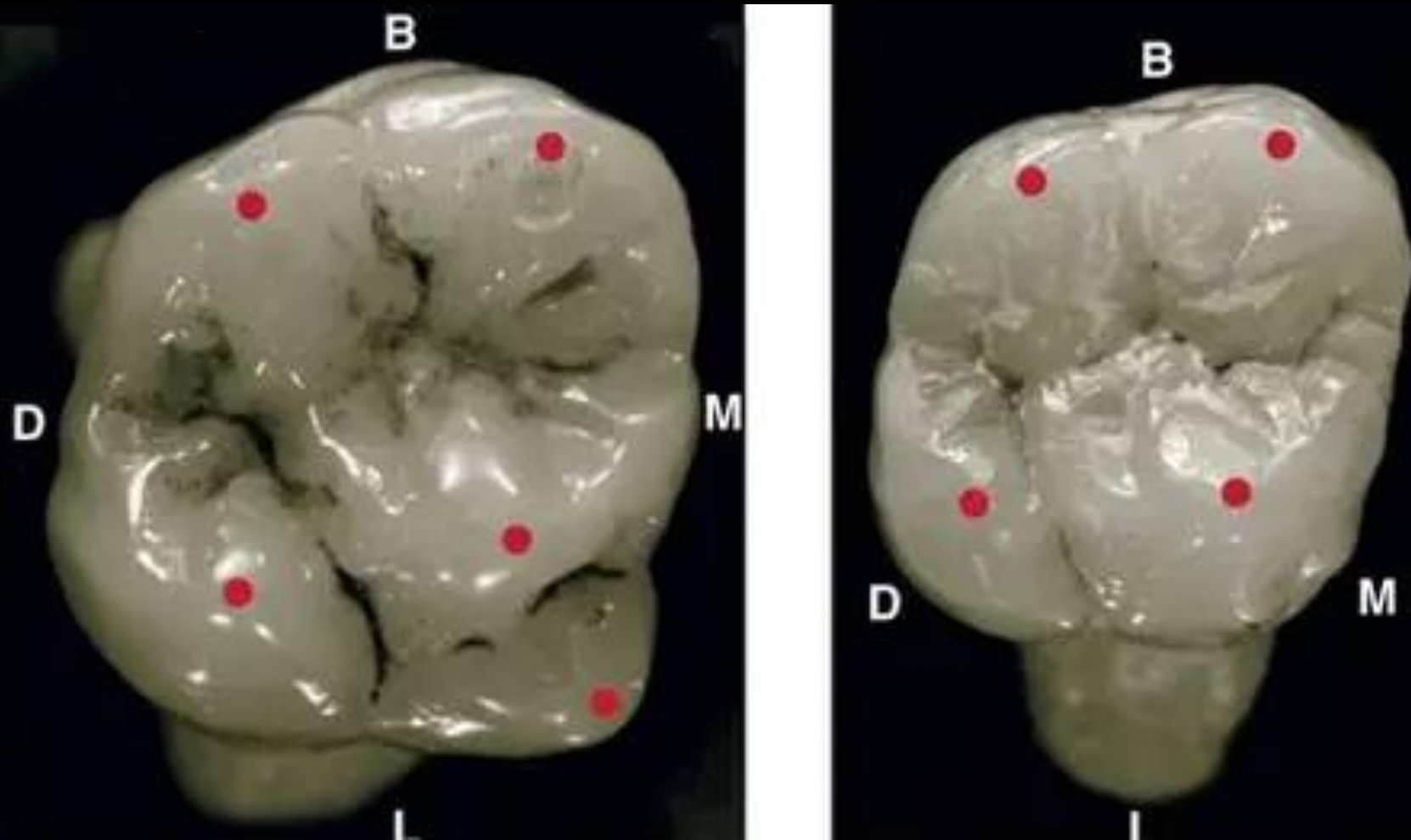


Shape Optimization:  
Build a bridge from buccal to lingual

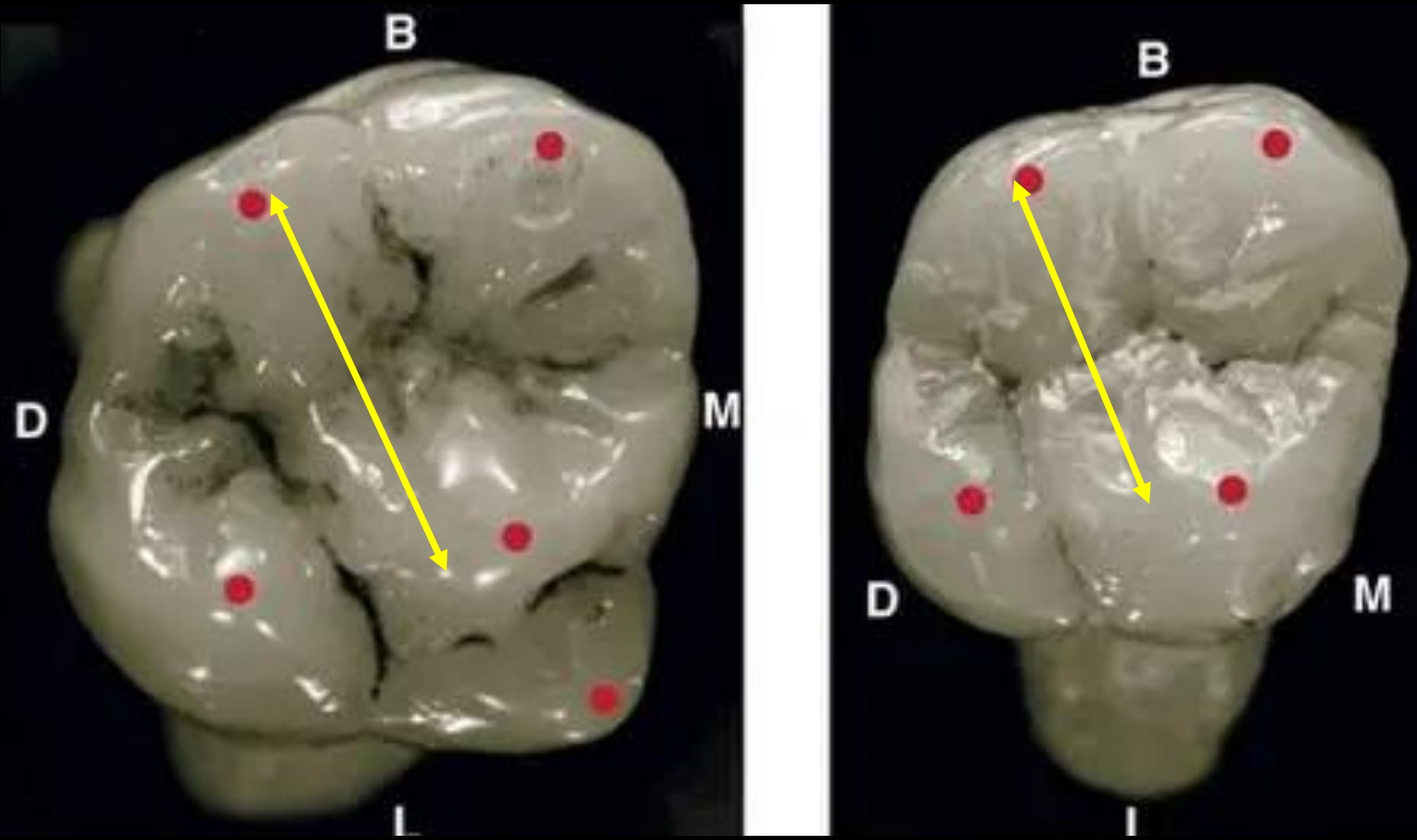


Is there anything illegal or immoral  
about the anatomy of a maxillary  
first molar?

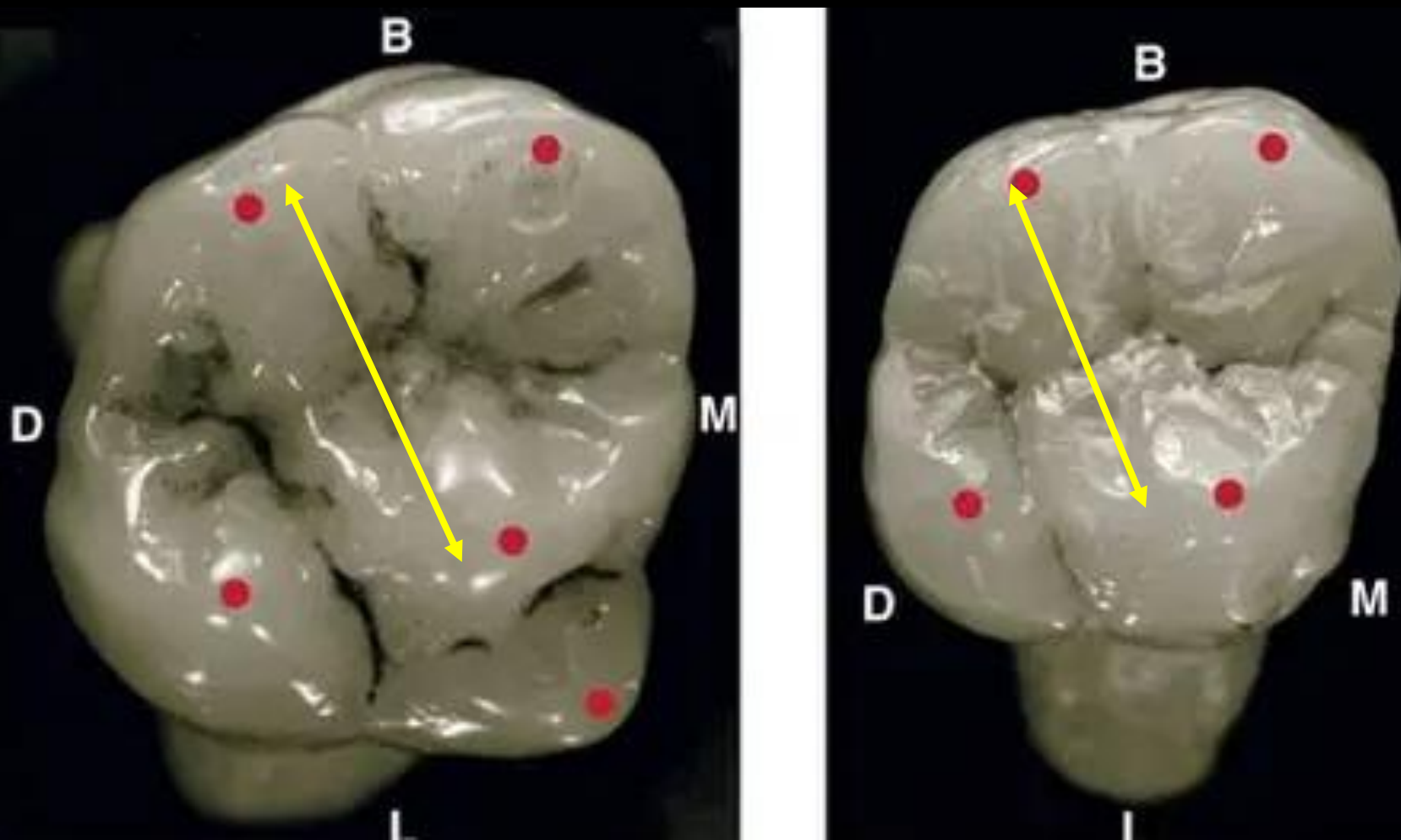
What unique trait does a maxillary first molar possess that protects it from cracking?



# 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)





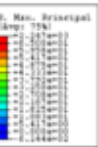




## 5 year post-op fracture of monolithic zirconia

### Stress/Strain Concentration

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



# Symptomatic Cracked Lower Molars: Bioclear Consult (2<sup>nd</sup> Opinion)

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

Meet Julia

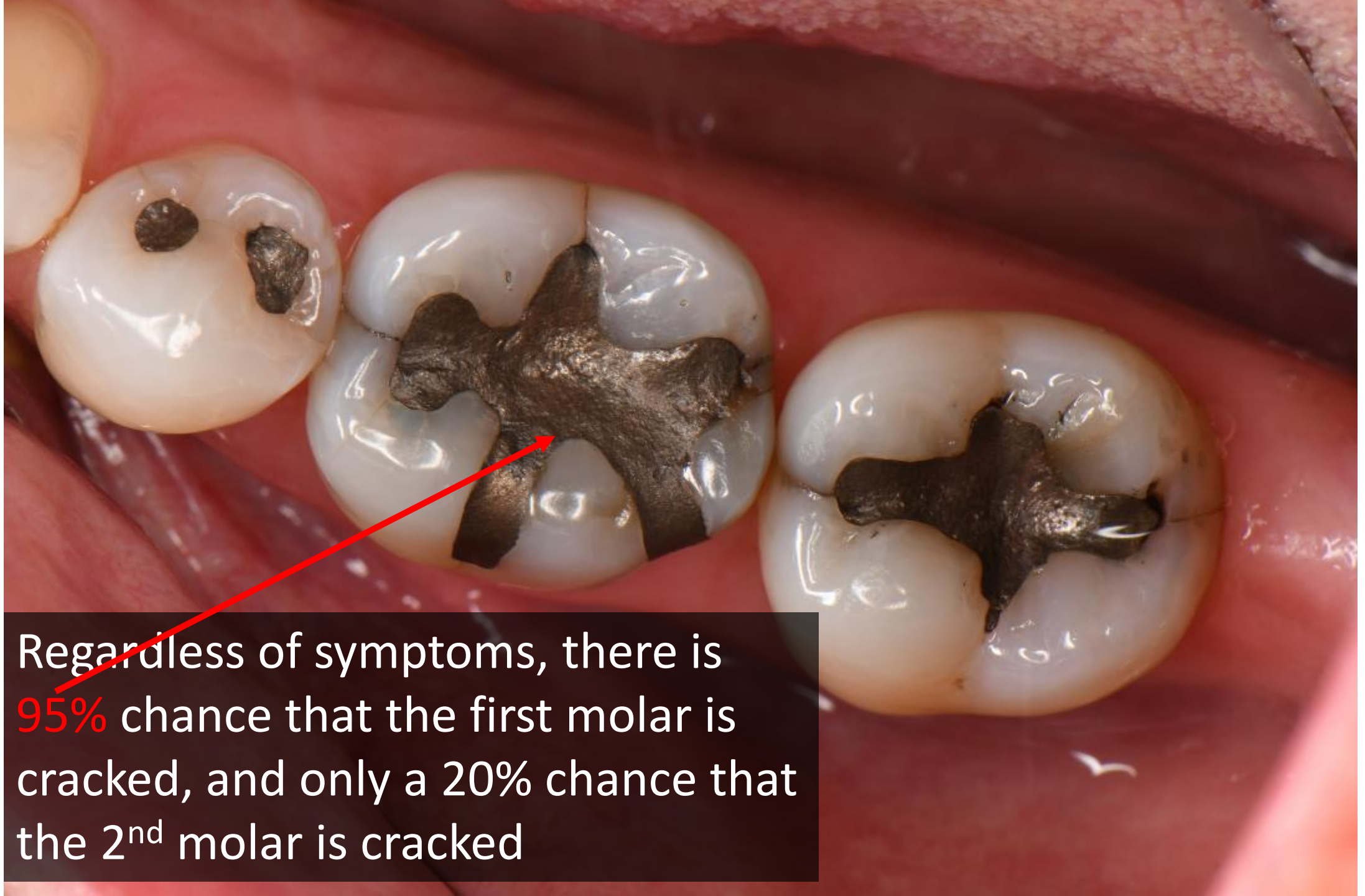












Regardless of symptoms, there is **95%** chance that the first molar is cracked, and only a 20% chance that the 2<sup>nd</sup> molar is cracked



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

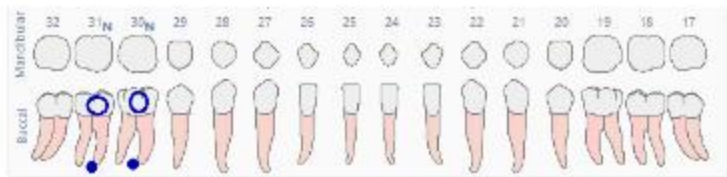


# Julia: The wet cotton roll test:

- 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

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

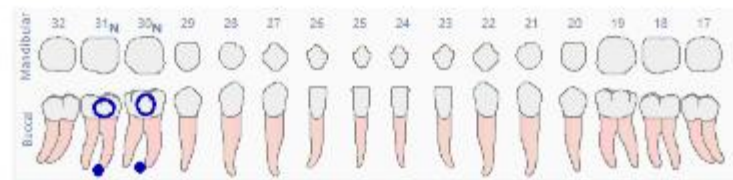
**Posterior Overlay:** Replace existing failing restorations, cracked tooth, rejuvenation of tooth appearance and color.

- **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.

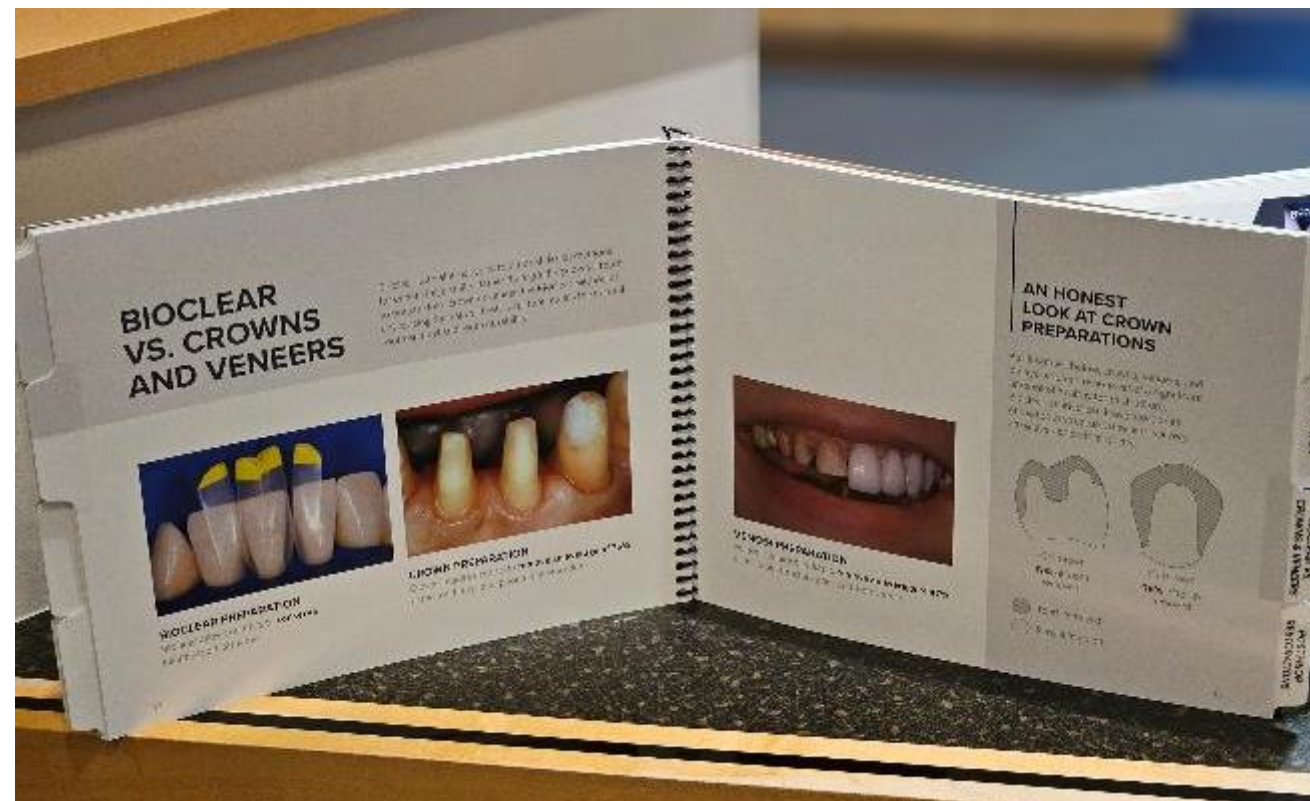
- **Disassembly**

- 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 clear crowns, veneers and all-ceramic crowns are applied, a significant amount of the tooth structure is preserved. Traditional crown preparations remove 76% of the tooth structure. Bioclear veneers and all-ceramic crowns are conservative.

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

**VENEER PREPARATION**  
Bioclear veneers require an average of 4% of the tooth structure prior to the procedure.

- work on crown
- grinding tooth



Julia's overlay treatment images





































Time to *harmonize* the occlusion





Before Harmonizing

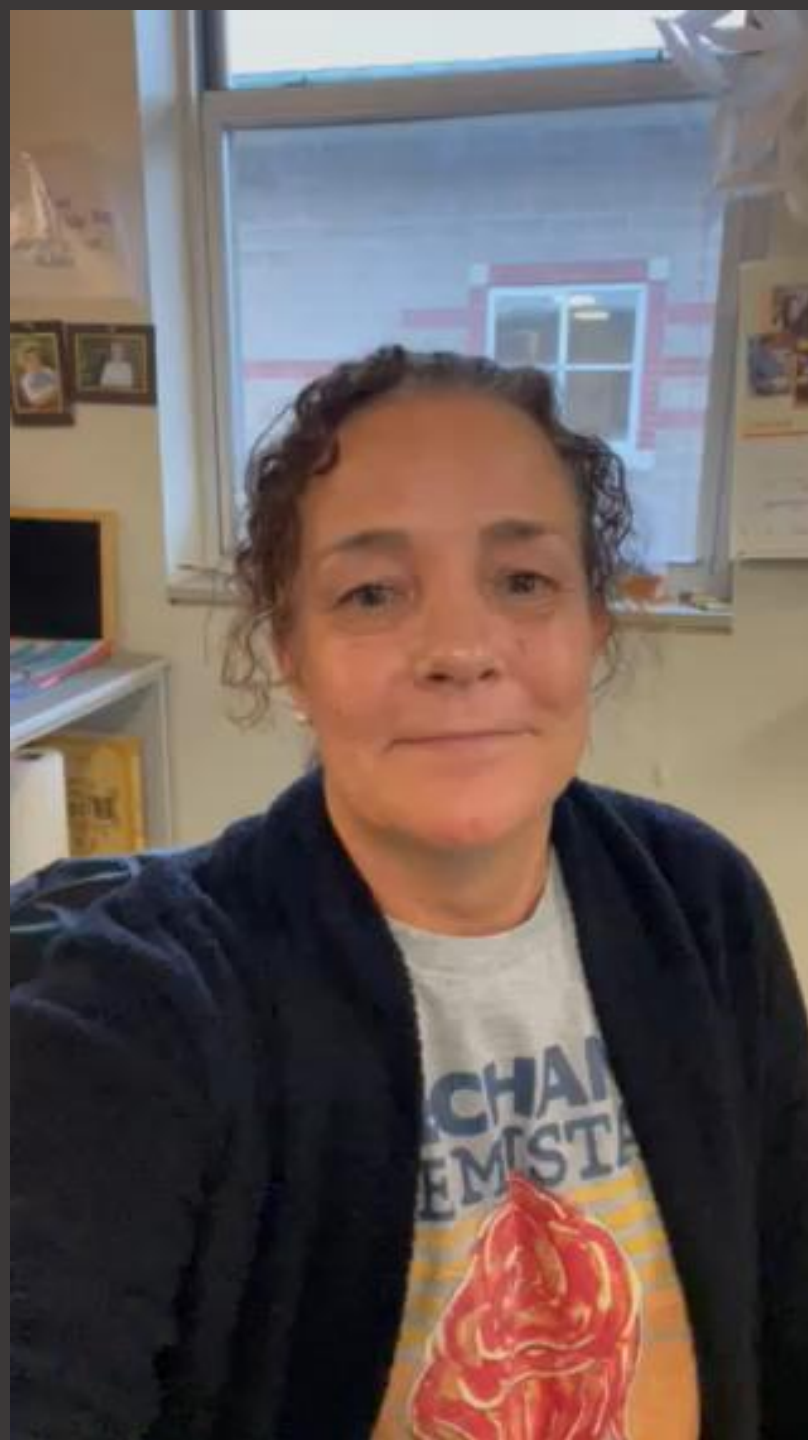


After Harmonizing

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

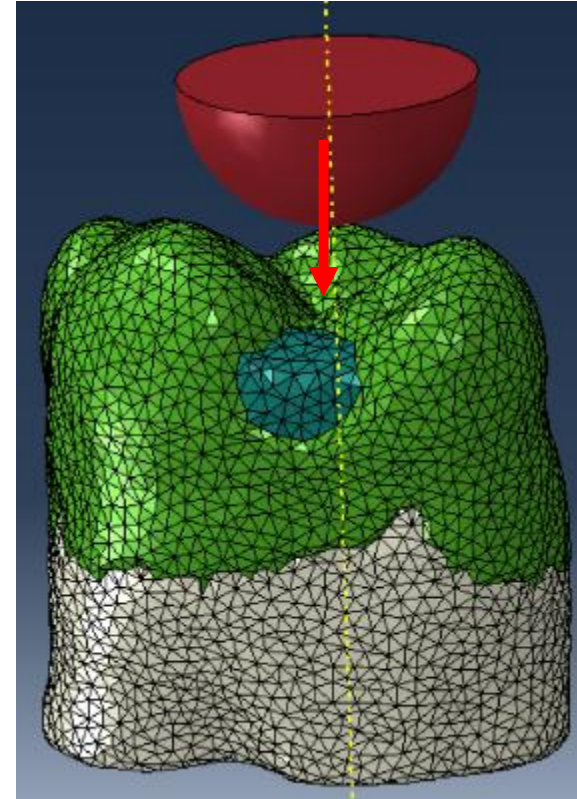
# What are the modern Interproximal cavity preps?

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

## 2. Finite Element Analysis of Stresses in Restorations due to Occlusal Loading

### Methods

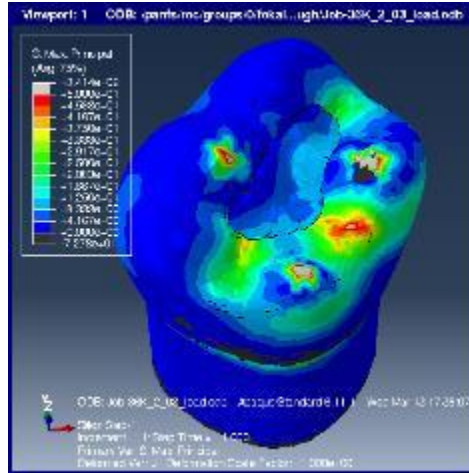
- Occlusal stress simulated by adding a hemisphere as an antagonist to the occlusal surface with downward vertical force (1000N) , resulting in three occlusal areas
- Principal stresses on the restorations and tooth were compared.



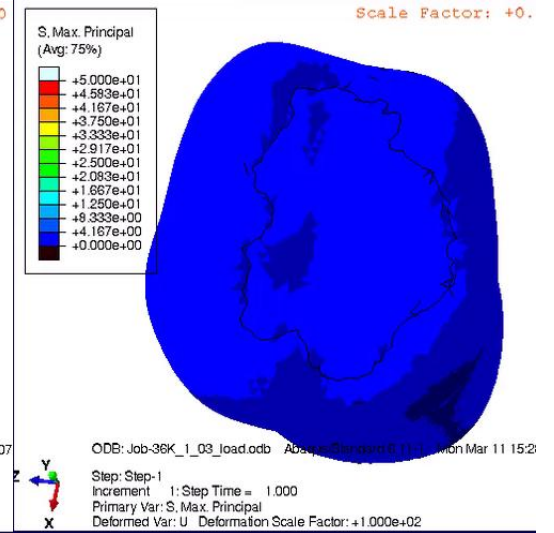
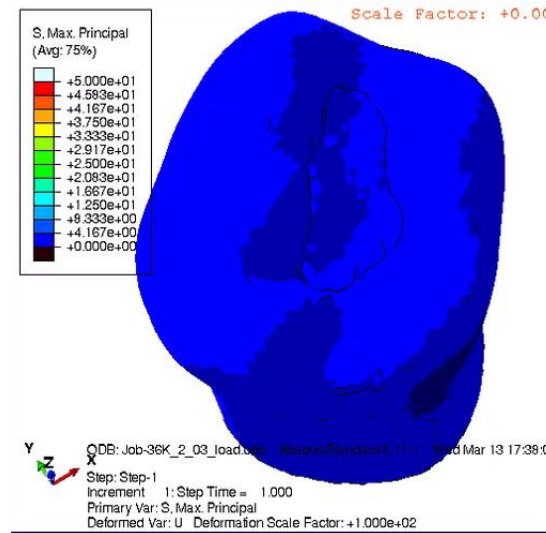
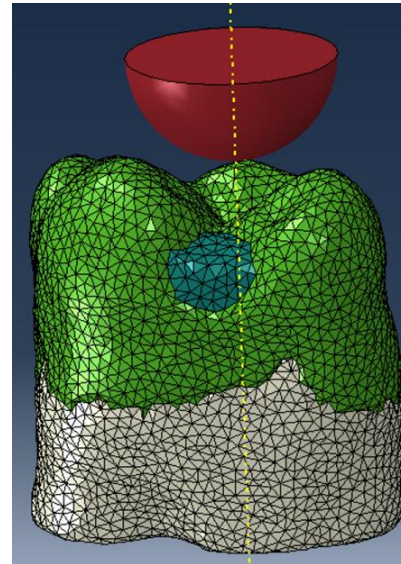
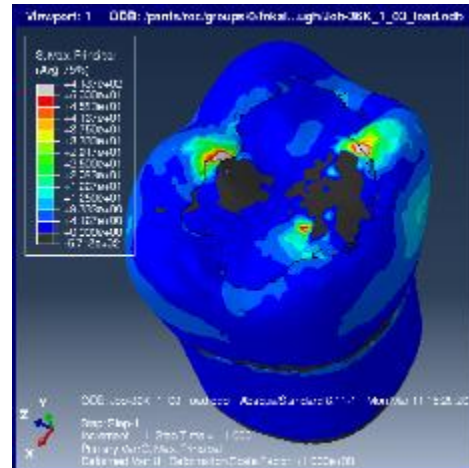
# 2. 3D Finite Element Analysis of Stresses in Class I Restorations due to Occlusal Loading

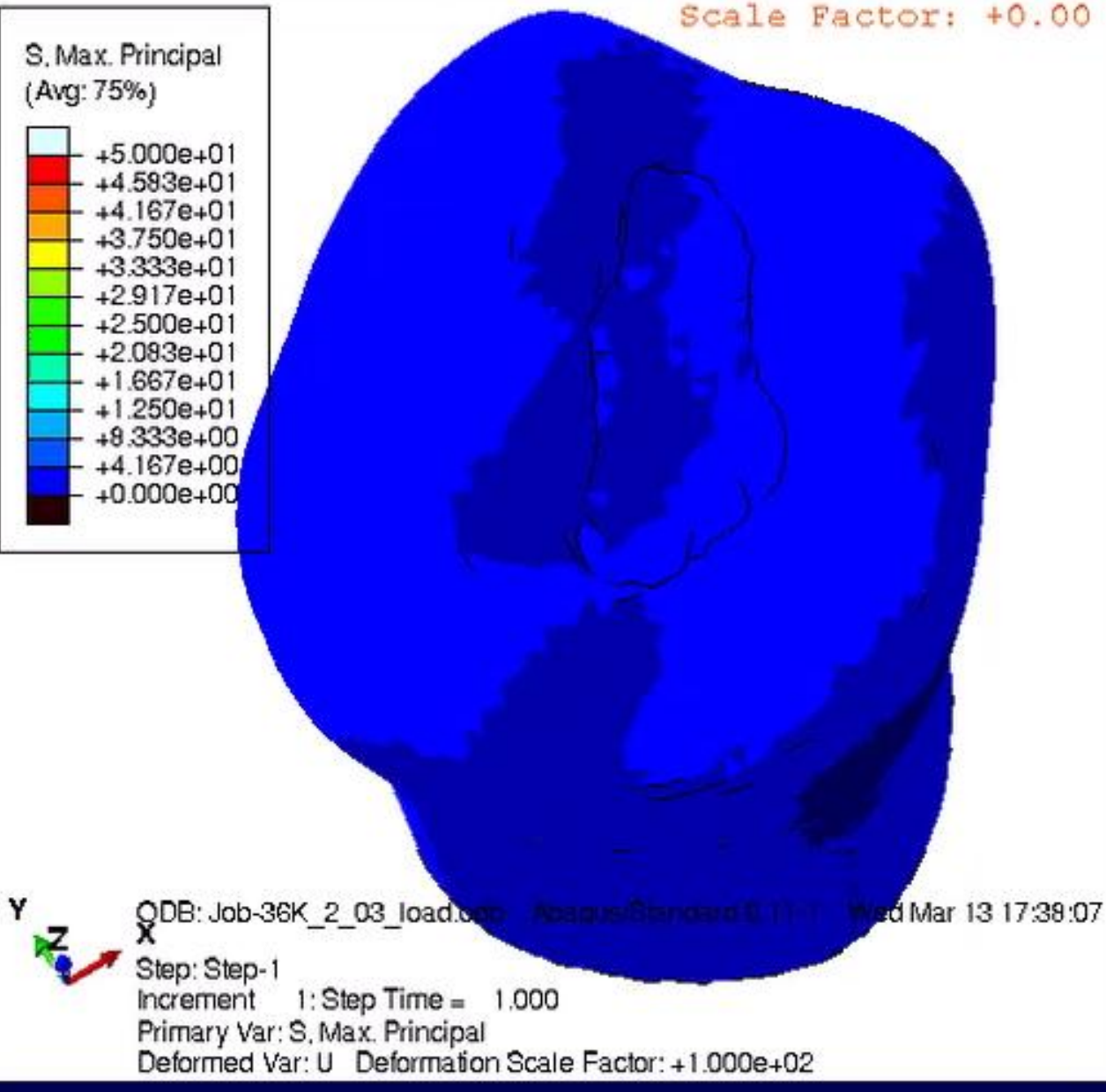
## Max principal stress contours

Black

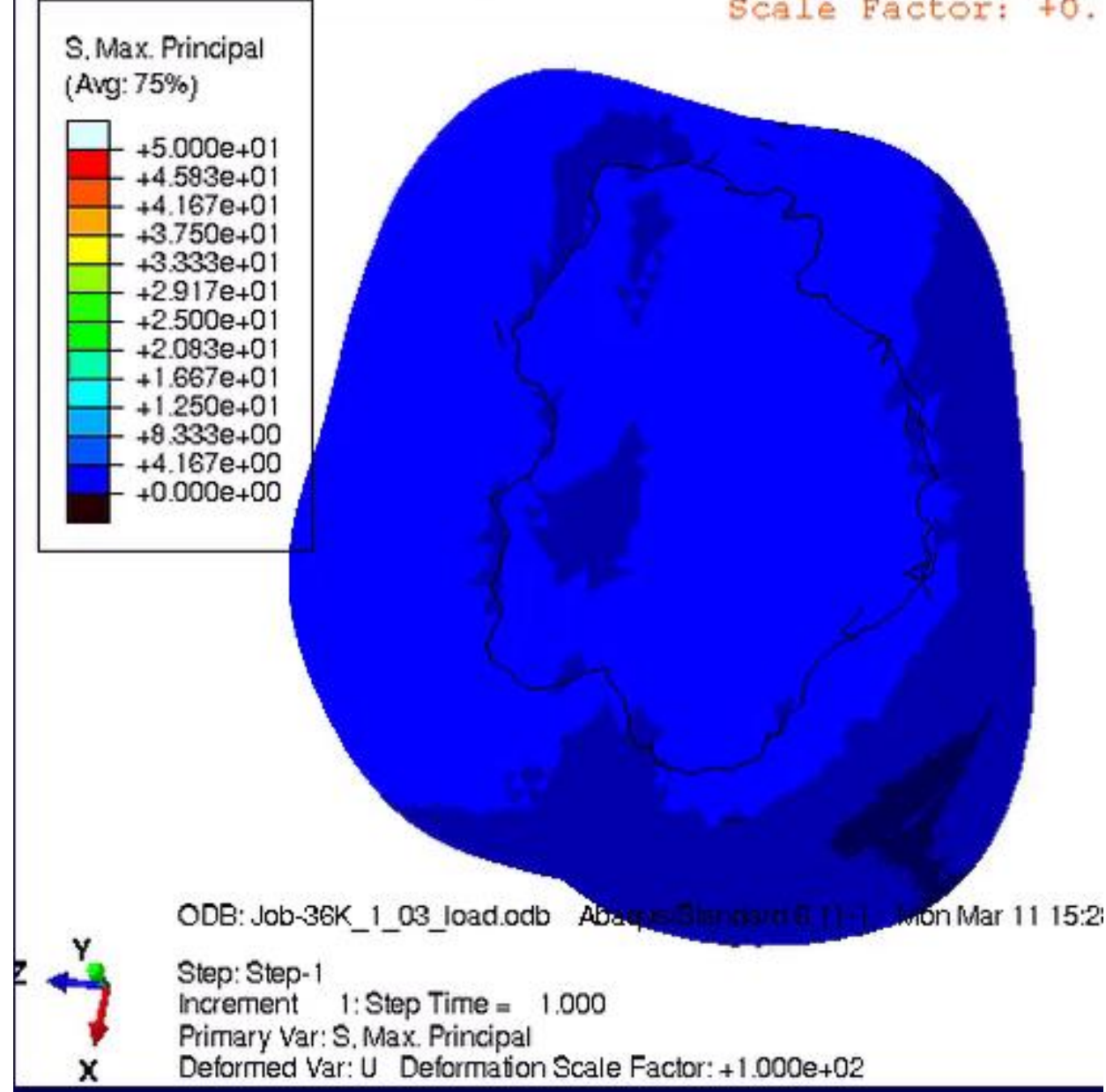


Clark





**Black**



**Clark**



# Preliminary Mechanical Assessments of the Bioclear Method

Ning Ye BSc, MS

Hooi Pin Chew BDS, FDSRCS, PhD

Alex Fok PhD

**Minnesota Research Center for Biomaterials and Biomechanics**

Disclosure: This study was funded by 3M



UNIVERSITY OF MINNESOTA

**Driven to Discover®**













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



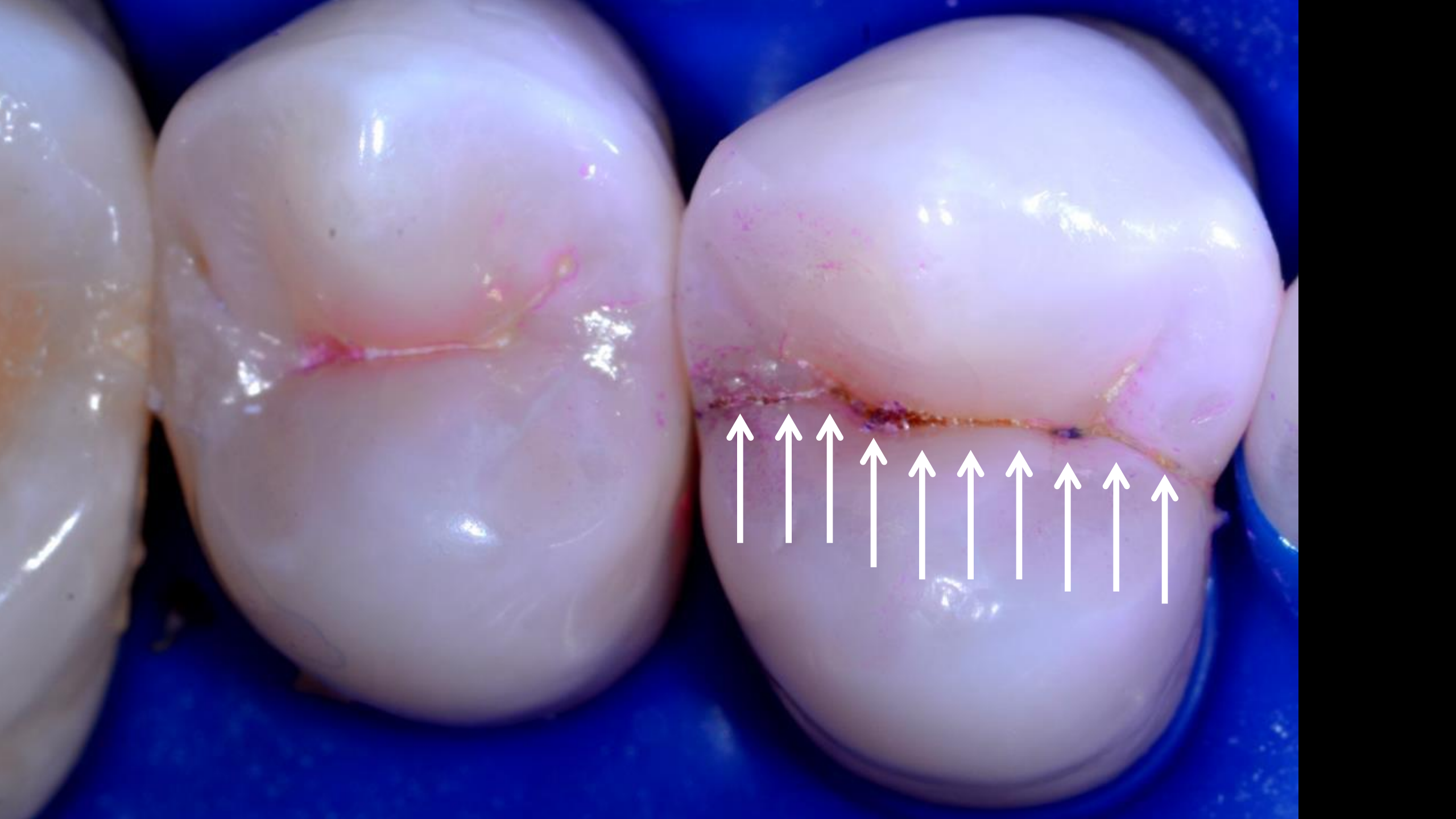
12 year follow up



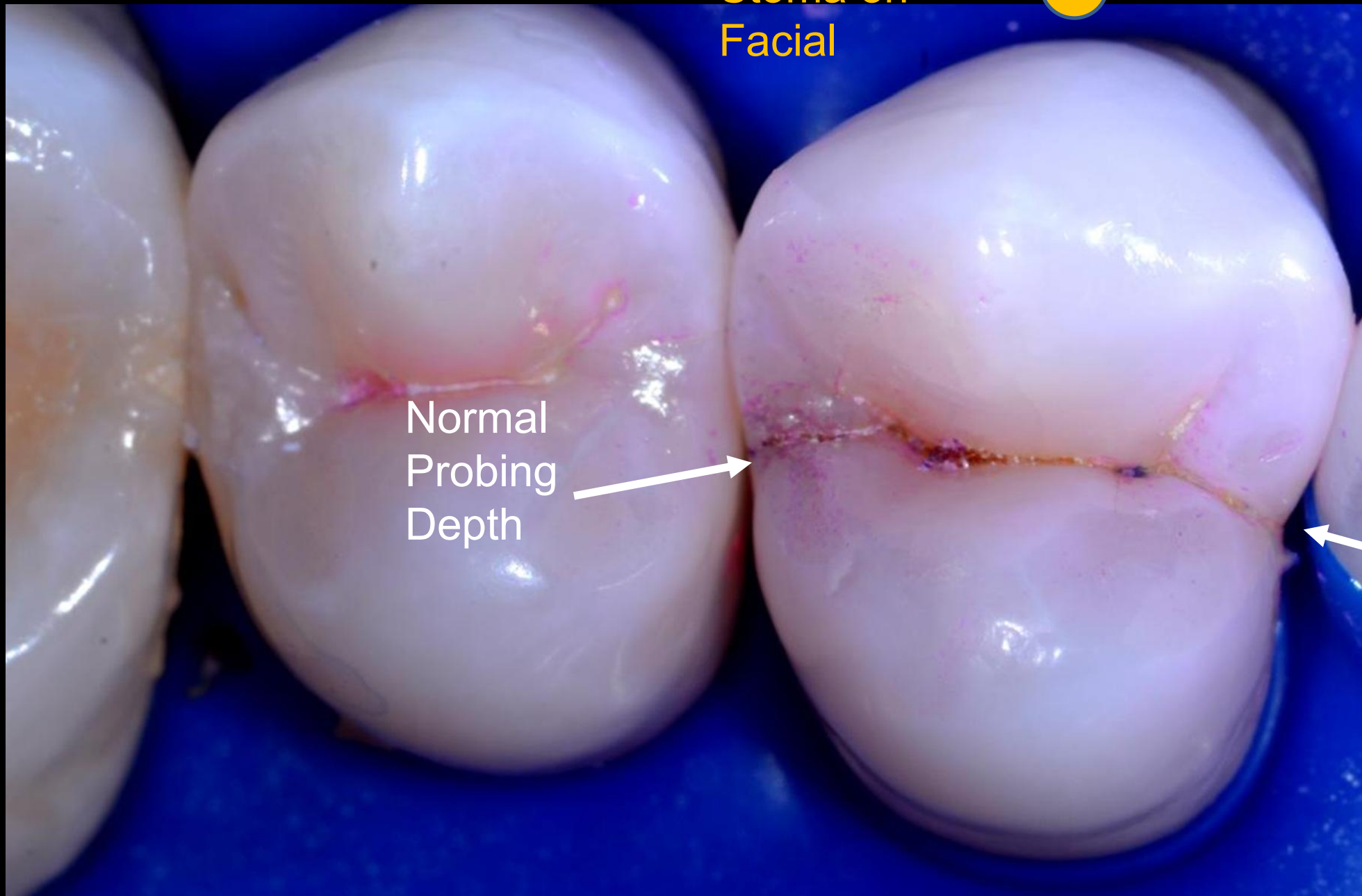
# An Extreme Calla Lily Clinical Case

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





Stoma on  
Facial

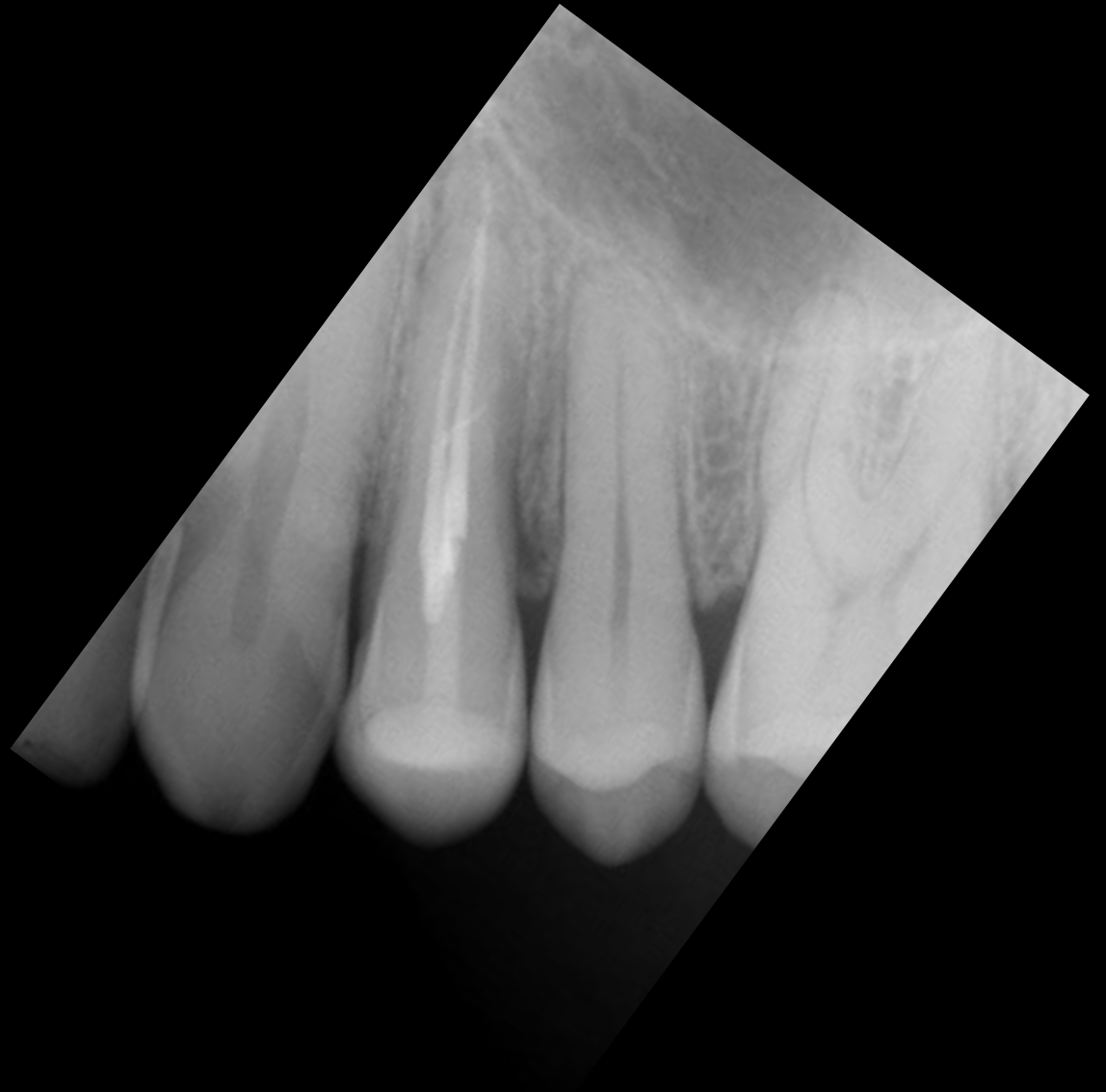


Normal  
Probing  
Depth



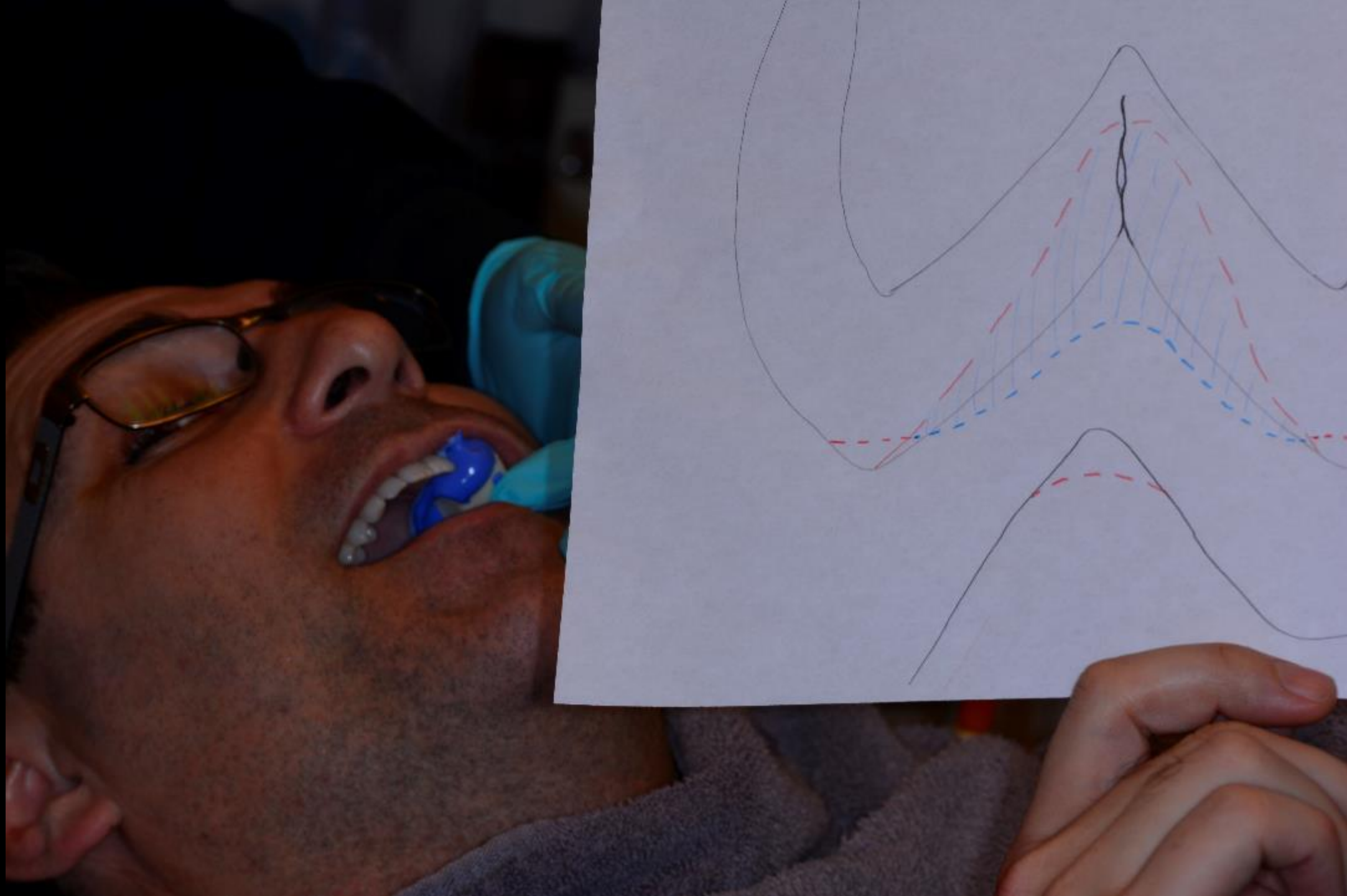
Normal  
Probing  
Depth











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



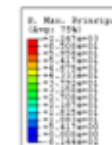
“David that’s not going to work, do a crown.”



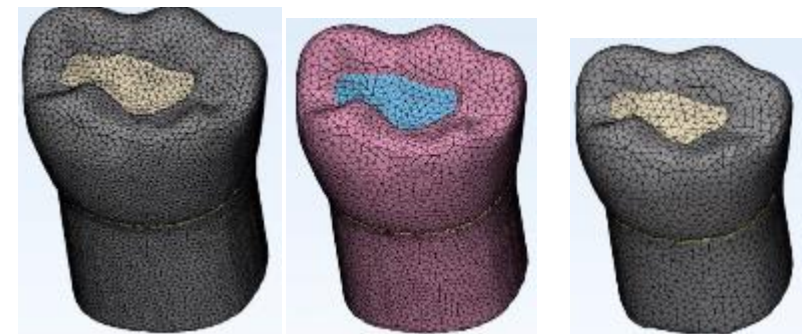
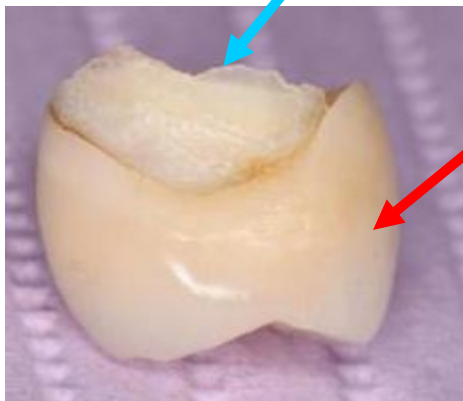
7 years post-op

### 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 “3<sup>rd</sup> option”

# ■ When to do endo, when to extract

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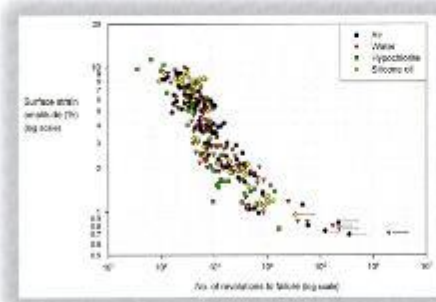
# ■ When to do endo, when to extract

# JOE

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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

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### Key Words

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# Dec 2007



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6 year  
evaluation  
.....the first  
study of  
its kind



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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.
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- (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.
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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.

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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 probings less than 3 mm in the space associated with the identified crack. Increased interproximal probings 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. ?





**Discussion**

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

Variable	Mean	SD	Min	Max
Age (years)	32.5	5.2	21	45
Gender (Male/Female)	15/15			
Duration of disease (years)	12.5	8.5	2	35
Number of attacks per year	4.5	3.5	1	15
Number of attacks per month	1.5	1.2	0	5
Number of attacks per week	0.5	0.4	0	2
Number of attacks per day	0.2	0.1	0	1
Number of attacks per hour	0.05	0.03	0	0.2
Number of attacks per minute	0.005	0.003	0	0.02

SD, standard deviation; Min, minimum; Max, maximum.



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** Comparison of the performance of the different methods for the detection of the different types of defects.

Defect	Visual	Ultrasonic	Radiography	Thermal	Acoustic Emission	Strain	Acoustic	Electromagnetic	Other
Cracks	Low	High	High	Low	High	High	High	High	High
Delamination	High	Low	High	High	Low	Low	Low	Low	Low
Porosity	Low	Low	High	Low	Low	Low	Low	Low	Low
Disbonding	High	Low	High	High	Low	Low	Low	Low	Low
Corrosion	High	Low	High	High	Low	Low	Low	Low	Low
Impact	High	Low	High	High	Low	Low	Low	Low	Low
Spalling	High	Low	High	High	Low	Low	Low	Low	Low
Reinforcement	High	Low	High	High	Low	Low	Low	Low	Low
Delamination	High	Low	High	High	Low	Low	Low	Low	Low
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Reinforcement	High	Low	High	High	Low	Low	Low	Low	Low
Delamination	High	Low	High	High	Low	Low	Low	Low	Low



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

**Table 1** (continued)

Study	Year	Sample Size	Study Design	Outcome	Conclusion
1	1998	100	RCT	Endothelial dysfunction	Endothelial dysfunction is a marker of cardiovascular risk.
2	2001	200	Cohort	Endothelial dysfunction	Endothelial dysfunction is associated with increased risk of cardiovascular events.
3	2003	300	RCT	Endothelial dysfunction	Endothelial dysfunction is a marker of cardiovascular risk.
4	2005	400	Cohort	Endothelial dysfunction	Endothelial dysfunction is associated with increased risk of cardiovascular events.
5	2007	500	RCT	Endothelial dysfunction	Endothelial dysfunction is a marker of cardiovascular risk.



- Spontaneous Pain? Do the endo
- Pain to heat that lingers? Do the Endo
- Pain that wakes you at night? Do the endo
- Pain to cold and chewing that lingers for more than a minute or two? Do the endo

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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 probings less than 3 mm in the space associated with the identified crack. Increased interproximal probings 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?



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 probings were recorded in the mesial and distal interproximal spaces and furca. These interproximal probings 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 peritapical diagnosis. Cases with RP were treatment planned for crowns only, regardless of peritapical diagnosis.

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

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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):1–13.
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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3. Blatt W. Incomplete crown construction in pulpal periodontal disease. J Periodontol 1973;44:269–70.
4. Cameron CE. The cracked tooth syndrome: additional findings. J Am Dent Assoc 1976;83:971–5.
5. Wetse FS, Desberry Jr, James A. Cracked-tooth syndrome: vertical fractures of posterior teeth. In: Wetse FS, ed. Endodontic therapy. 5th ed. St Louis: Mosby, 1982:6–15.
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# What is the pulpal death rate for bridge abutments? 32%



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

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



Big picture:  
Prepare,  
impress and  
temporize  
normally but  
wait 6-8 weeks  
to seat crown



Big picture:

For smaller ICF's  
with mild symptoms,  
a gold or porcelain  
onlay may obviate  
the wait period for  
the crown seat.



Big picture:

Bioclear

Composite

Overlays have  
shown immediate  
elimination of  
symptoms\*



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?

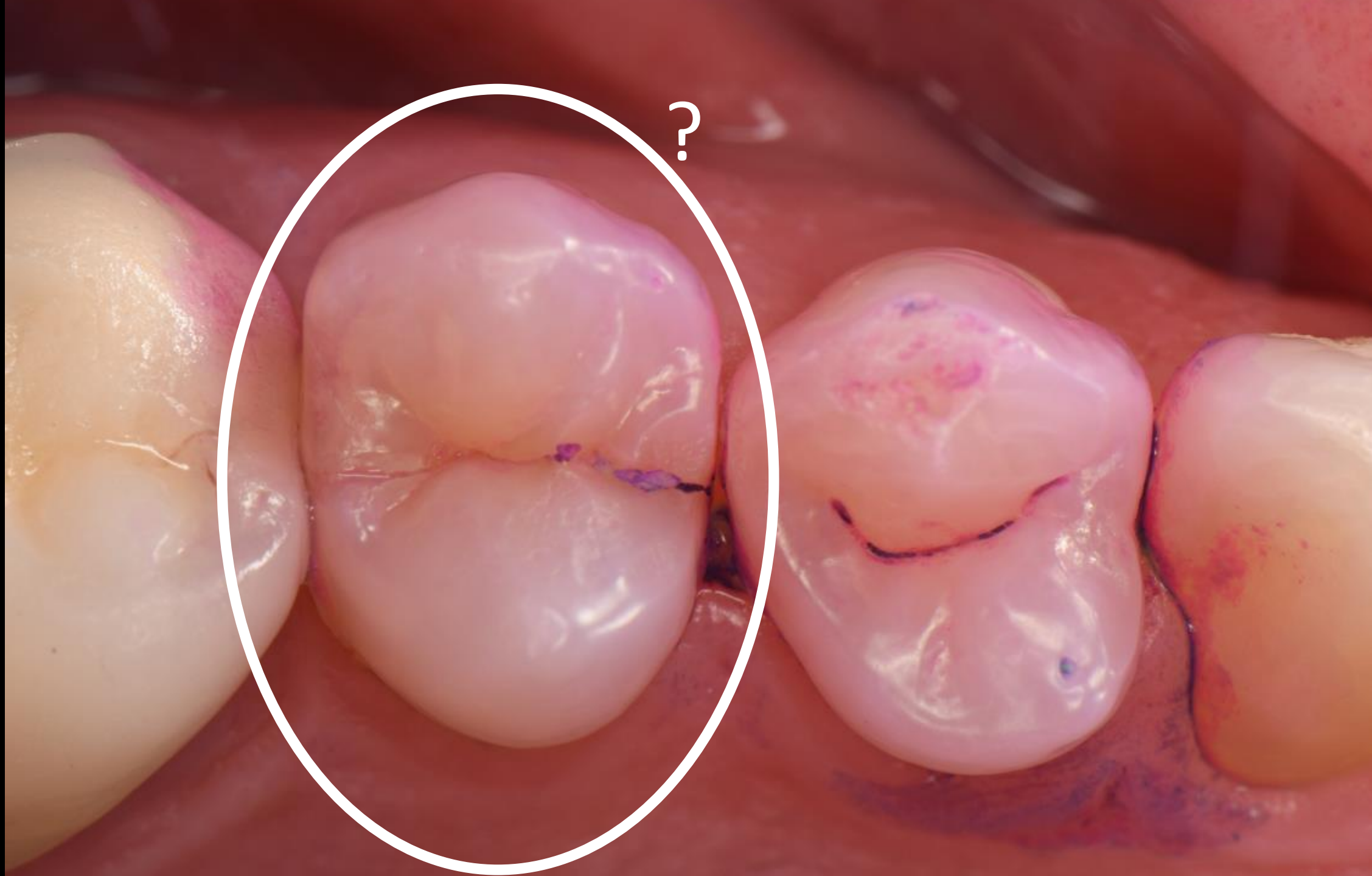


Which tooth is cracked?



?

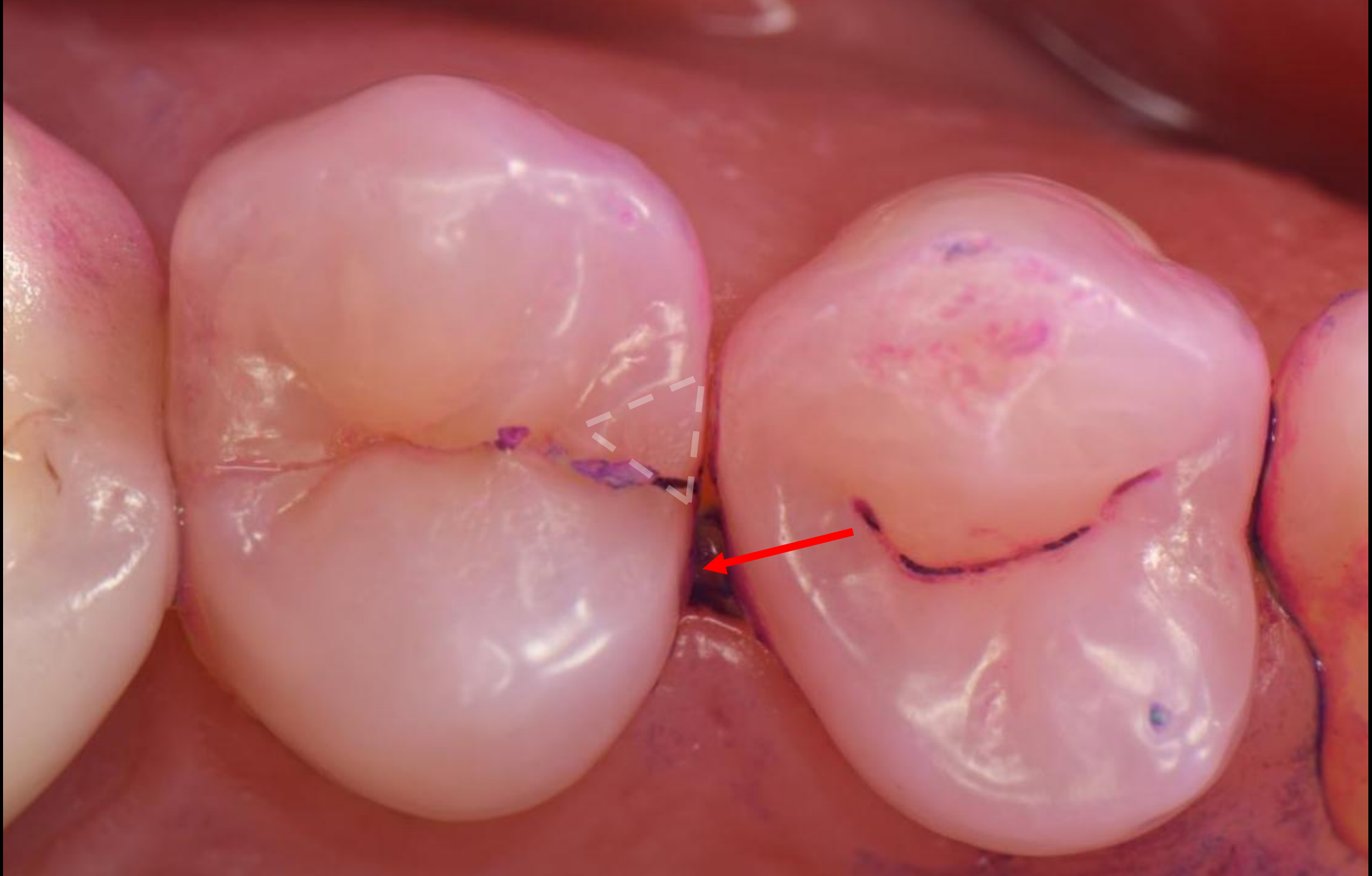










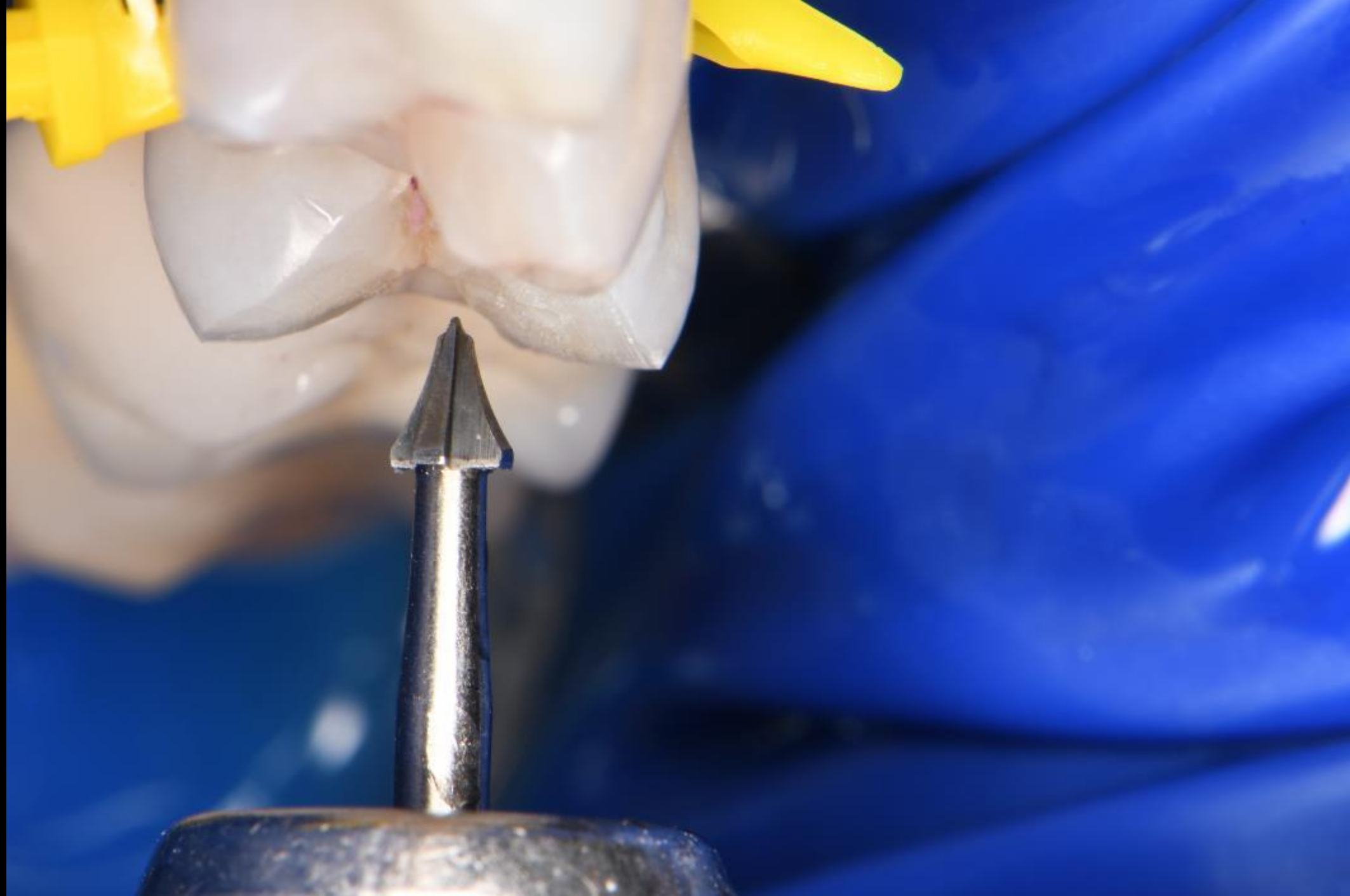




























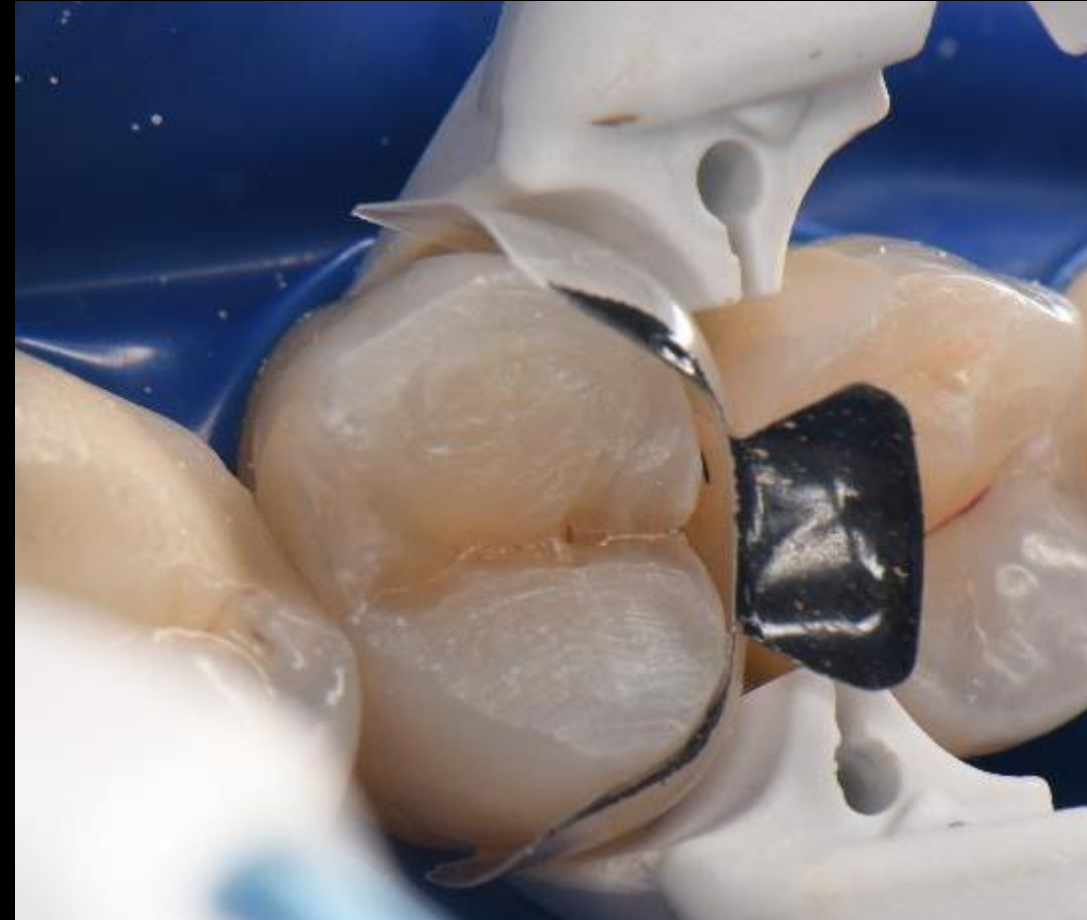






# Learning Objectives from the Case:

- 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



Modern Restoration

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

**I**nfinity edge

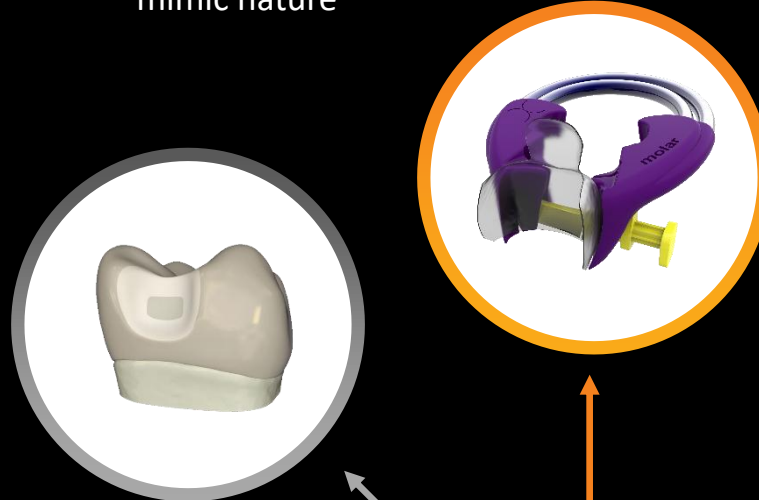
**C**ompression based

**E**namel 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

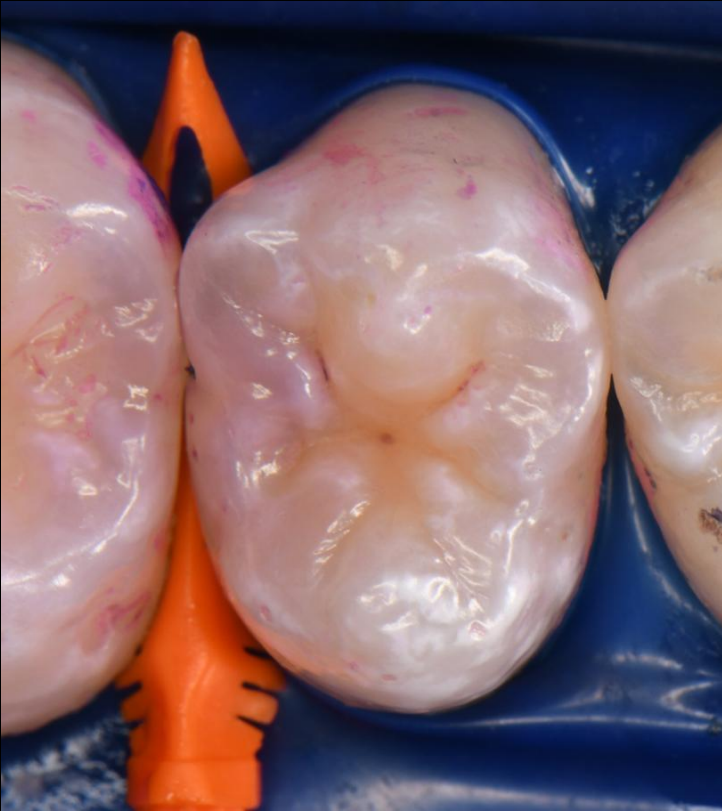
## Final Polish

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



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

∞ BIOCLEAR



Are all  
Separators  
Equal?

**NO!**



Stretched to 20mm ONCE!!!





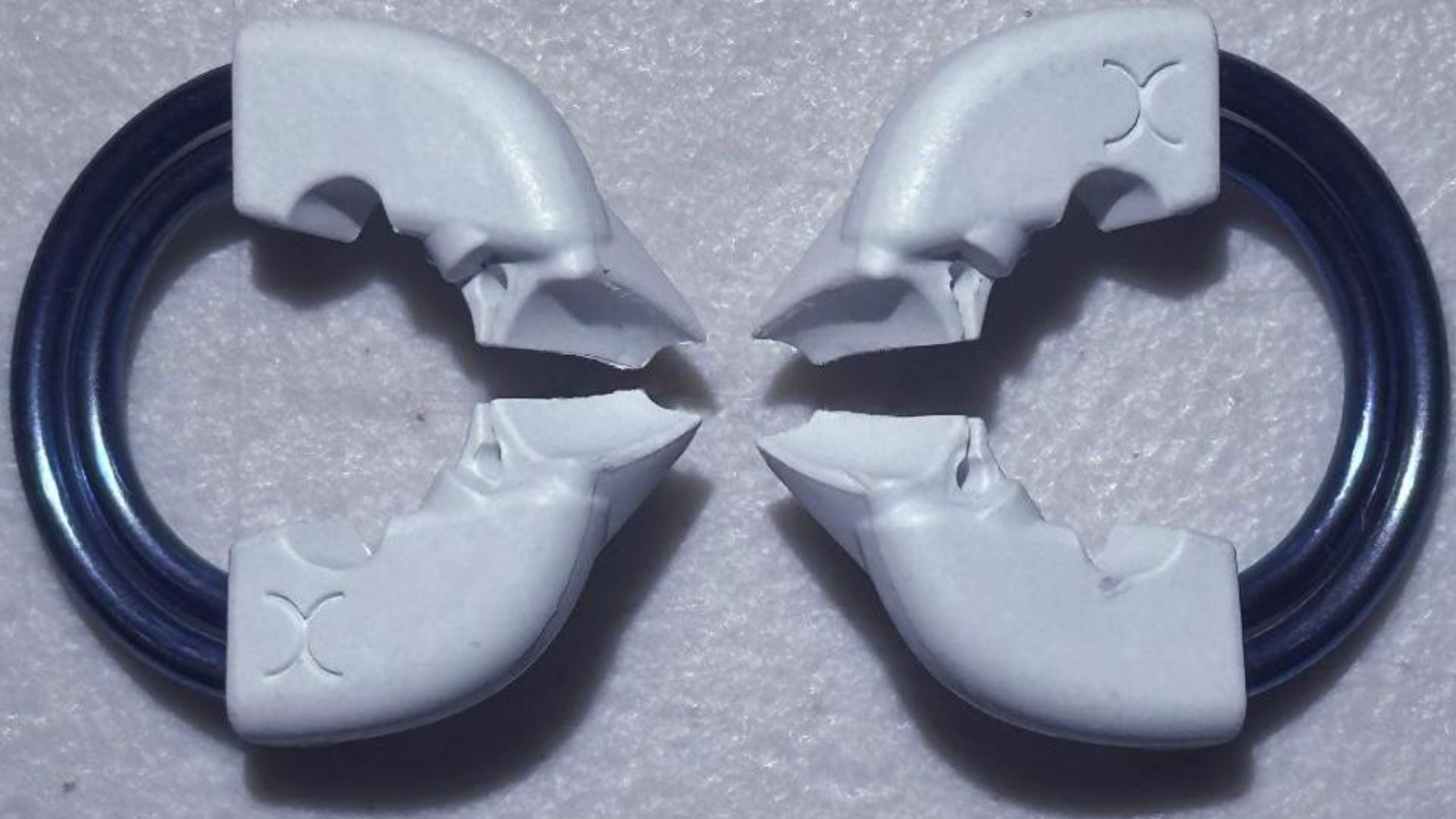
And now most of  
the power is  
permanently lost

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

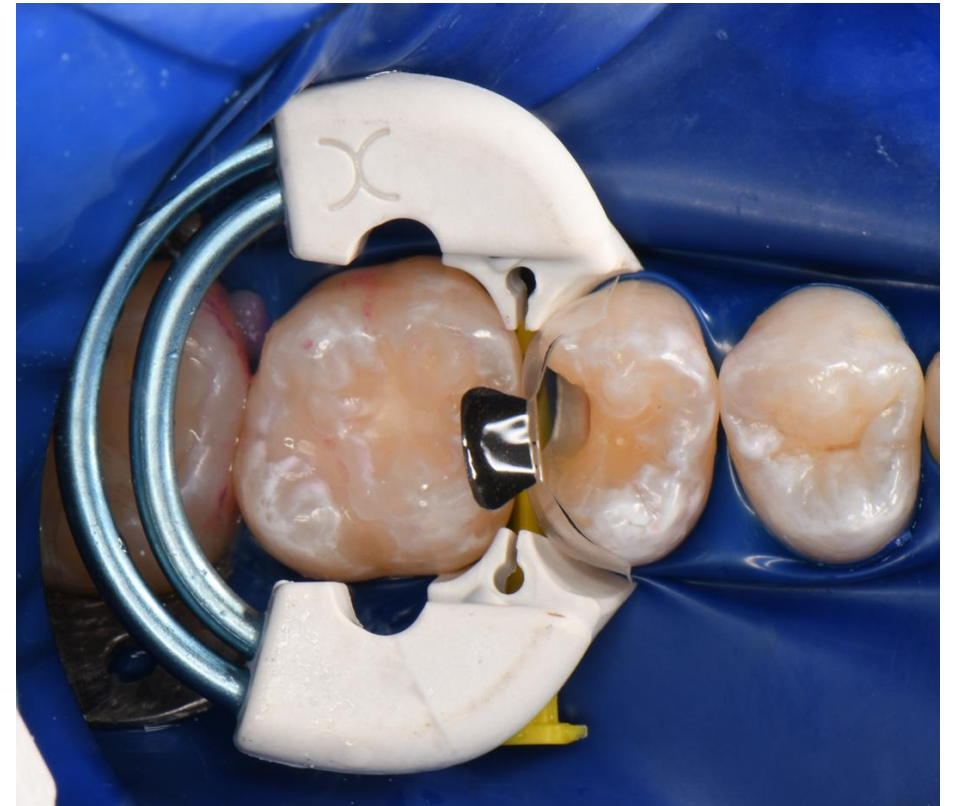
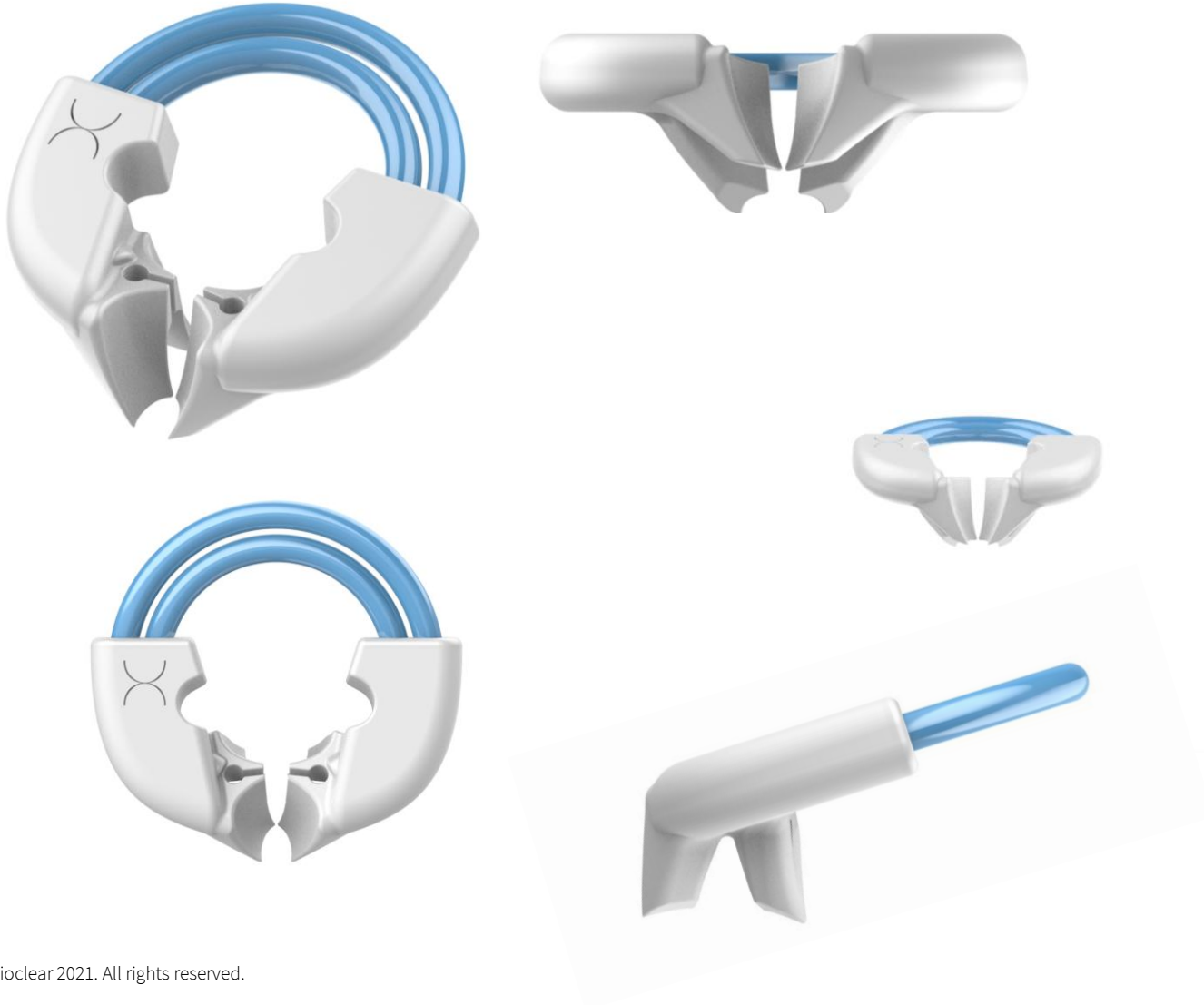
Stretched to 20mm Twenty Times



Stretched to 20mm Twenty Times



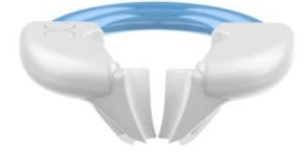
# TwinRing Universal





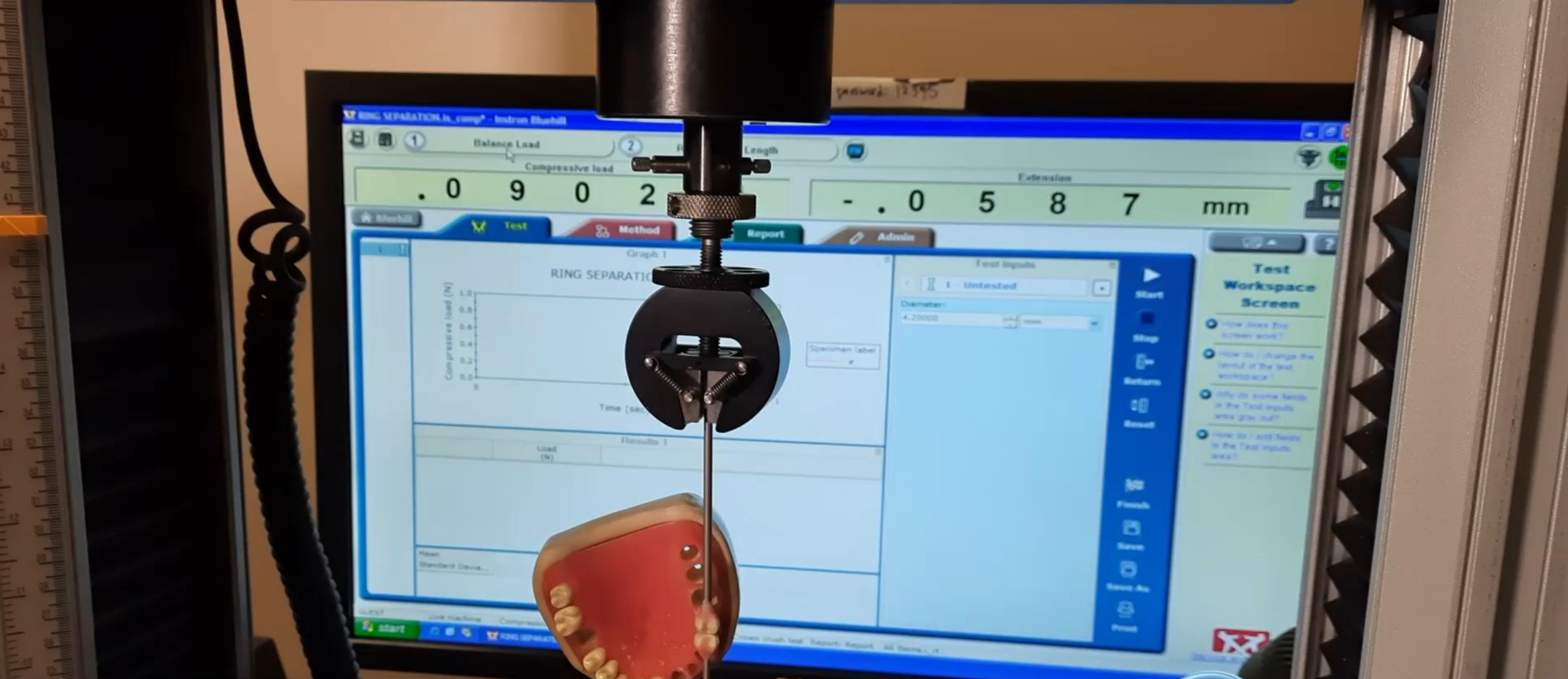
## How do we win the *Snug Contact Game?*

- Power
- Strategy
- Technique



## How do we win the *Snug Contact Game?*

- Power
- Strategy
- Technique



### Nate Lawson DMD PhD

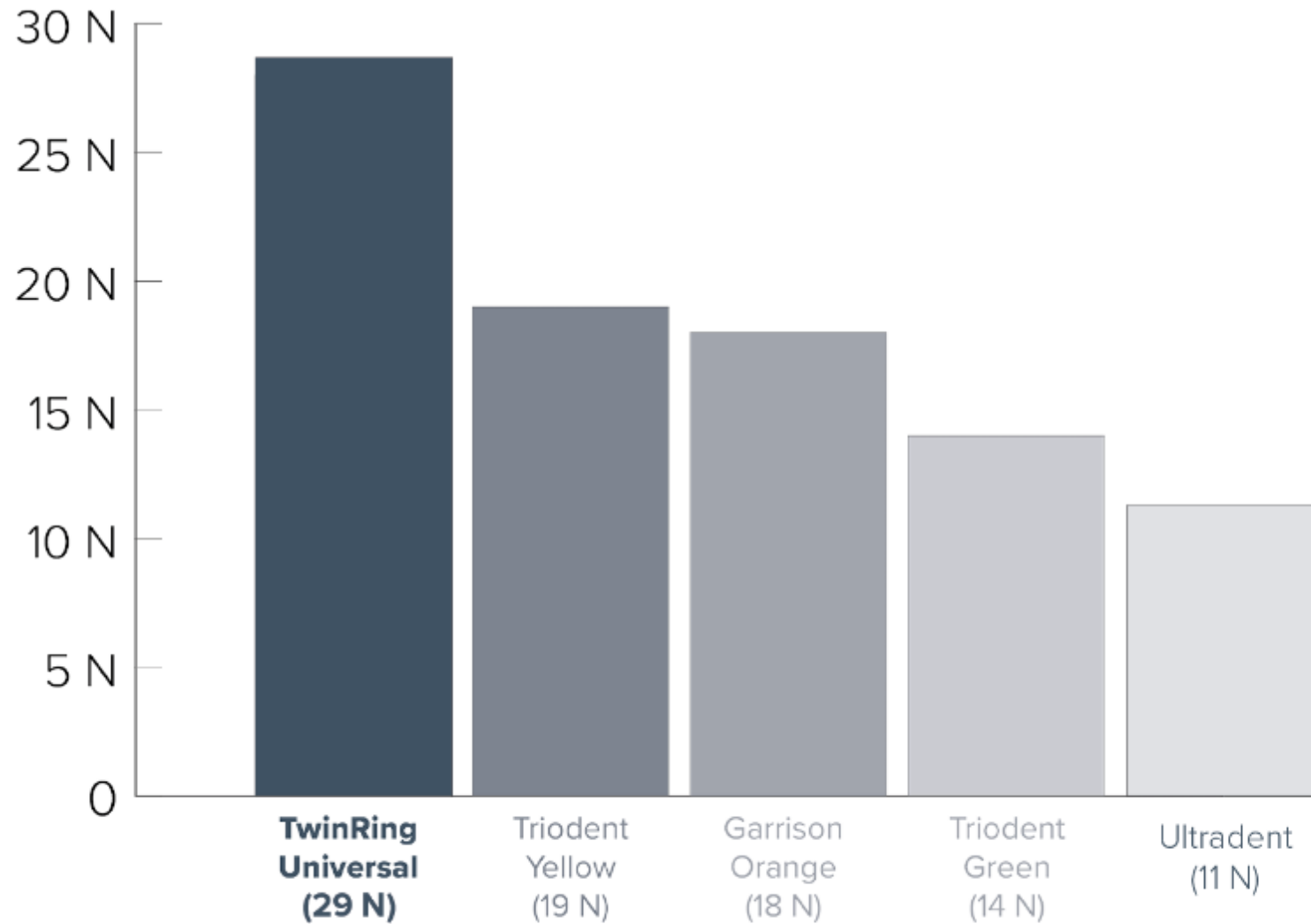
Director of the Division of Biomaterials and Pranit Bora. BDS, MDS.

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

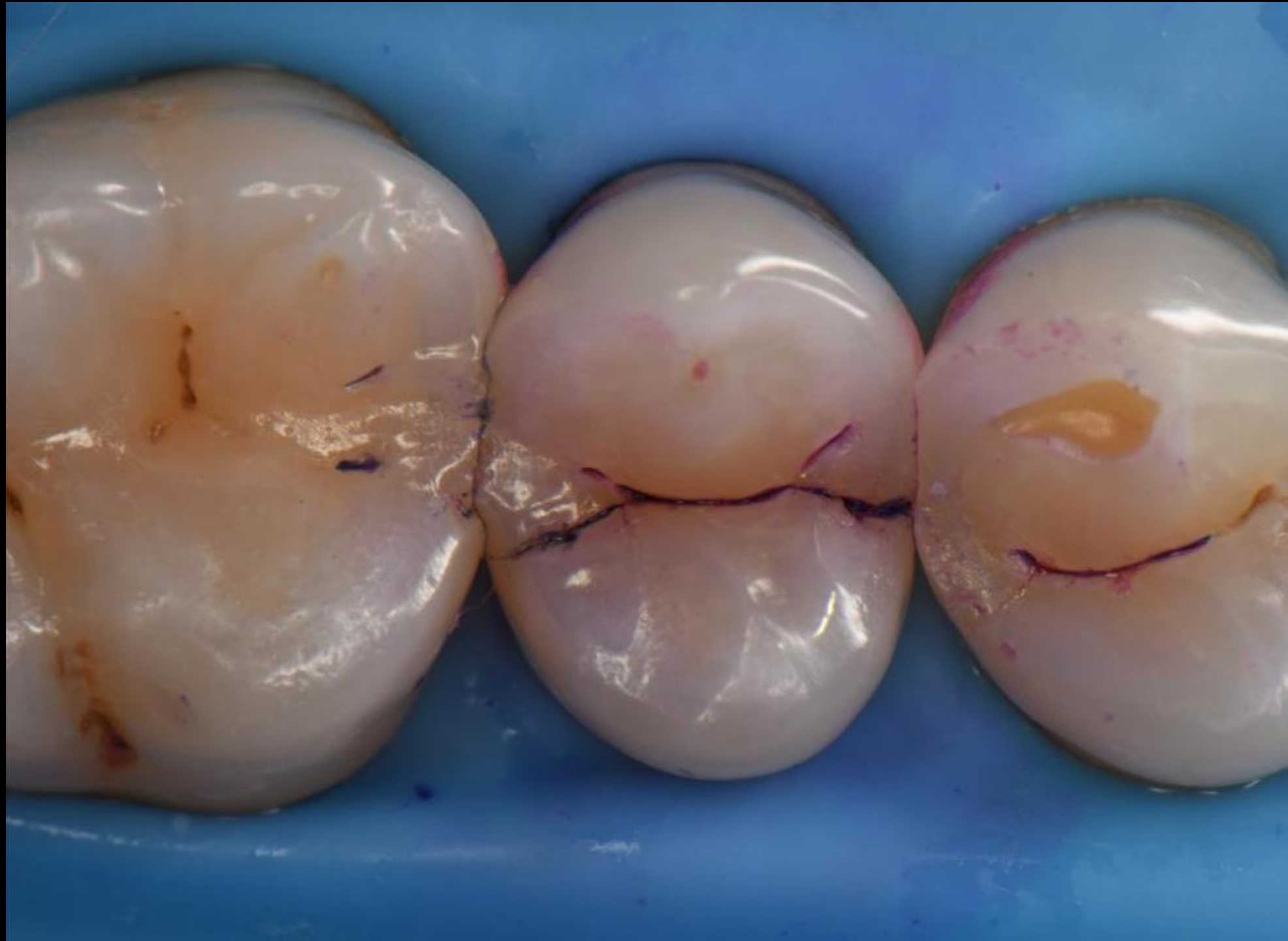


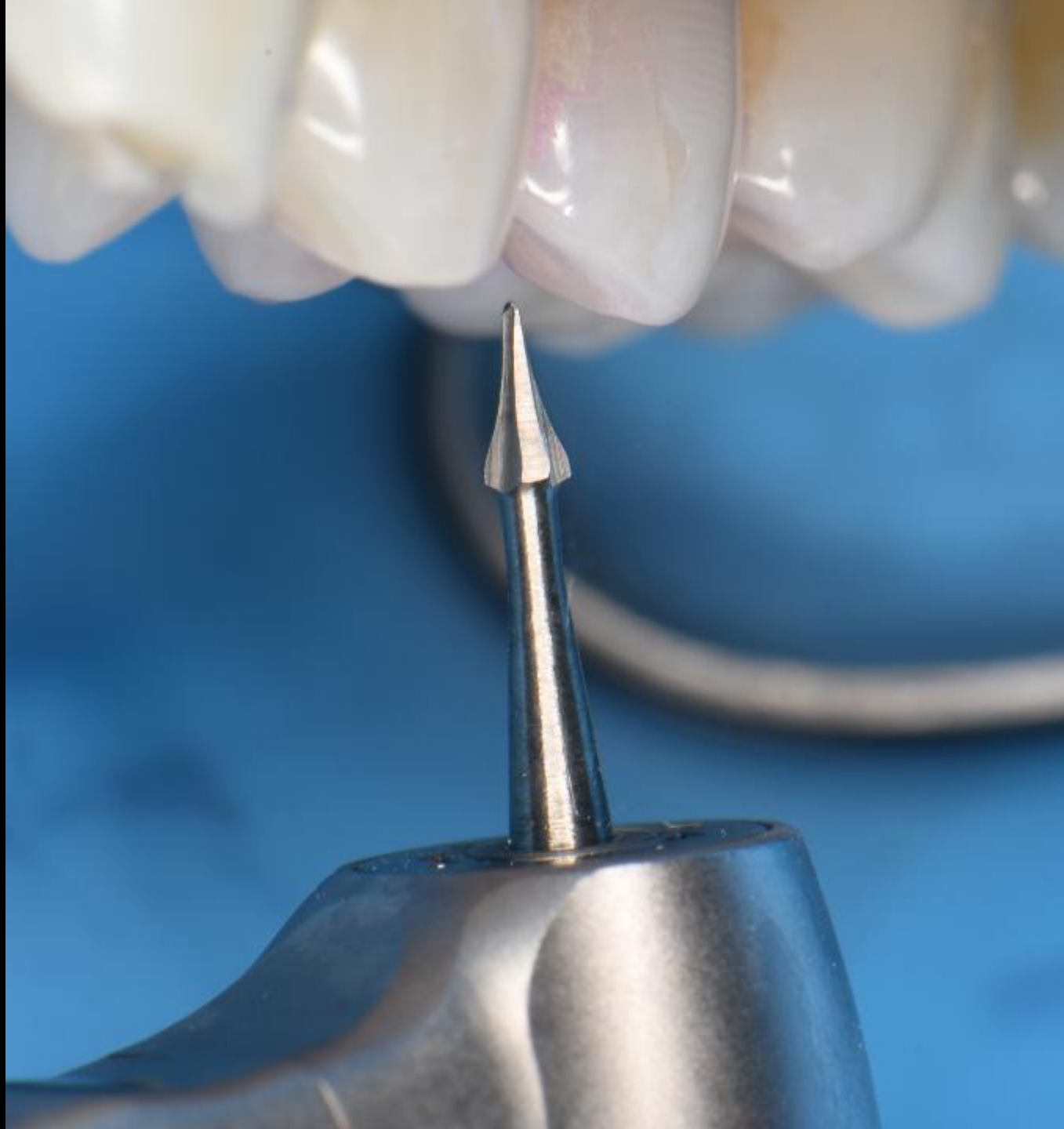
EVOLVE  
MATRIX

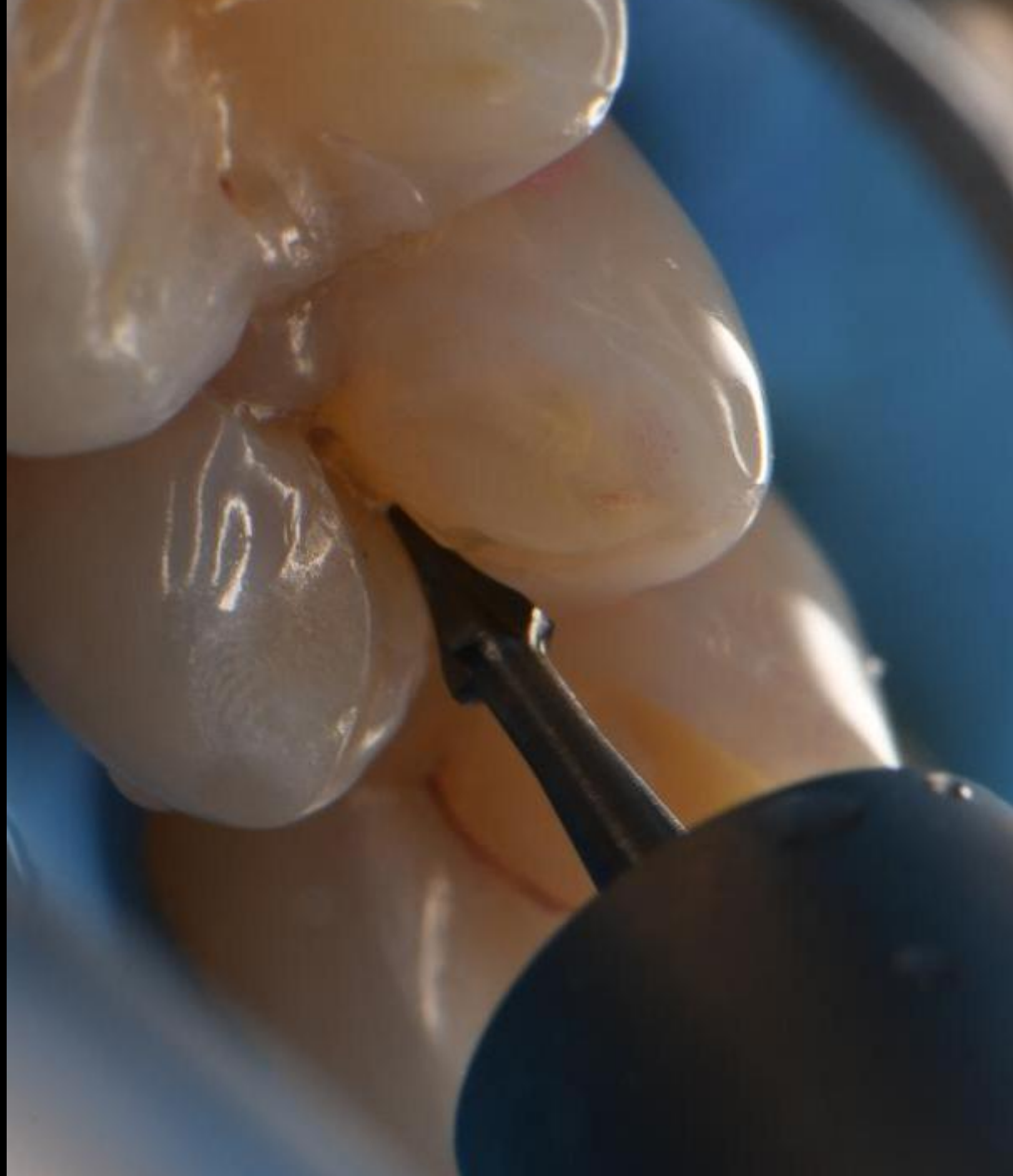
# Asymptomatic Cracked Maxillary Premolar

Treatment: Bioclear Overlay Utilizing SS White CLF (Calla Lily  
Fissurotomy carbide and diamond) Burs, Bioclear Calla Lily  
Preparation and Restored with GC A-1 Bulk Injectable







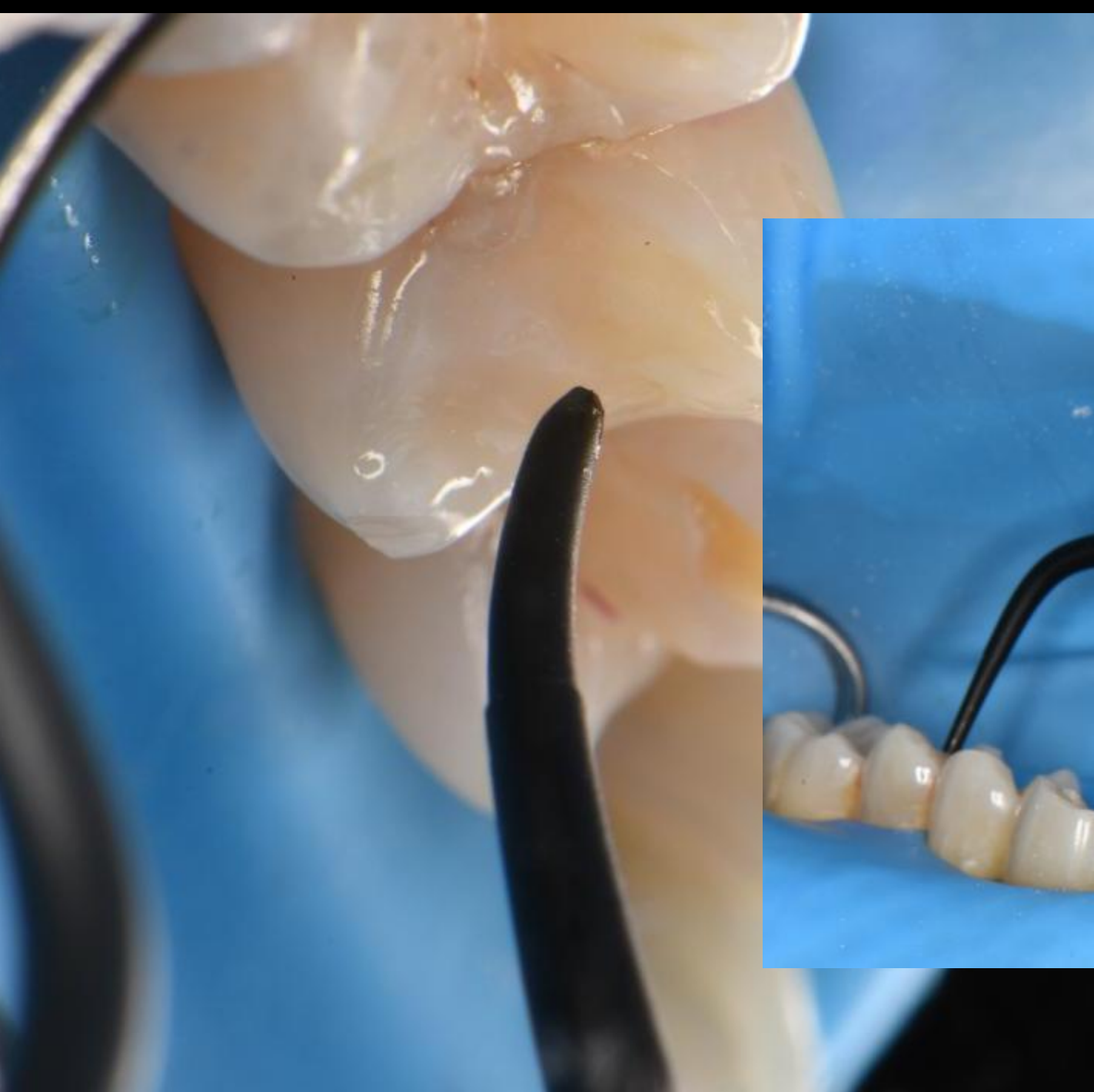












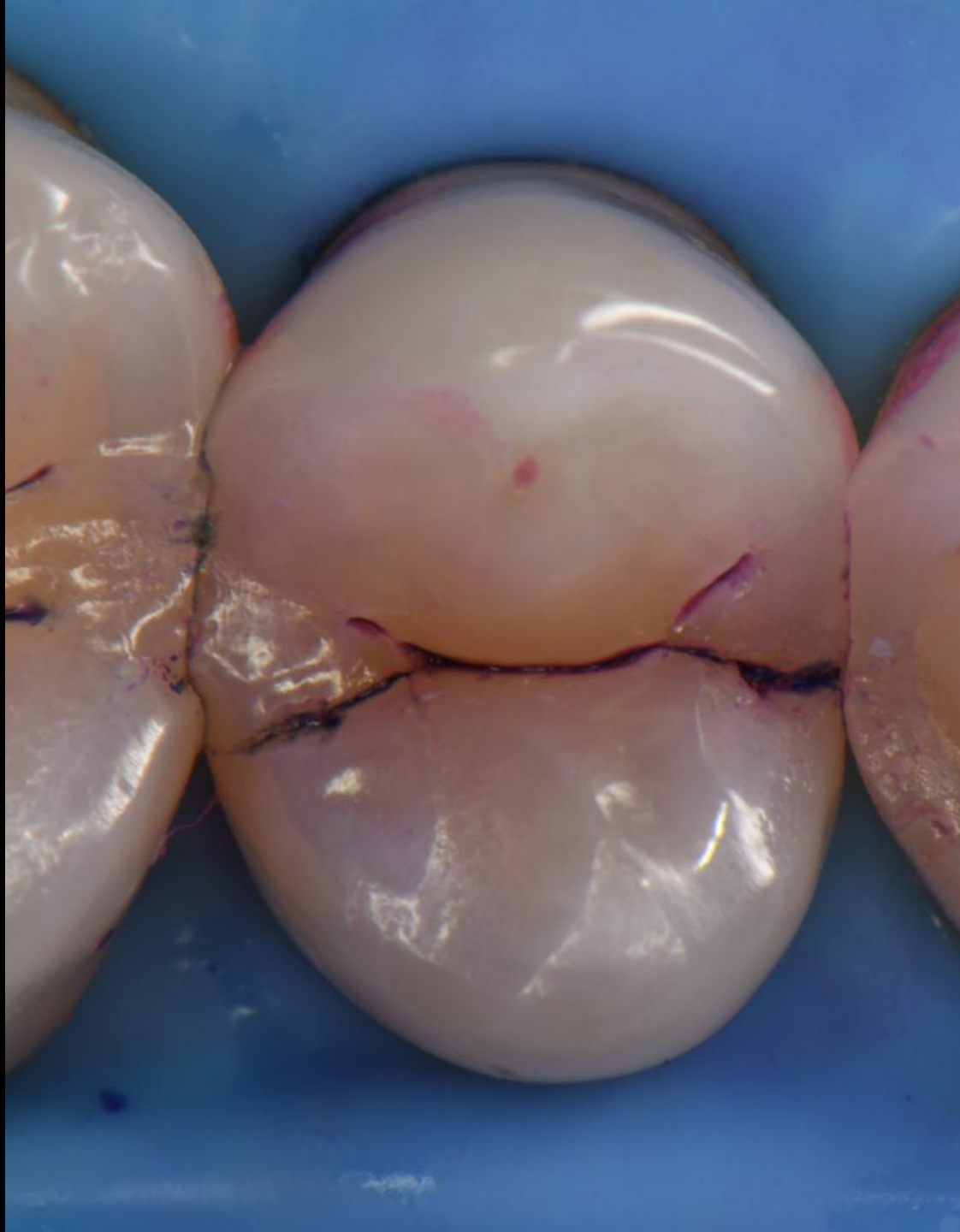








You can anticipate  
these occlusal marks:







Harmonizing the occlusion: keep adjusting the opposing teeth until there are heavier marks away from the impact of the new restoration.



**BIG PICTURE:  
LEAVE THE NEW  
COMPOSITE IN  
SLIGHT HYPO-  
OCCLUSION**

# What are the necessary tools?

- SS White -Bioclear CLF Bur Block
- Bioclear Disclosing, blaster an Aluminum Tri hydroxide powder
- GC G-aenial Bulk Injectable
- Bioclear HeatSync heater
- Bard Parker with 12 blade
- Bioclear Tru Contact saw
- Burs and polishers for *Harmonizing* the occlusion



What if things  
don't go our way  
and we have to  
do an endo  
access through  
our composite  
overlay?









What if things don't go our way and we have to do an endo access through our composite overlay?

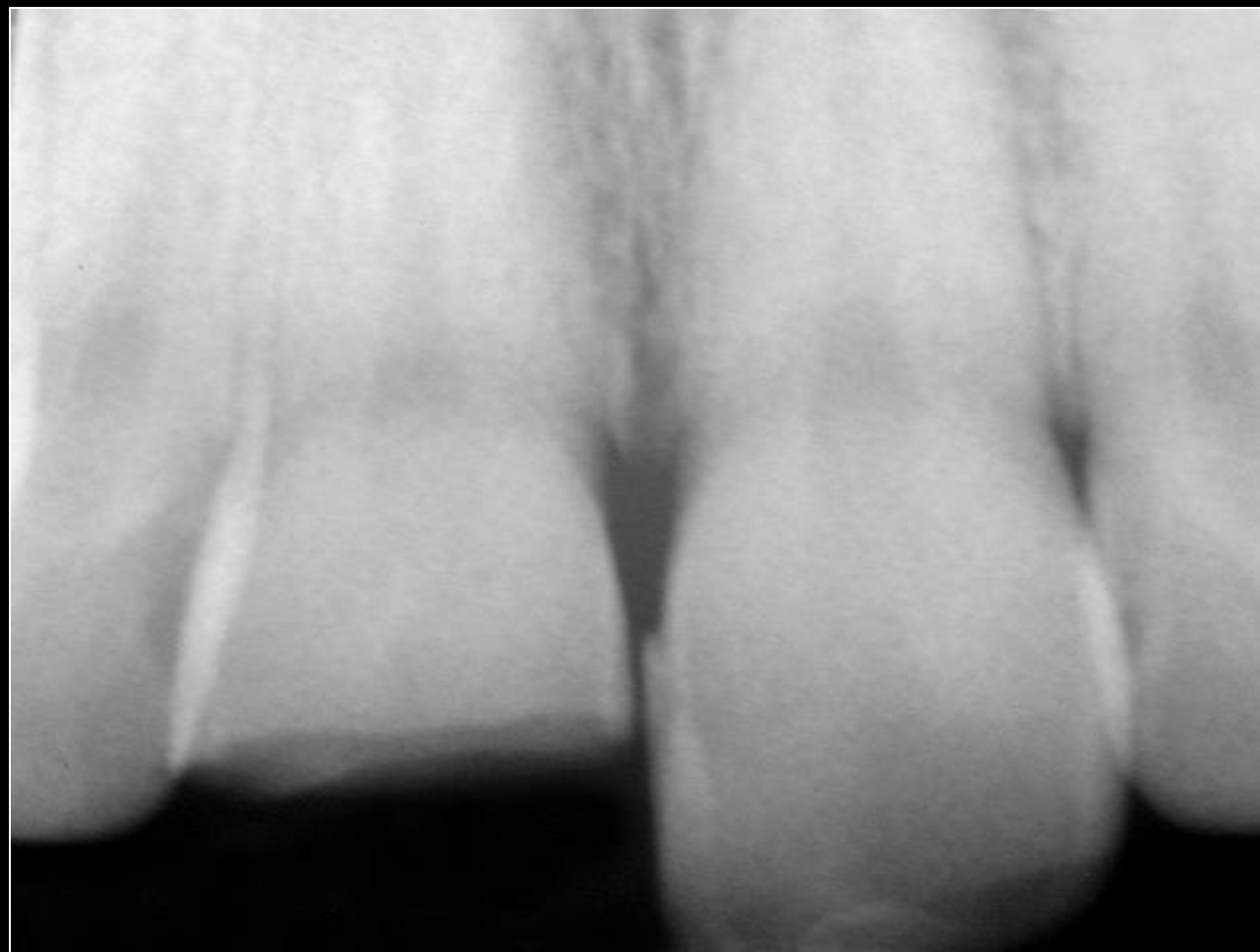
**Redo the overlay, composite needs to be monolithic**



# In this case based lecture today we explore:

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





What Would You Do?

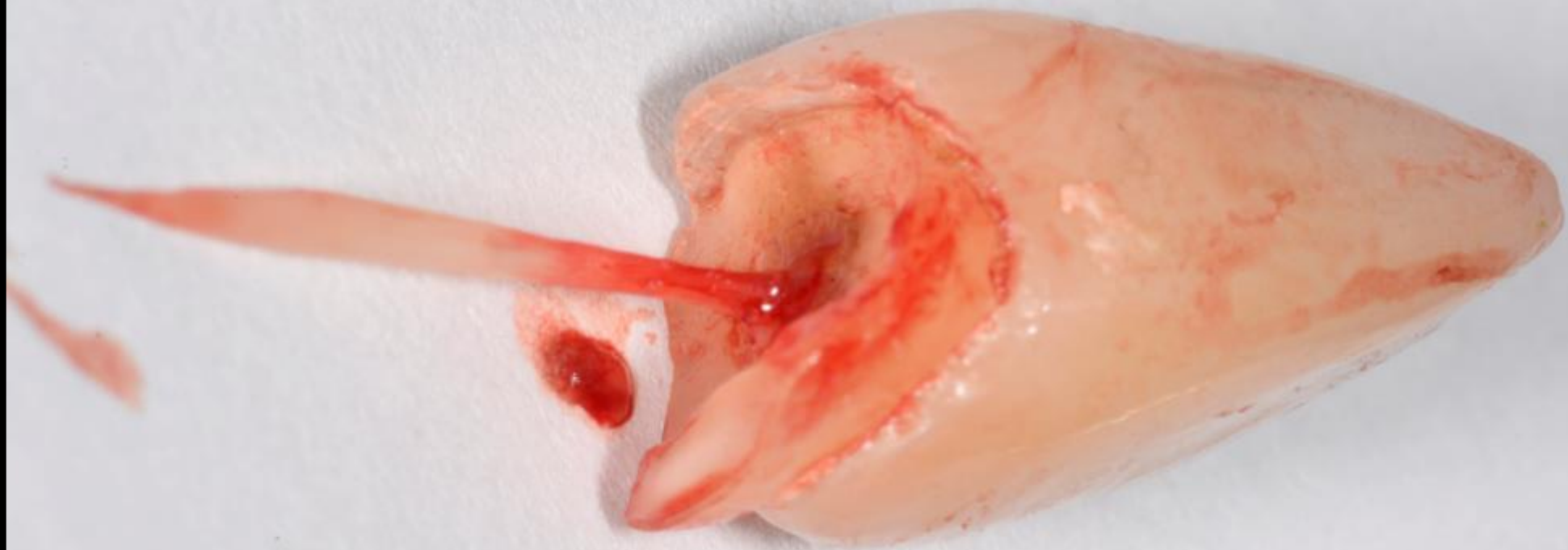


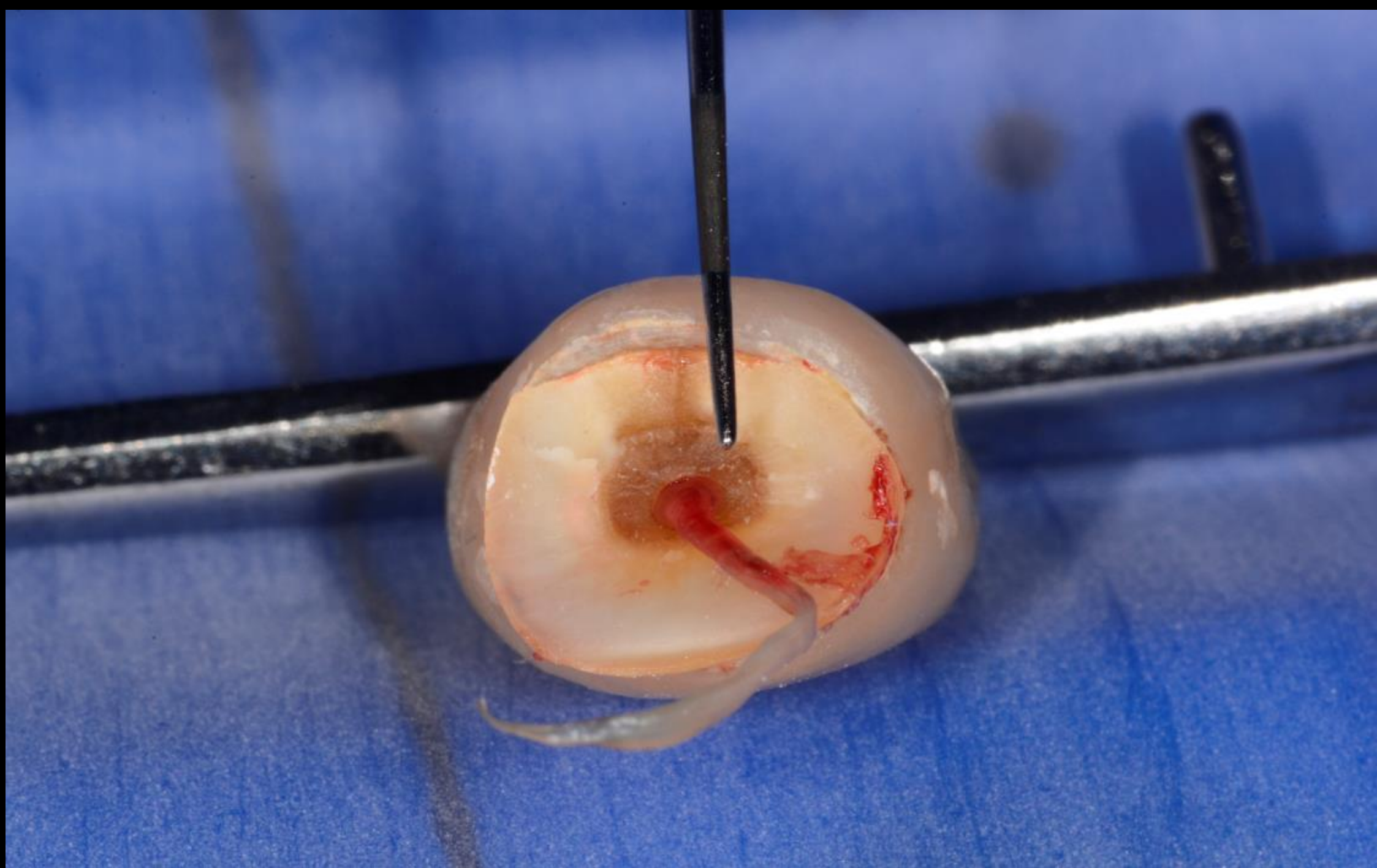
A different  
toothache  
patient we saw  
recently...

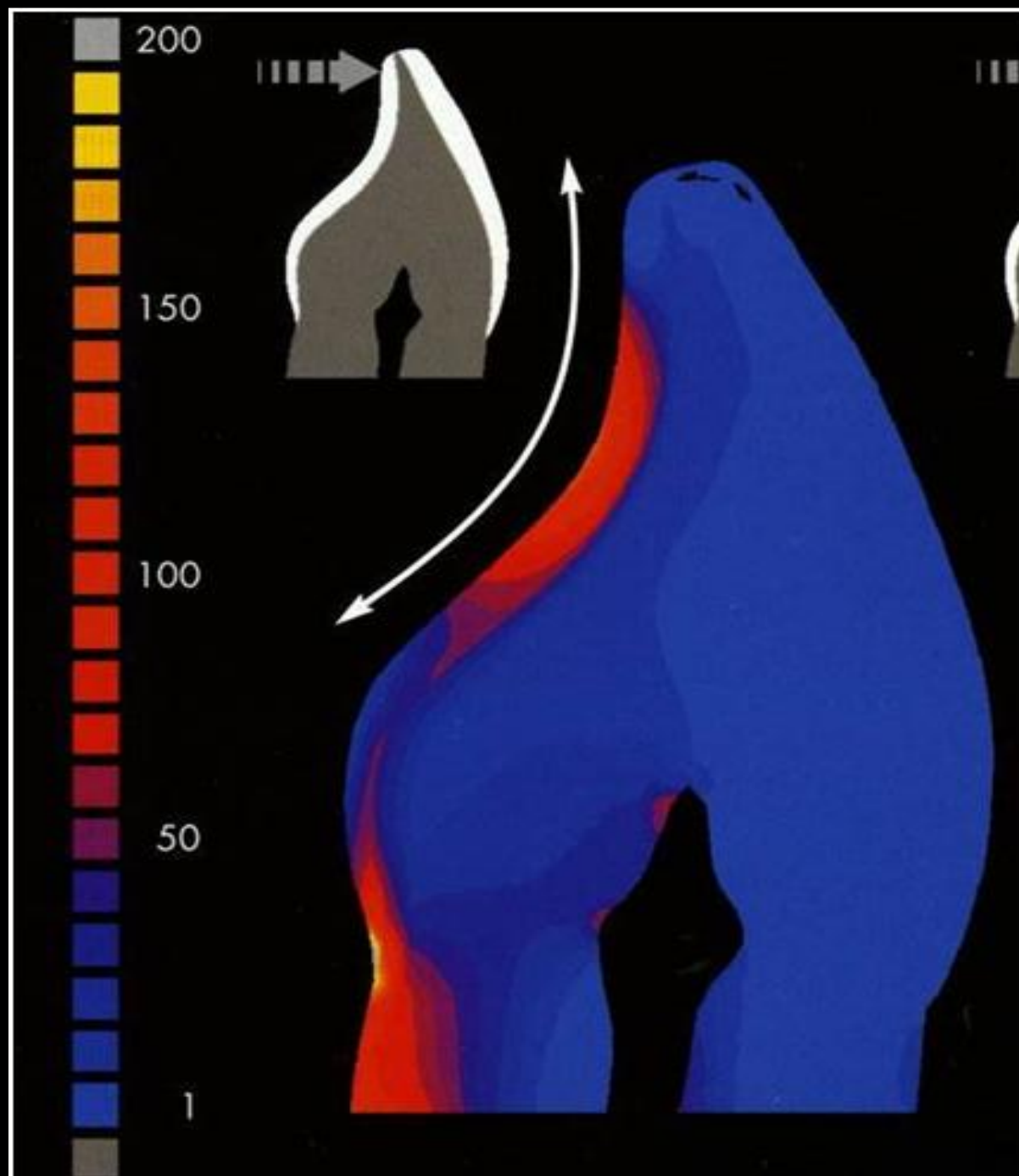
















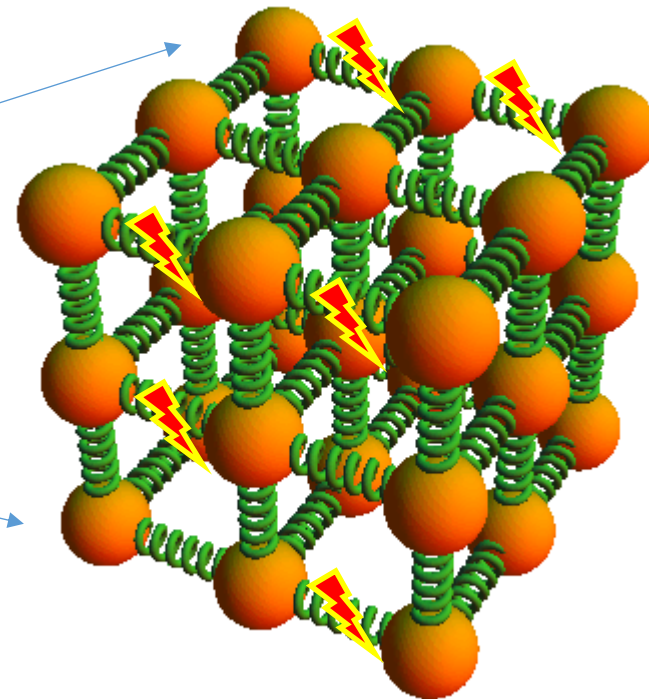
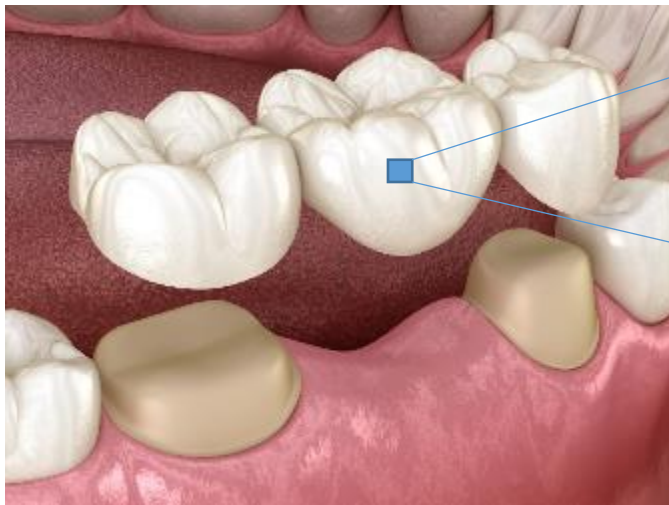




# Basics of Solid Mechanics



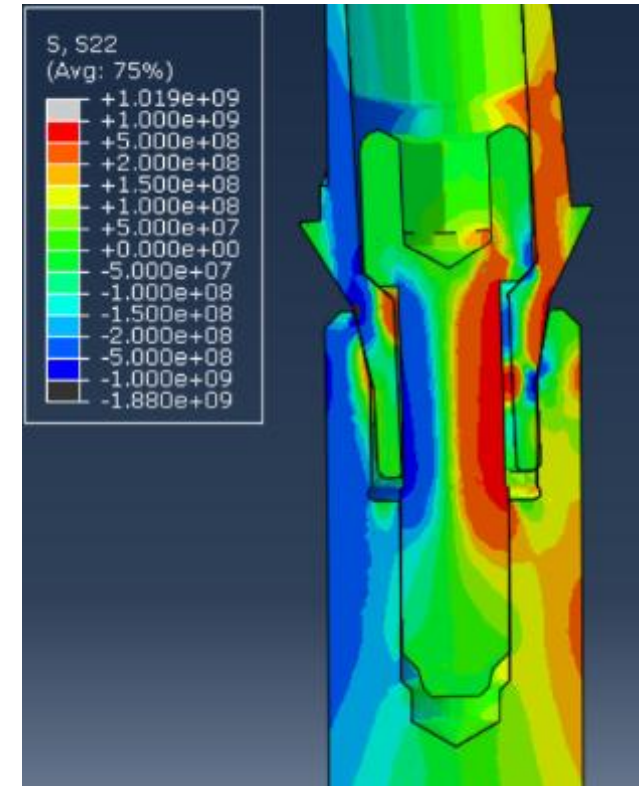
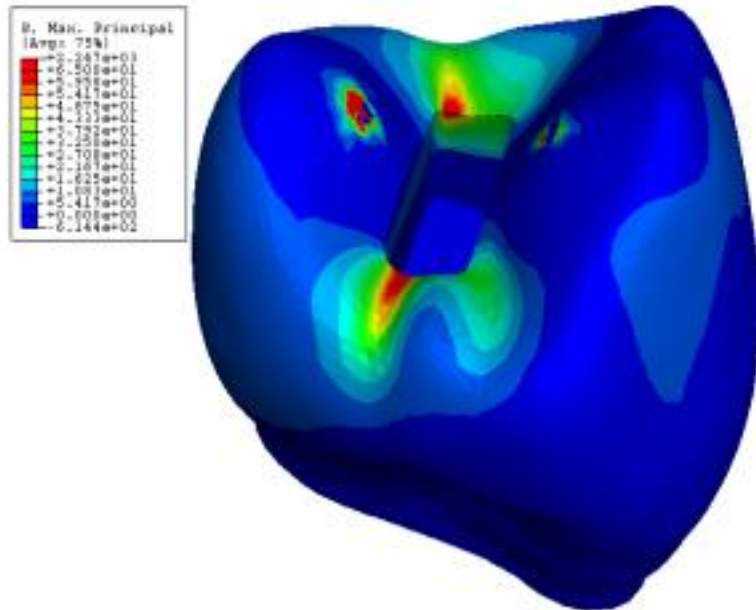
All solid structures can be considered as an assembly of many interconnected springs.



# 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

All Ceramic  
.8 Margin

All Ceramic  
1 mm Margin

All Ceramic  
1.4 mm Margin



53.0

70.4

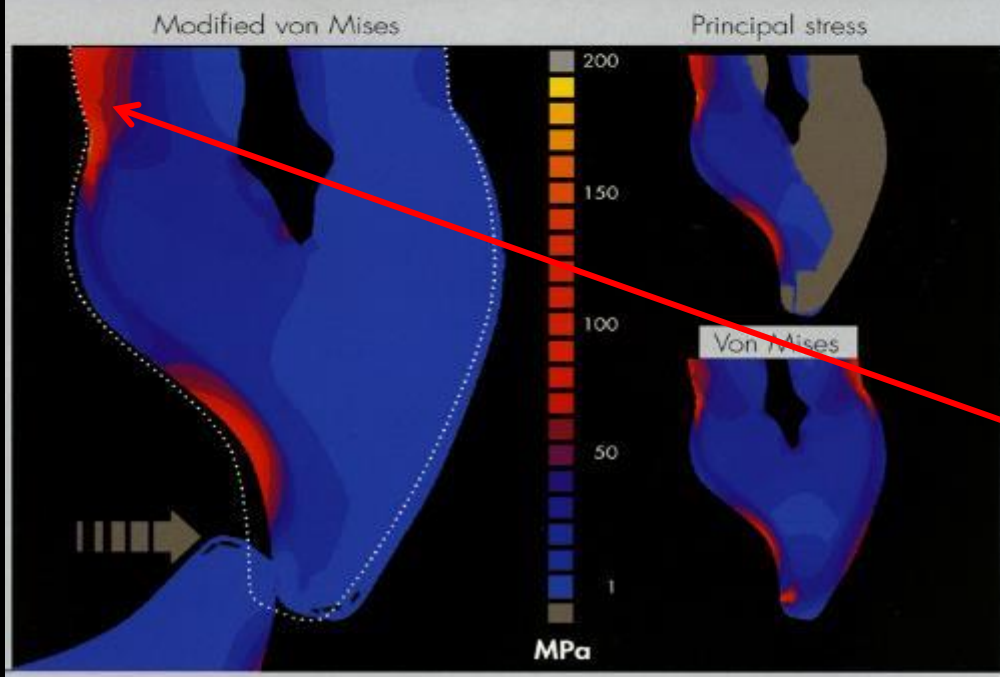
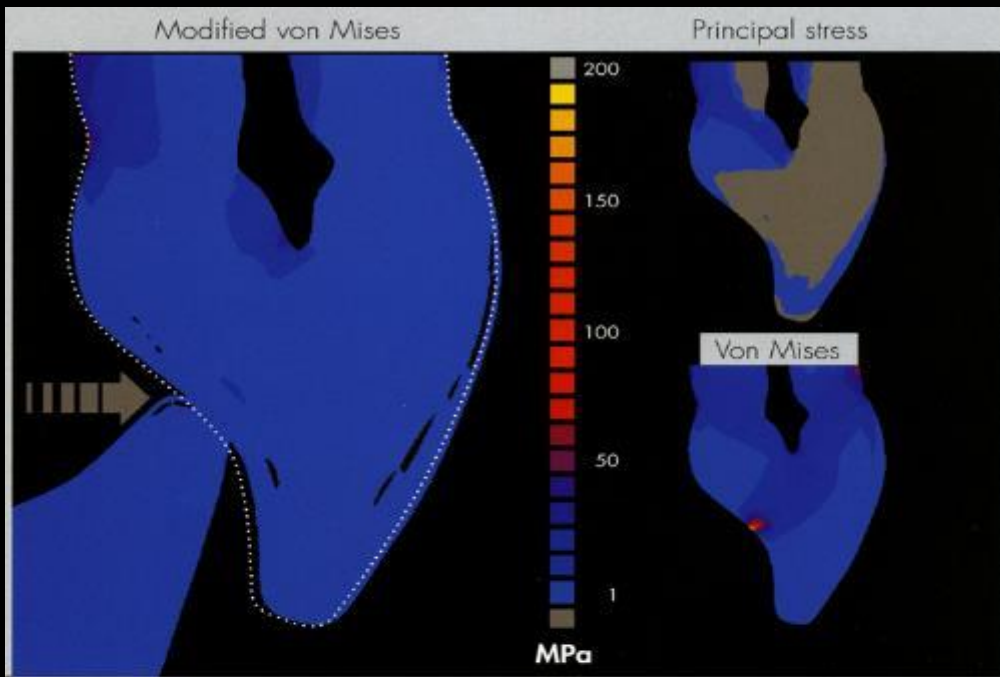
74.1

75.9

34 \*

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



The patient is a 35- year-old male. His original chief complaint was a discolored filling on the distal of tooth #8. The patient was given two treatment plans, one to simply replace a few defective restorations and remove caries with traditional fillings or in patient terms we said, “We can patch the holes, or I can rejuvenate your smile. The patchwork plan will be healthy but will not make a significant esthetic change. In addition, the severe wear and acid erosion present on the palatal surfaces could eventually lead to catastrophic problems later i.e. root canals, infection, and tooth loss.” The patient opted for Bioclear rejuvenation versus simple fillings because he wanted a beautiful smile. He chose Bioclear in lieu of crowns because he understood that Bioclear is a more conservative and healthier approach to achieving his goals than traditional crowns.

Phase one of the treatment plan was to restore the anterior six teeth, simultaneously opening the vertical dimension to reduce the need for aggressive tooth reduction for material thickness. In addition, because the patient needed to have the teeth lengthened by 2 mm, opening the vertical dimension by 2 mm allowed the overbite to be more ideal. Because the patient could only commit to the cost of the six Bioclear restorations (\$11,600) we placed transitional occlusal flowable composites (thick sealants) on the four maxillary premolar teeth, and we will allow the molars to settle into occlusion utilizing the well-researched Dahl Technique.

Phase two will be to restore the remaining teeth with Bioclear when the patient has his finances ready.

#### Treatment Summary Short Version:

Treatment was finished in a single 4-hour session. (Less experienced clinicians should plan to give one hour per tooth). Bioclear TSS Matrices were utilized on all the teeth except tooth #10. #10 required the Bioclear BT matrix system to create “instant ortho” and because a diastema was present there. Bioclear Diamond wedges were used as needed in areas where the contact was lost during caries removal or removal of old composites. Bioclear RSP X-course discs (Black) were used to shape the incisal edges and smooth the small seams present where the matrices meet on the facial and palatal. Final polish was achieved with Bioclear Magic Mix and then Rock Star Polish cups and cones.

One-week postoperative visit revealed healthy teeth and gingiva. The patient was ecstatic about his new smile, had zero post-operative pain or sensitivity, and expressed that his new bite with the increase in VDO felt more comfortable than before.





What percentage of the tooth is removed for a conservative crown prep?



Source: Google Images

# What percentage of the tooth is removed for a conservative crown prep?



Source: Google Images



Wouldn't it be nice to preserve nearly all the healthy tooth structure and at the same time completely rejuvenate this guy's smile?



**Simplified Smile Design!**

How long are his centrals currently? 8.5 mm



How wide are his centrals? 8.5 mm





Central Width  
7.0mm

7.5mm

8.0mm

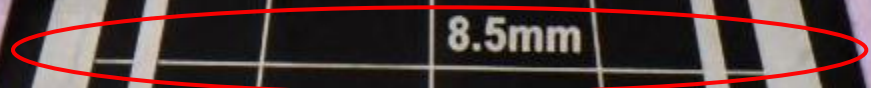
8.5mm

9.0mm

9.5mm

10mm

 **Panadent**  
**Esthetic Proportion**  
**Gauge**



Central Width

Central Height

8.0mm

10.0mm

8.5mm

10.6mm

9.0mm

11.2mm

9.5mm

11.8mm

10.0mm

12.5mm















**TSS**

TOOTH & SURFACE SPECIFIC  
MATRIX SYSTEM  
BY BIOCLEAR



140 Anterior Matrices  
25 Preformed #10-14 Maxillary & Distal  
Small & Medium Lower Incisors

75 Wedges  
25 Small, Medium  
50 Medium Wedges

**The next generation  
of anterior matrices:**  
We're taking the  
guesswork out of to  
matrix selection



Contact your Bioclear Sales Rep to Pre-Order  
WWW.BIOCLEARMATRIX.COM  
1.855.712.5427



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MATRIX SYSTEM  
BY BIOCLEAR



100 American Matrices  
100 Standard Plus Matrices & Covers  
100 Standard Plus Matrices & Covers  
100 Standard Plus Matrices & Covers

100 Matrices  
100 Standard Plus Matrices & Covers  
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145 Anterior Matrices  
15 Anterior & Posterior  
15 Anterior & Posterior

75 Matrices  
15 Anterior & Posterior  
60 Anterior Matrices

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MATRIX SYSTEM  
BY BIOCLEAR



961 Anterior Matrix  
962 Anterior Matrix  
963 Anterior Matrix  
964 Anterior Matrix  
965 Anterior Matrix  
966 Anterior Matrix  
967 Anterior Matrix  
968 Anterior Matrix  
969 Anterior Matrix  
970 Anterior Matrix

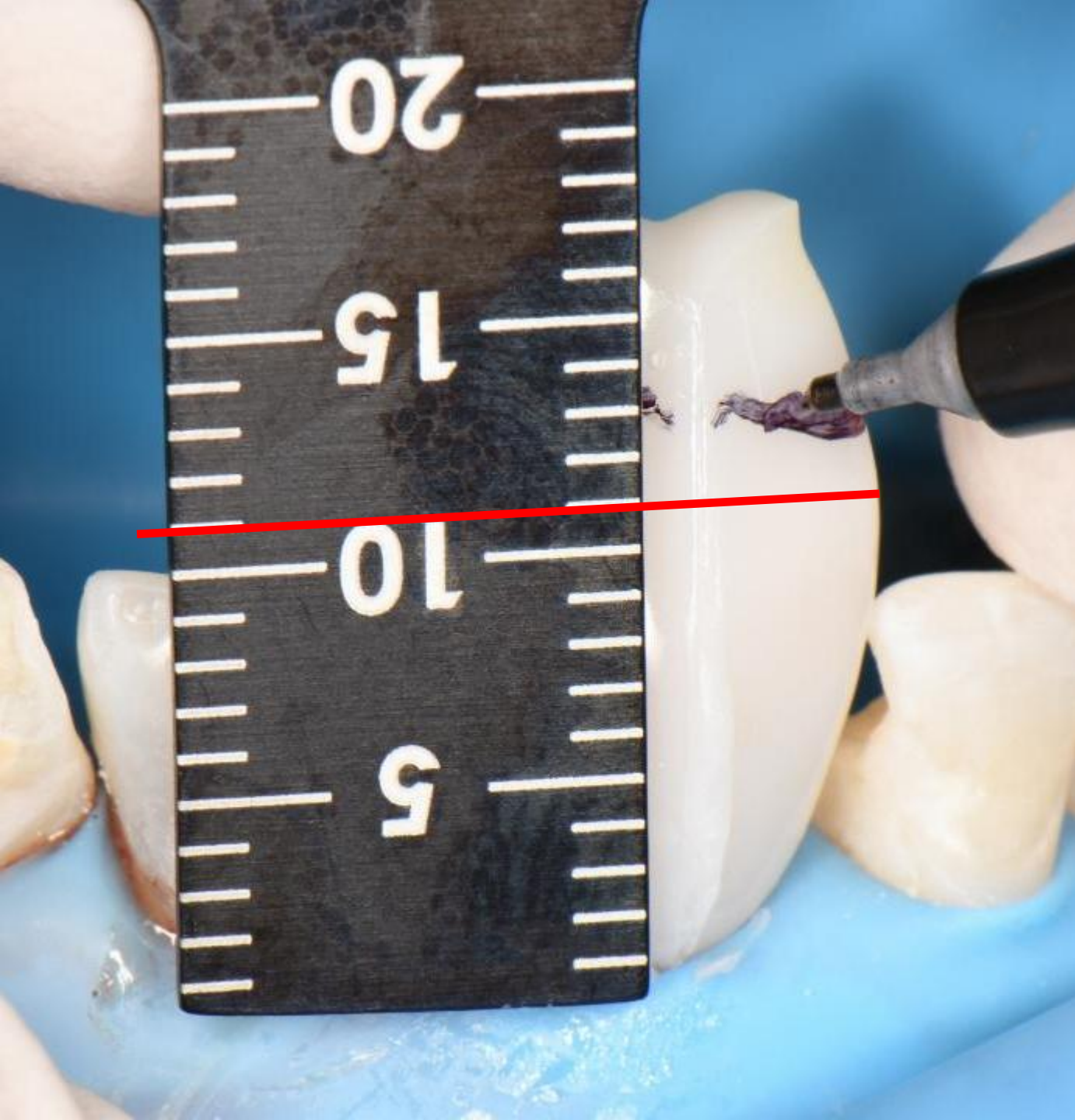
19 Wedges  
20 Wedges  
21 Wedges  
22 Wedges  
23 Wedges  
24 Wedges  
25 Wedges  
26 Wedges  
27 Wedges  
28 Wedges

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1 855 712 5327



































Pre-operative



Immediate Post-Operative

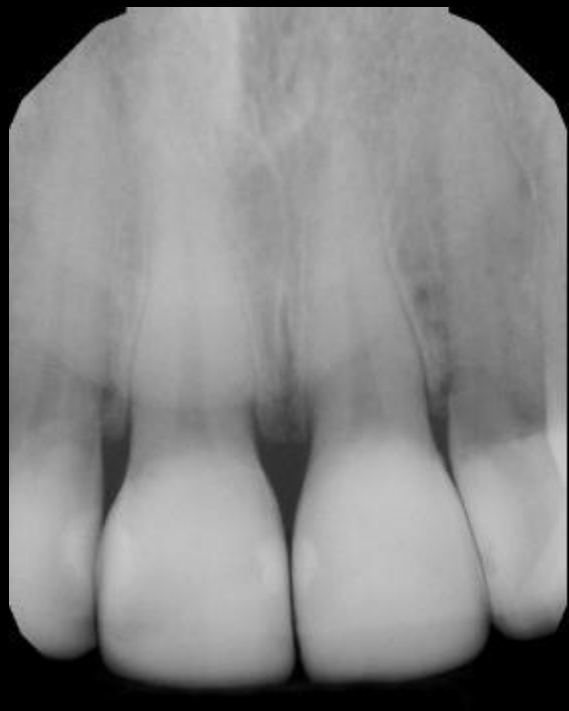


One Week Post-Operative

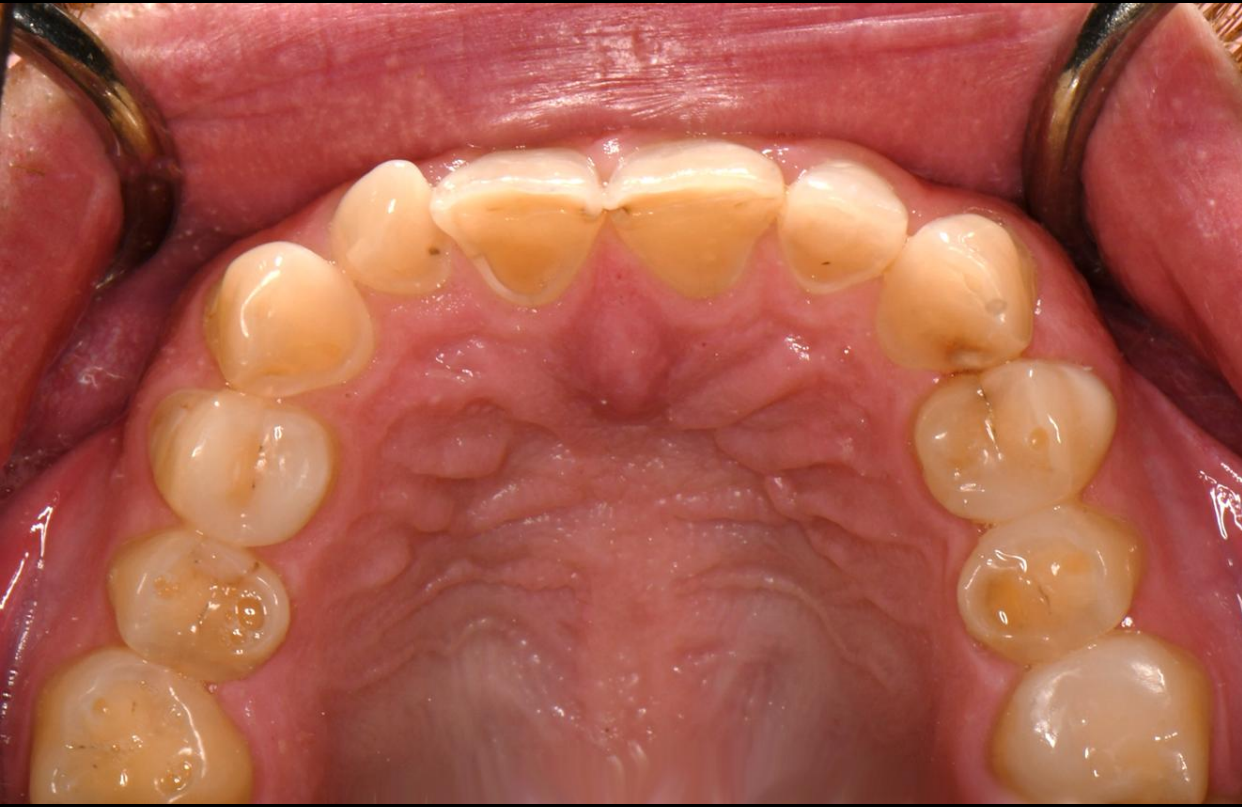












Day of treatment:  
About 4 hours



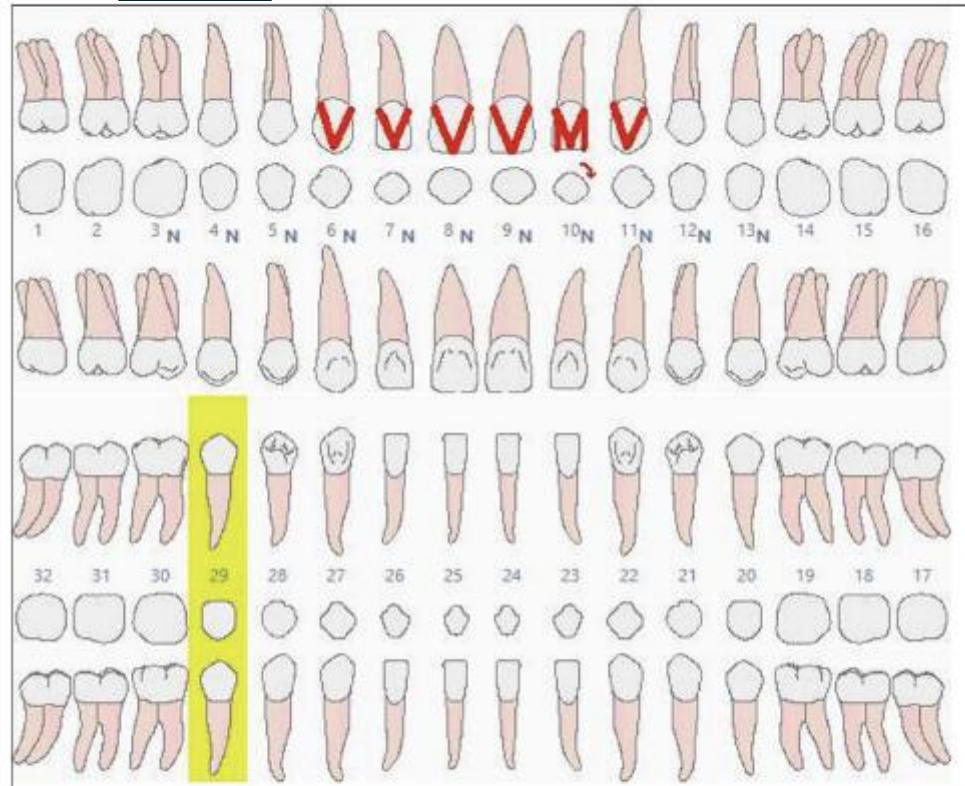
1-week  
post-op

Patient Chart

Patient Name



Patient ID



Date	Description	Provider	Tit	Surf	Status	Fee
1/15/2026	2993A - BIOCLEAR 360 REJUVENATION COMPLEX	David J. Clark, D.D.S.	6		Proposed	\$1,840.00
1/15/2026	2993A - BIOCLEAR 360 REJUVENATION COMPLEX	David J. Clark, D.D.S.	7		Proposed	\$1,840.00
1/15/2026	2993A - BIOCLEAR 360 REJUVENATION COMPLEX	David J. Clark, D.D.S.	8		Proposed	\$1,840.00
1/15/2026	2993A - BIOCLEAR 360 REJUVENATION COMPLEX	David J. Clark, D.D.S.	9		Proposed	\$1,840.00
1/15/2026	2993A - BIOCLEAR 360 REJUVENATION COMPLEX	David J. Clark, D.D.S.	10		Proposed	\$1,840.00
1/15/2026	2993A - BIOCLEAR 360 REJUVENATION COMPLEX	David J. Clark, D.D.S.	11		Proposed	\$1,840.00
1/15/2026	199.2 - BIOCLEAR ORTHO CORRECTION PER TOOTH	David J. Clark, D.D.S.	10		Proposed	\$306.00
1/15/2026	299.5 - BIOCLEAR DIASTEMA CLOSURE	David J. Clark, D.D.S.	10	MD	Proposed	\$285.00



# Total Bioclear Case Fee?

# \$11,631

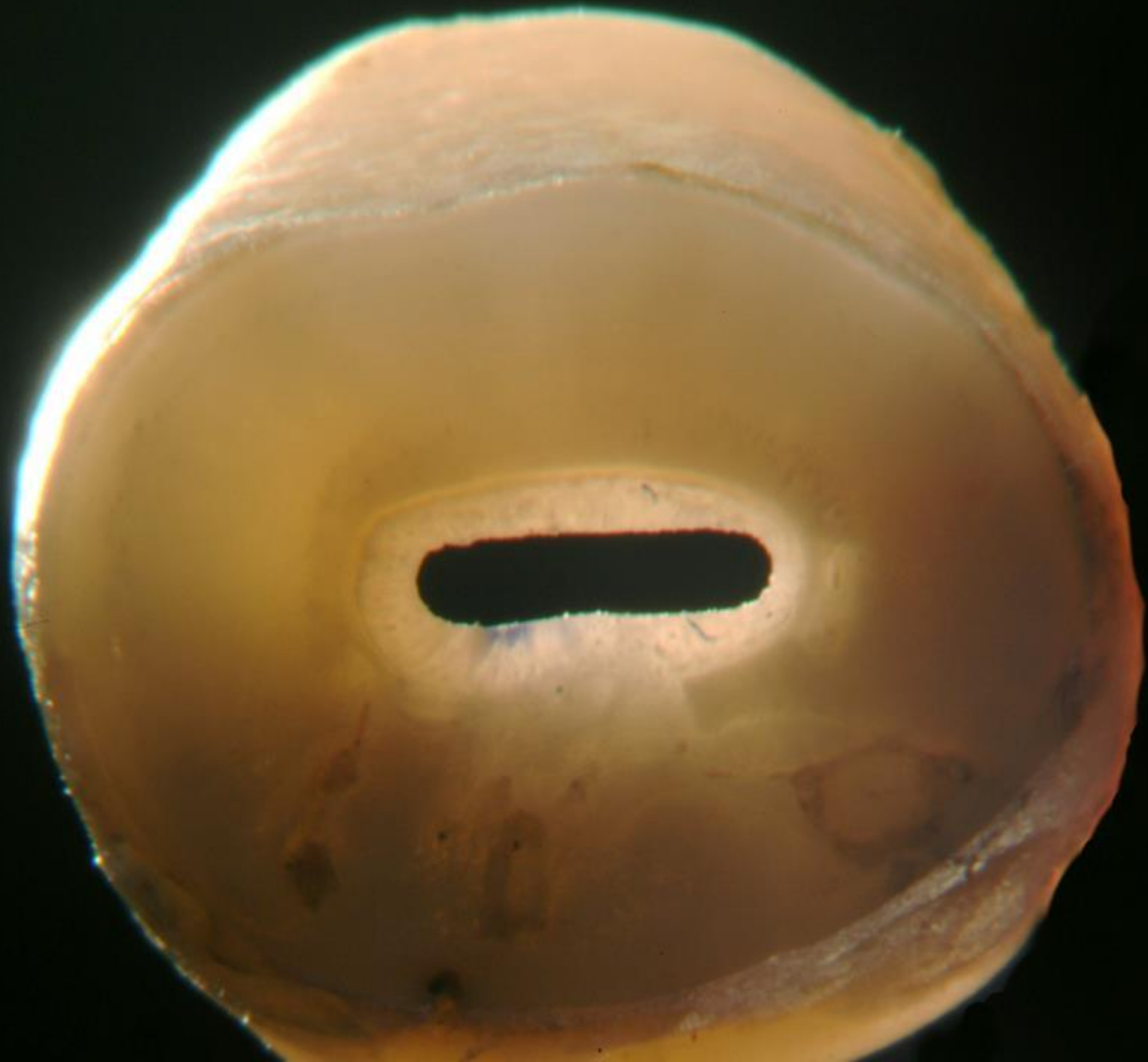


**ONE OF THE ENDURING  
FIRST IMPRESSIONS OF  
CLINICAL MICROSCOPE  
DENTISTRY IS THE  
STAGGERING ARRAY OF  
CRACKS THAT ARE  
SUDDENLY VISIBLE**

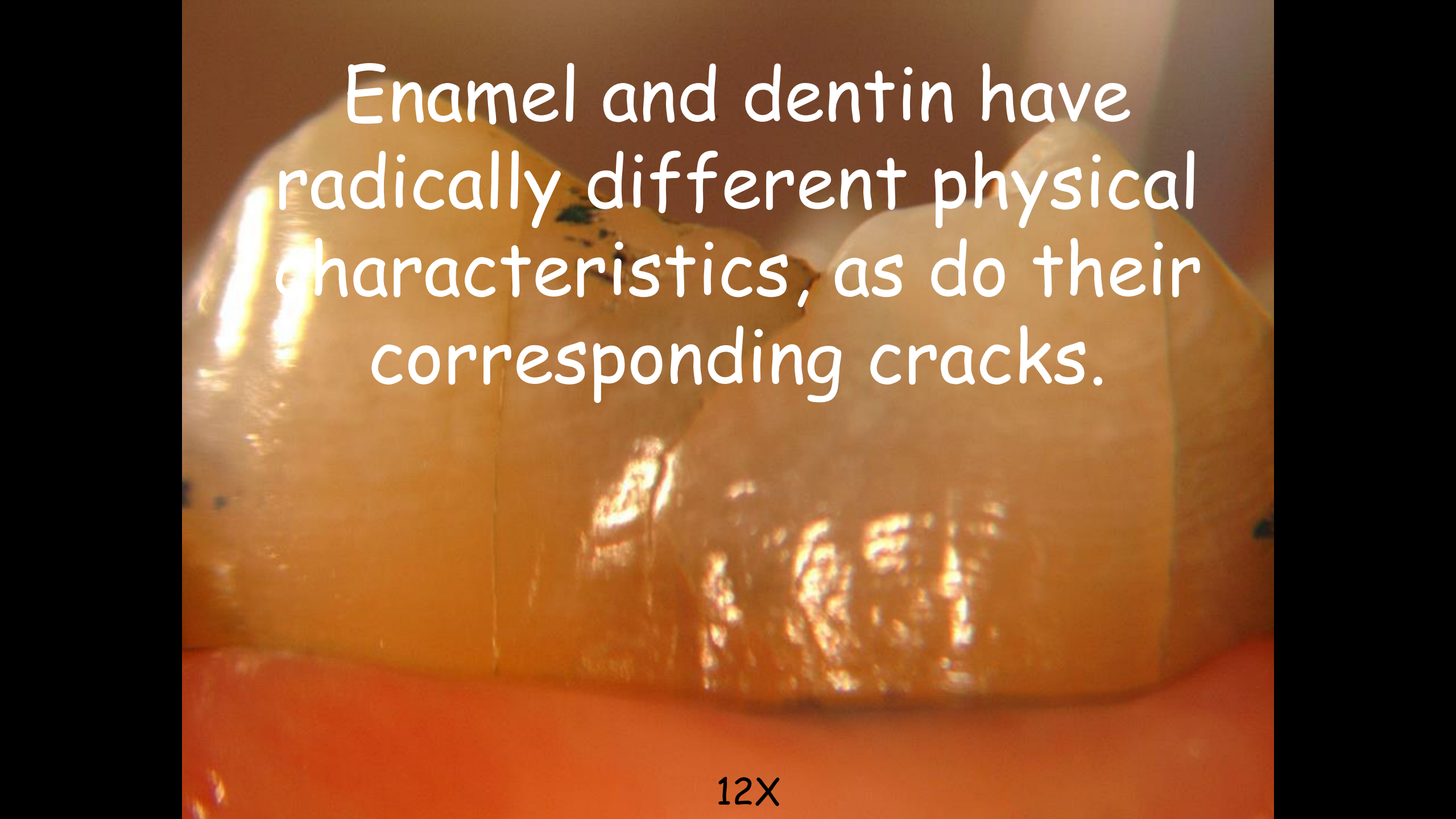
Clark, D.J., Paquette J., Sheets C., *Journal of Esthetic and Restorative  
Dentistry; Special Edition, 2004*

Nature does  
nothing  
uselessly.

Aristotle 322 BC

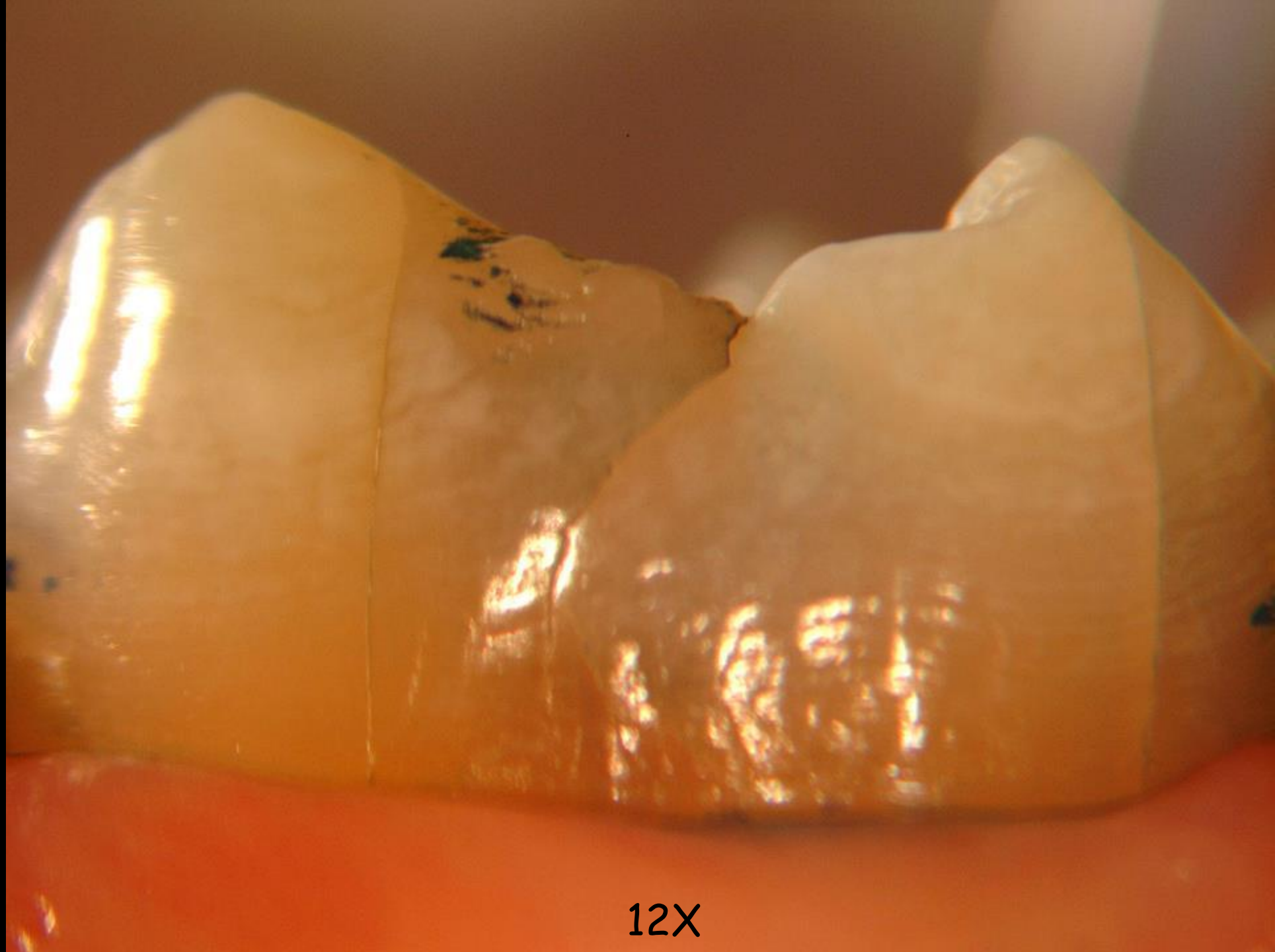


Enamel and dentin have radically different physical characteristics, as do their corresponding cracks.

A microscopic image 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. There are several cracks visible in the enamel, and the text indicates that these cracks correspond to the physical characteristics of the enamel and dentin.

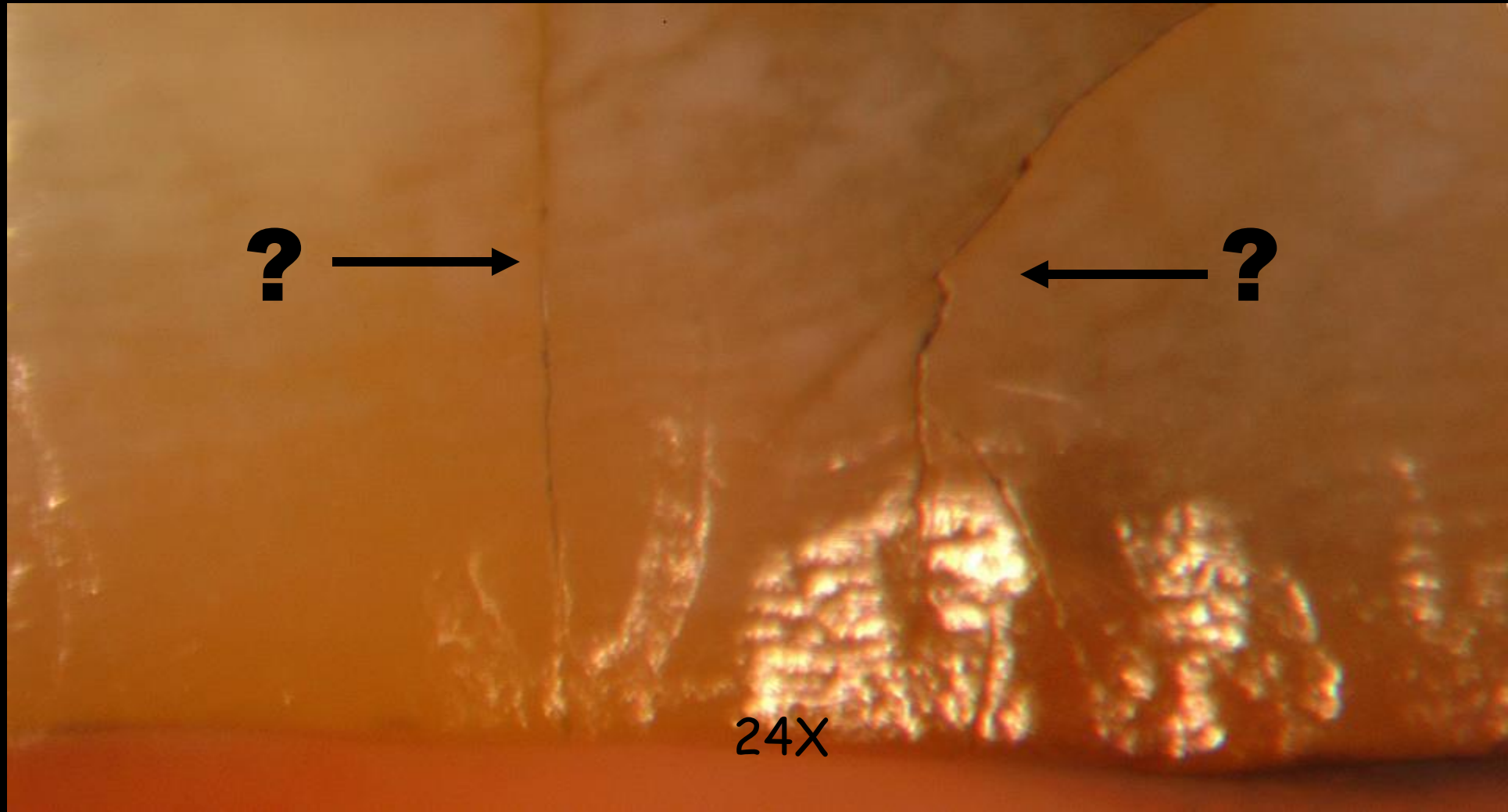
Enamel and dentin have radically different physical characteristics, as do their corresponding cracks.

12X



12X

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







# JOURNAL OF ESTHETIC AND RESTORATIVE DENTISTRY

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Japan Academy of Esthetic Dentistry, International Federation of Esthetic Dentistry,  
American Academy of Cosmetic and Adhesive Dentistry,  
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, DDS,  
JACQUELINE B. QUINN, DDS

### ABSTRACT

The diagnosis of cracked tooth and incomplete coronal fracture have historically been symptomatic. The dental operating microscope at 40× 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 dentists who lack an appropriate treatment plan or symptoms or deterioration in tooth structure occur. Generally, many cracks are not structural and can locate microleakage and overextension. Methodologic microscopic examination, 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 subjective and range of crack descriptions.

### CLINICAL SIGNIFICANCE

This article gives new guidelines for recognition, classification, and treatment of cracked teeth based on the routine use of 40× magnification. The significance of enamel cracks is they where no critical cracks is detailed.

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

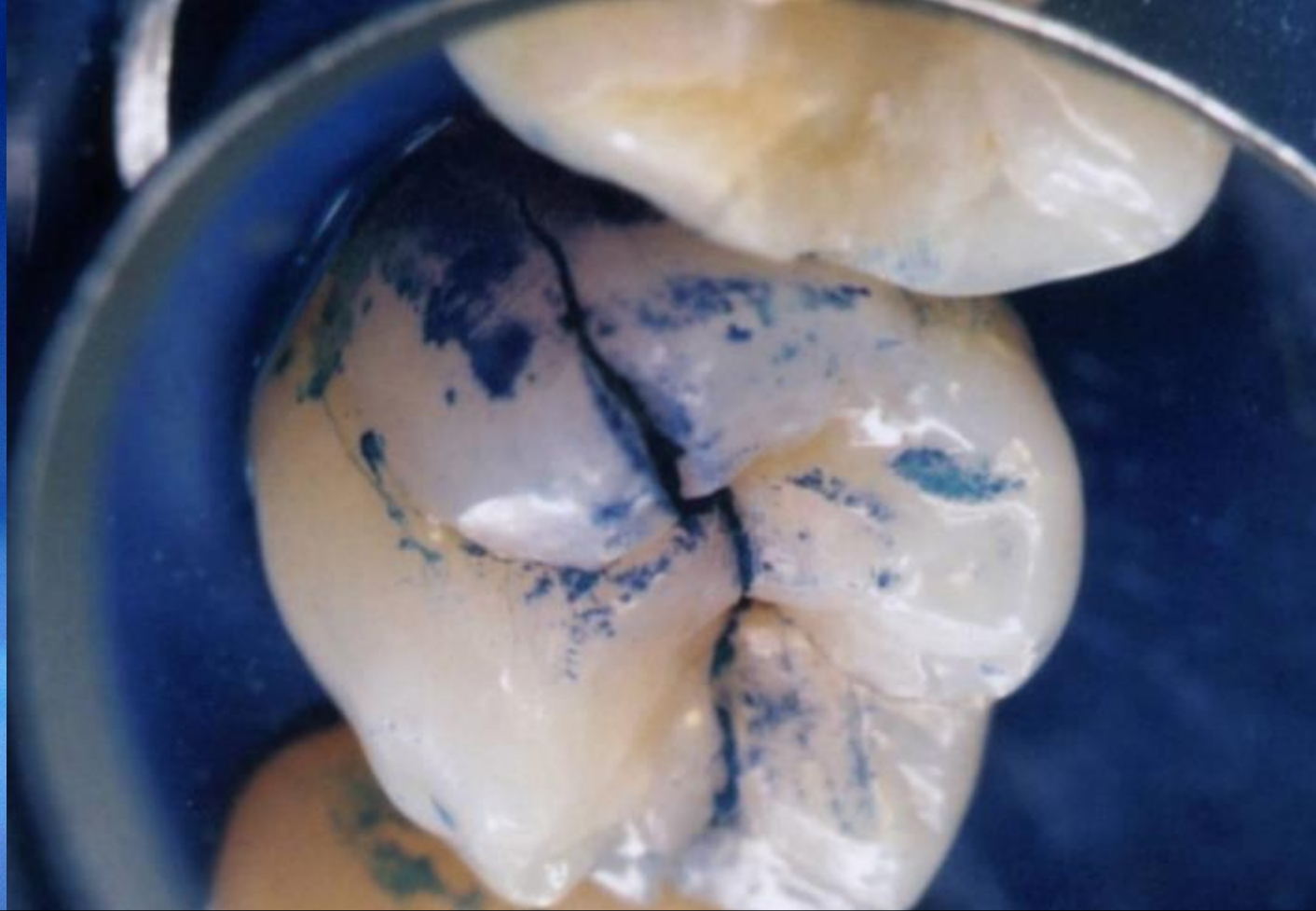
**M**icroscopic and symptomatic diagnoses have been the accepted modalities for cracked teeth. The inherent limitations of the lack of visual confirmation result in therapies that often come out late in the treatment process. One limiting factor, irrespective of vision through a clinical microscope is 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 (40× 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 discussing trauma, pulp involvement, and periodontal involvement 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.

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

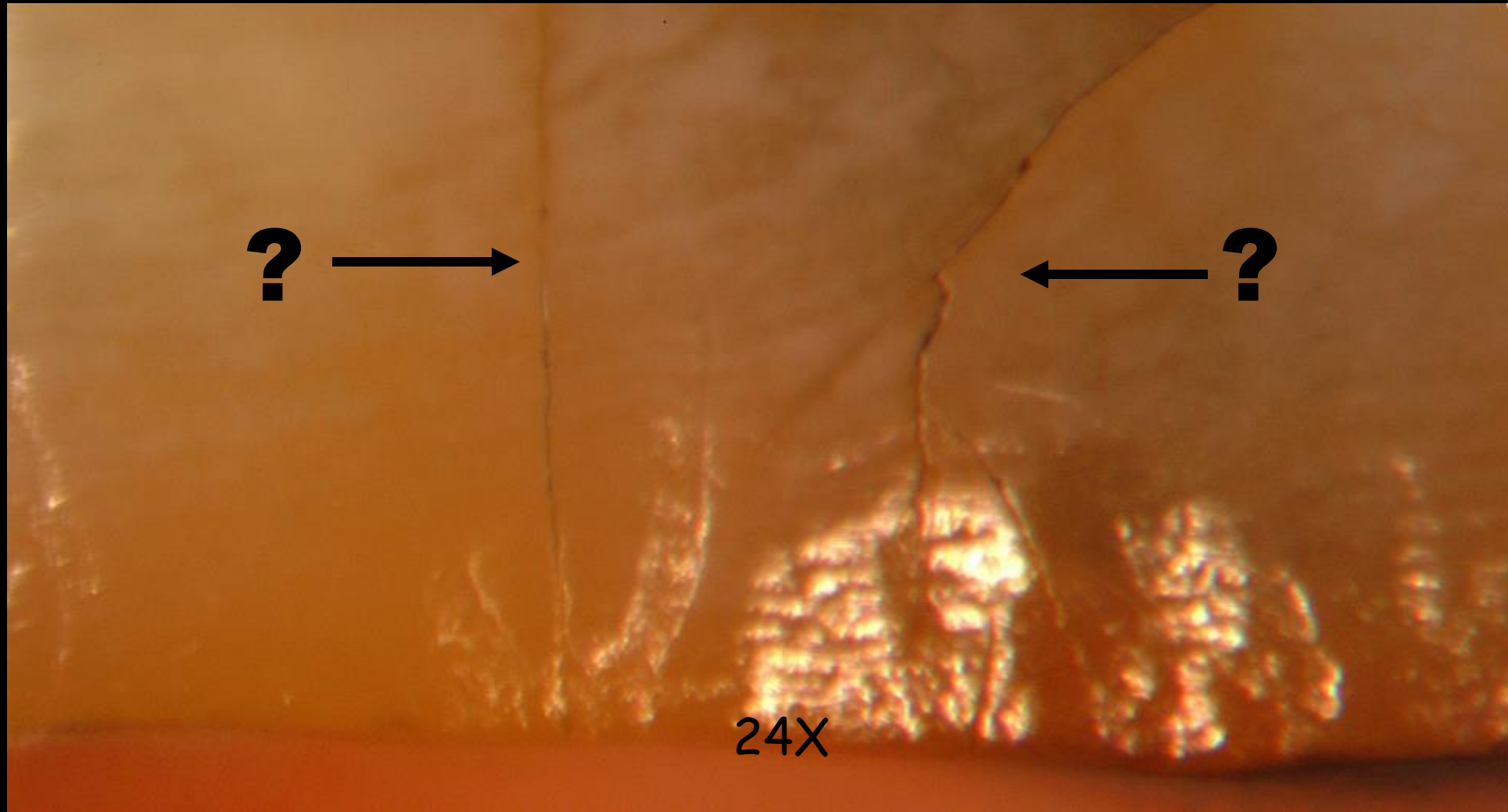
# Endstage Oblique Fracture Cuspal Fracture

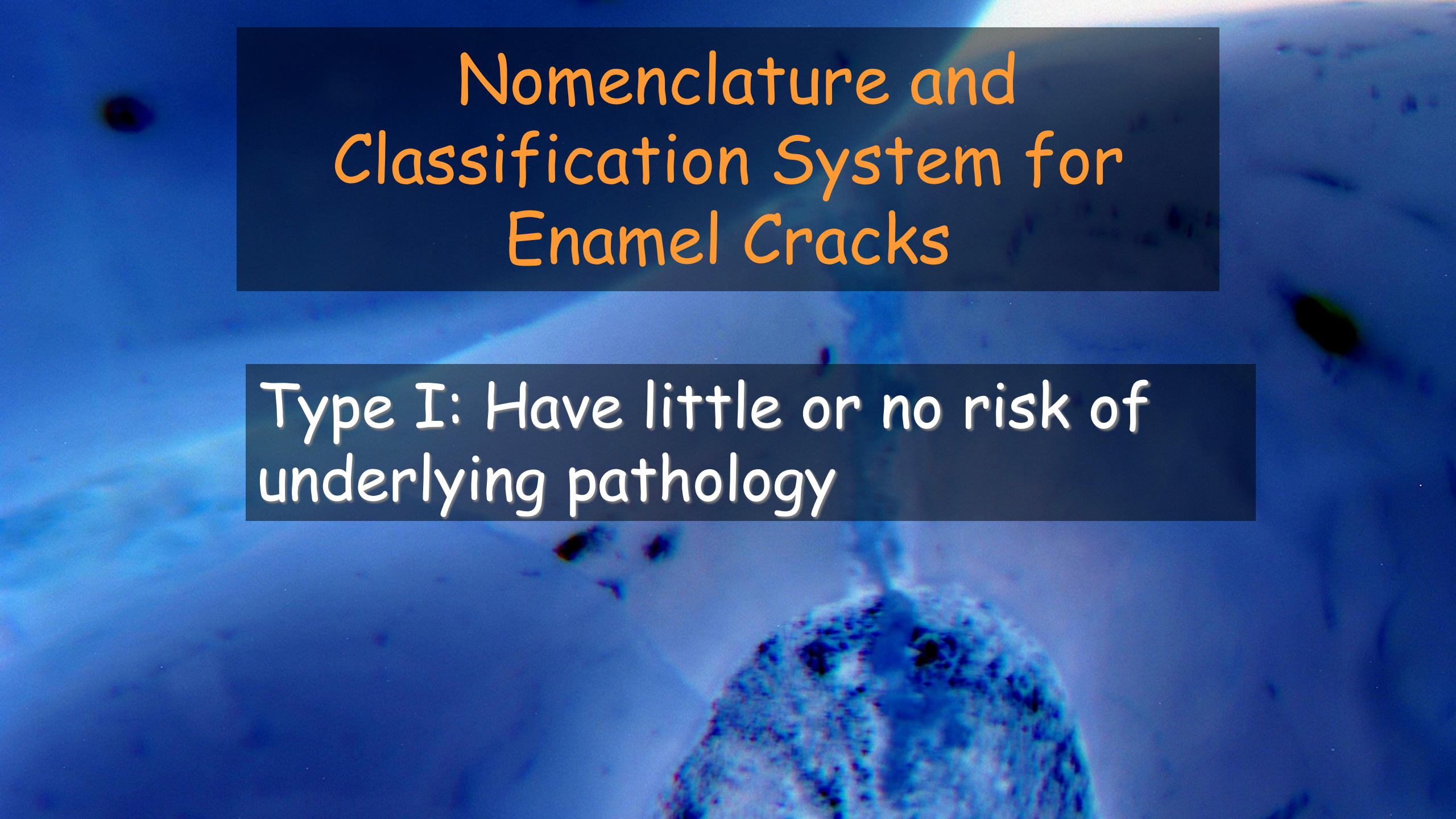


Enamel and dentin have radically different physical characteristics, as do their corresponding cracks.

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

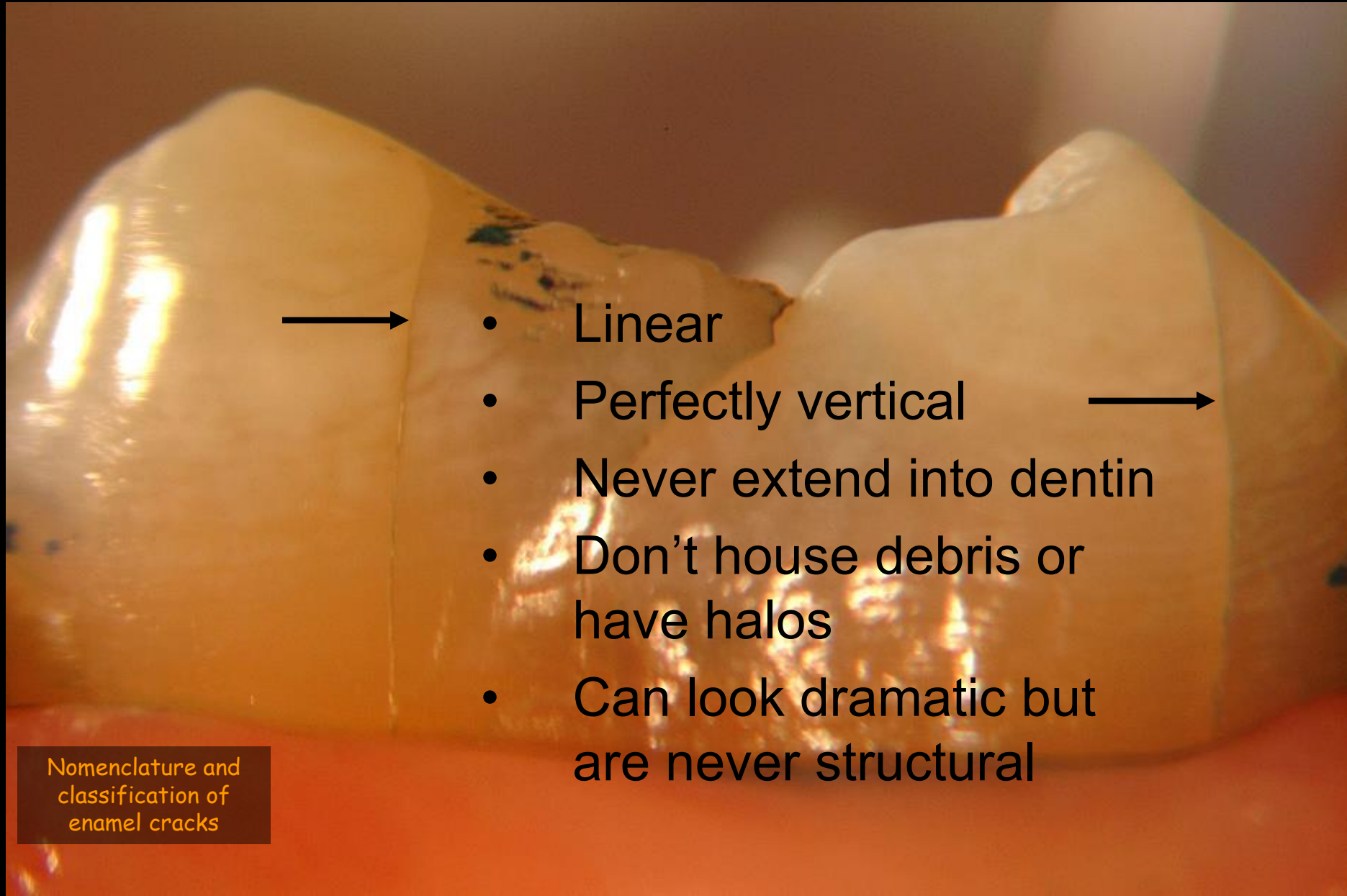
Type I: Have little or no risk of underlying pathology

- 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

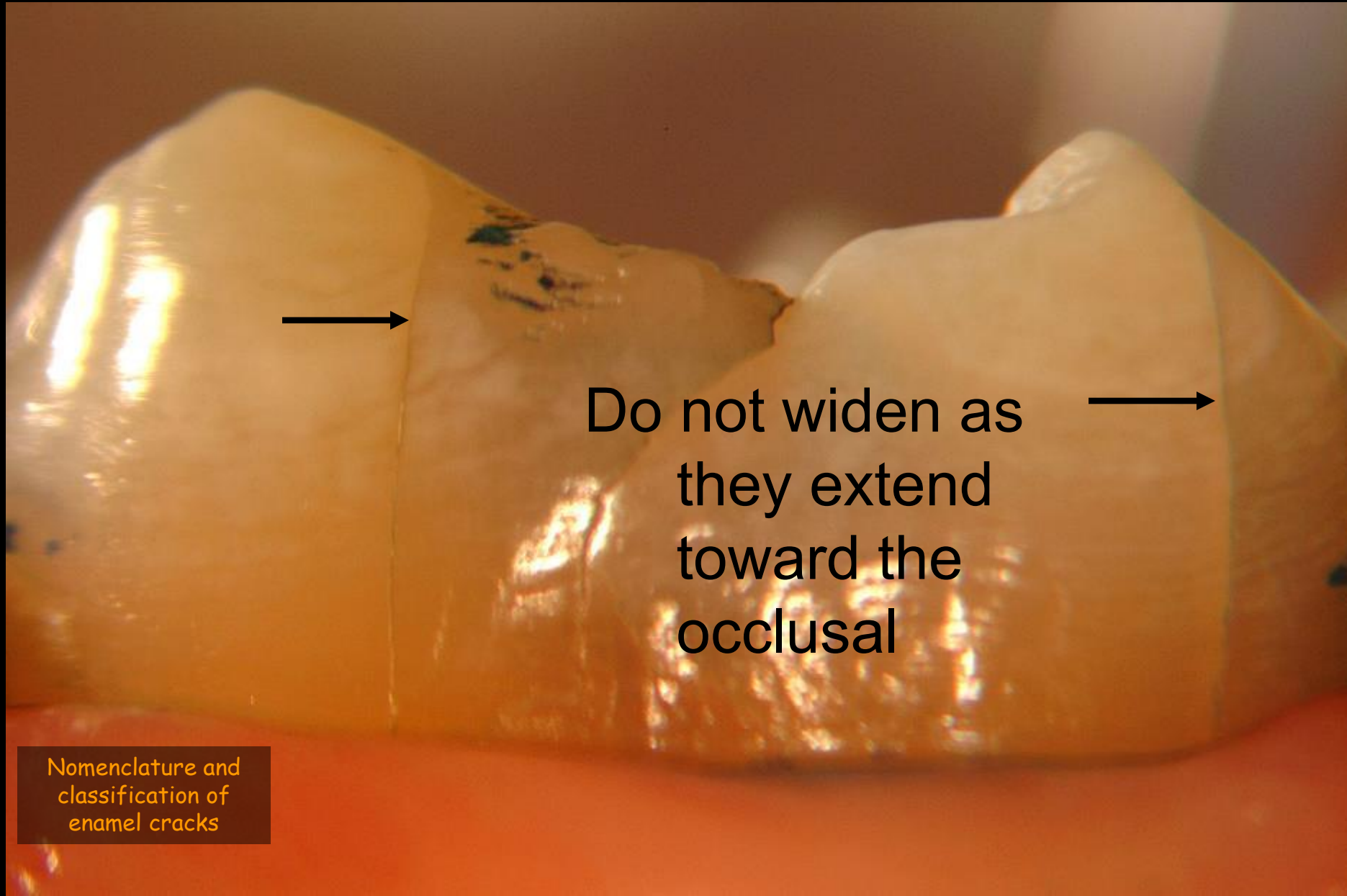
# Craze Lines



- 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

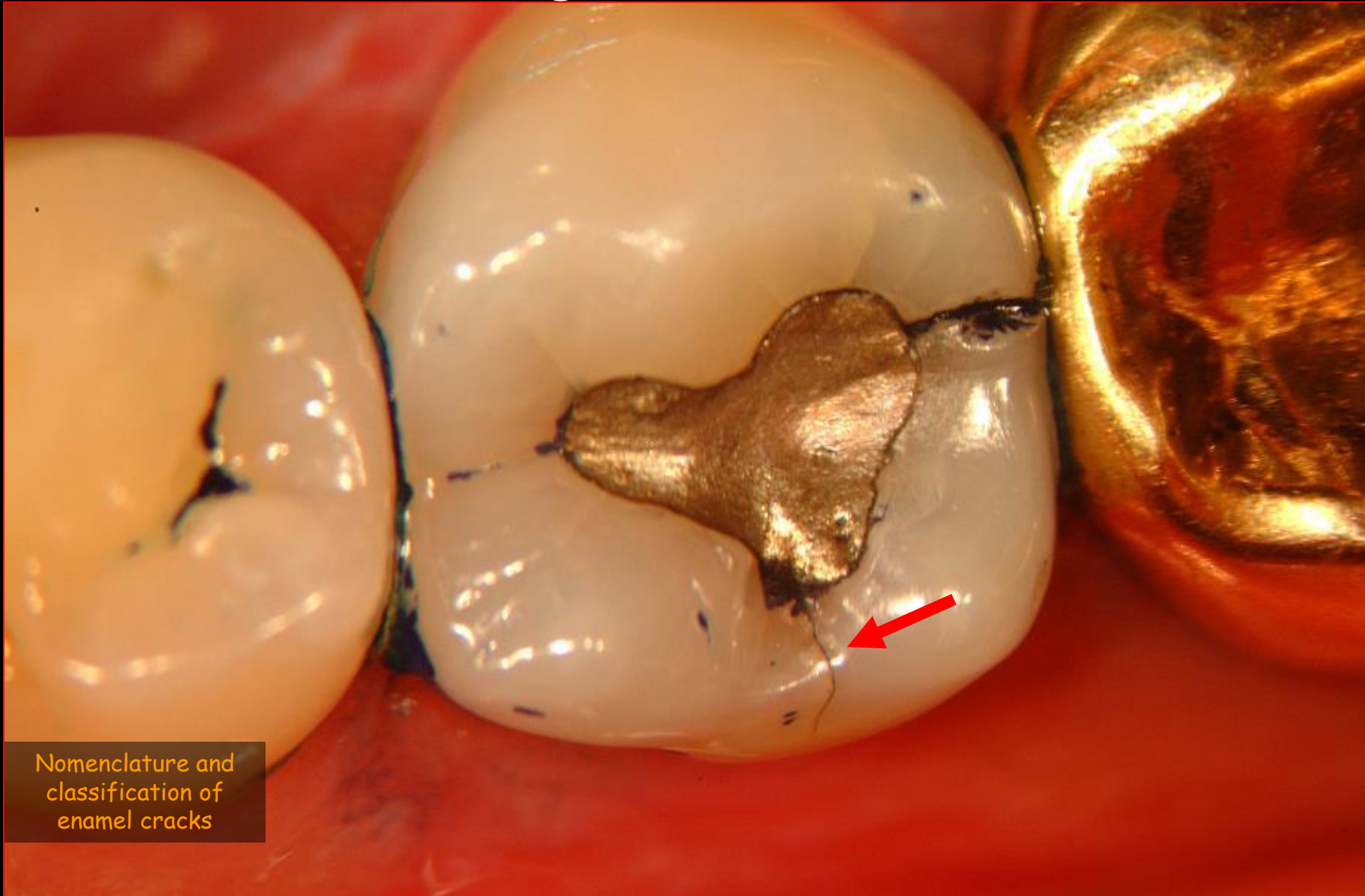
# Craze Lines



Do not widen as  
they extend  
toward the  
occlusal

Nomenclature and  
classification of  
enamel cracks

# C. Cracks that follow anatomic grooves

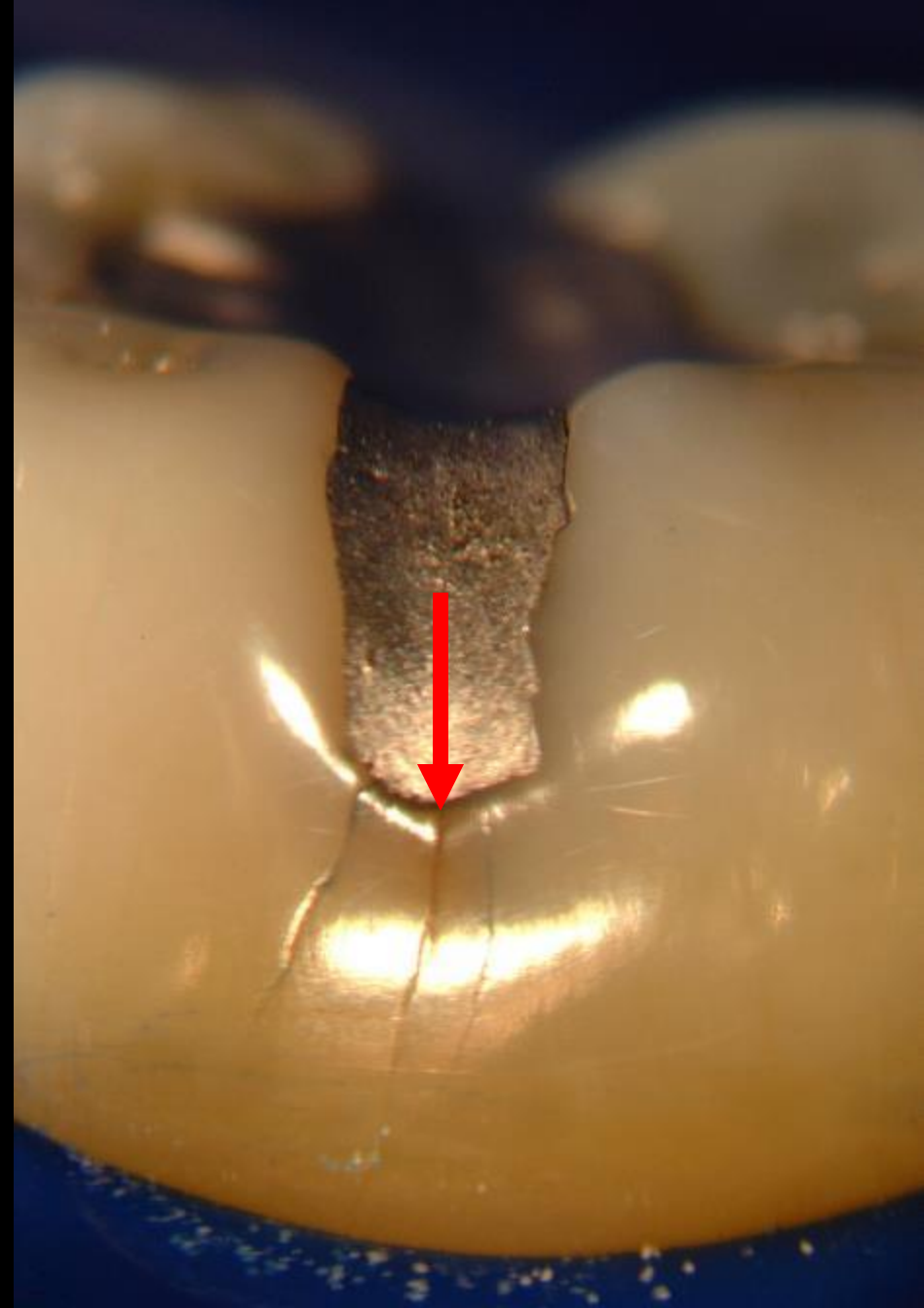


Nomenclature and  
classification of  
enamel cracks

C. Cracks that follow natural anatomic grooves

D Superficially Stained Cracks

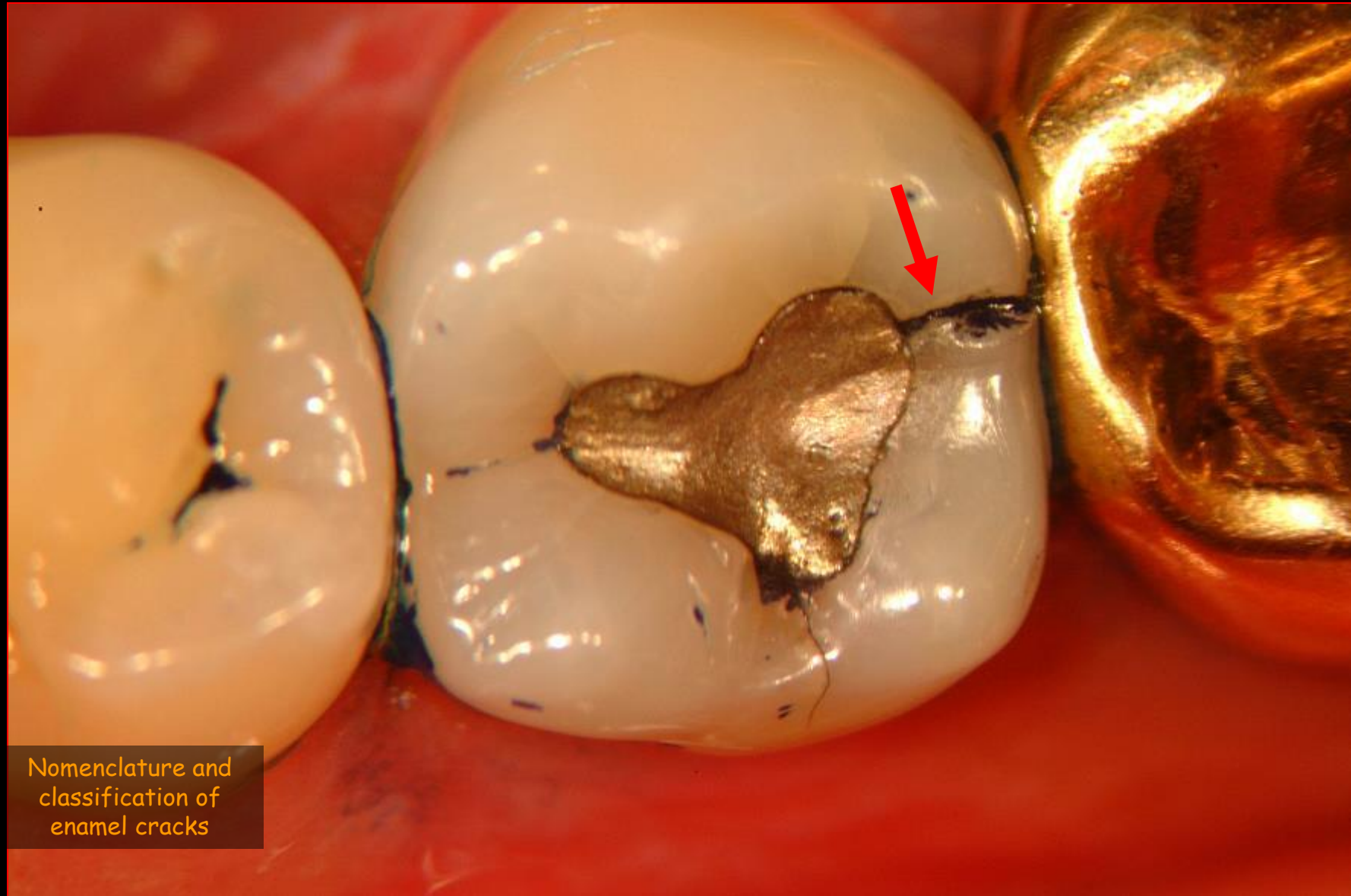
Nomenclature and  
classification of  
enamel cracks



## 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

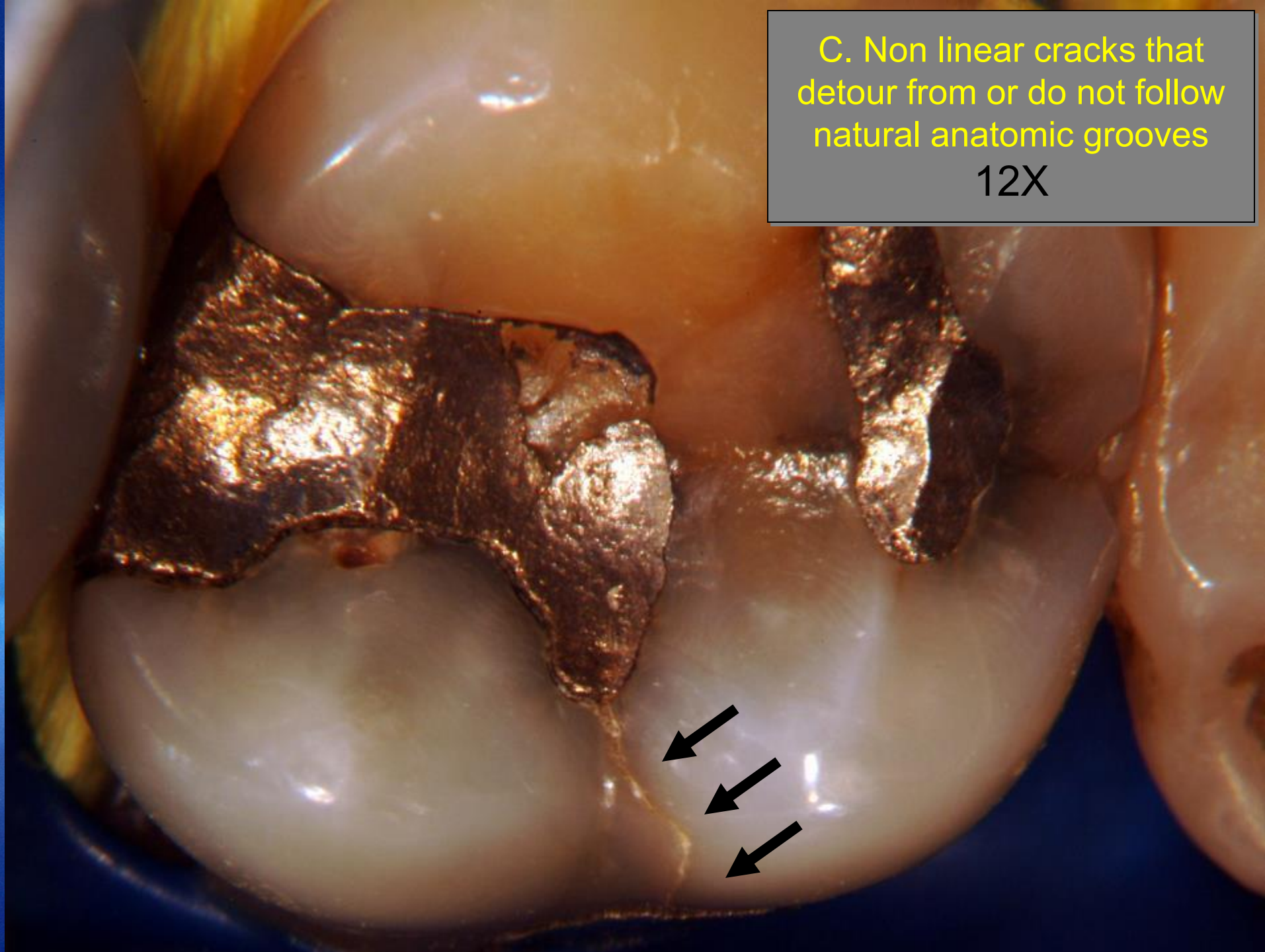
- A) V-shaped enamel ditching with or without an adjoining restoration often associated with a wear facet centered over an otherwise benign crack
- B) Cracks that detour from or do not follow natural anatomic grooves



8X

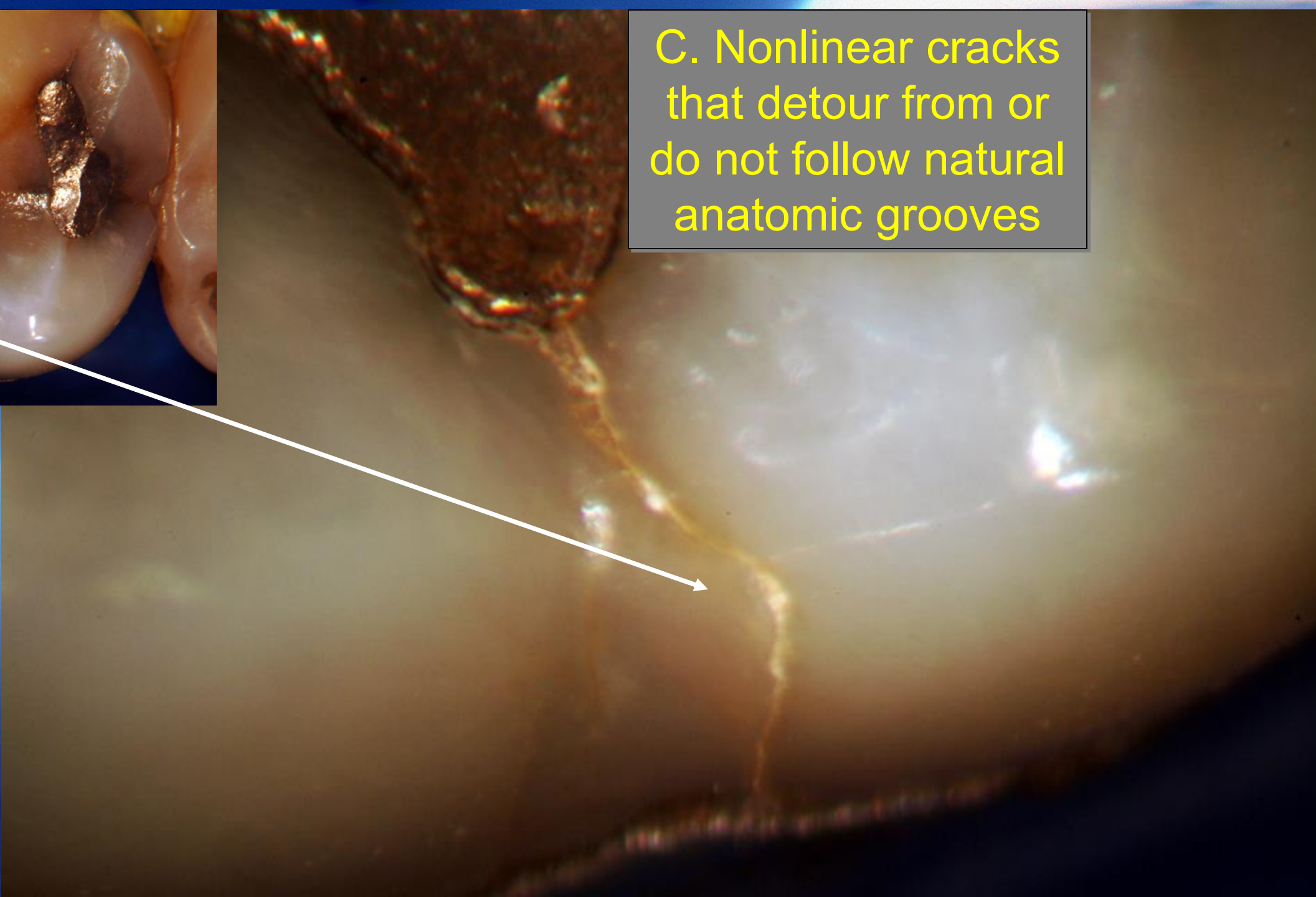
C. Non linear cracks that  
detour from or do not follow  
natural anatomic grooves

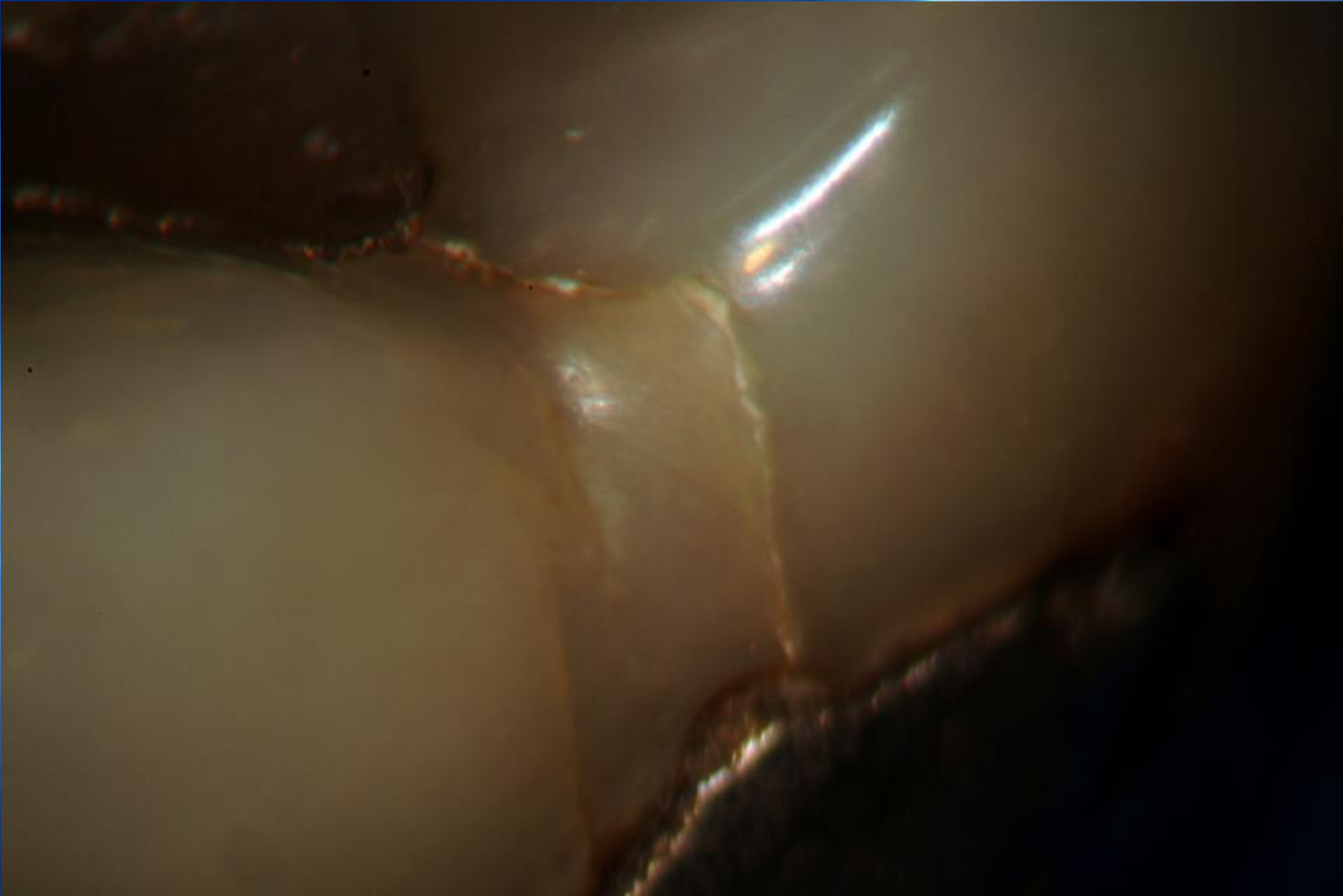
12X



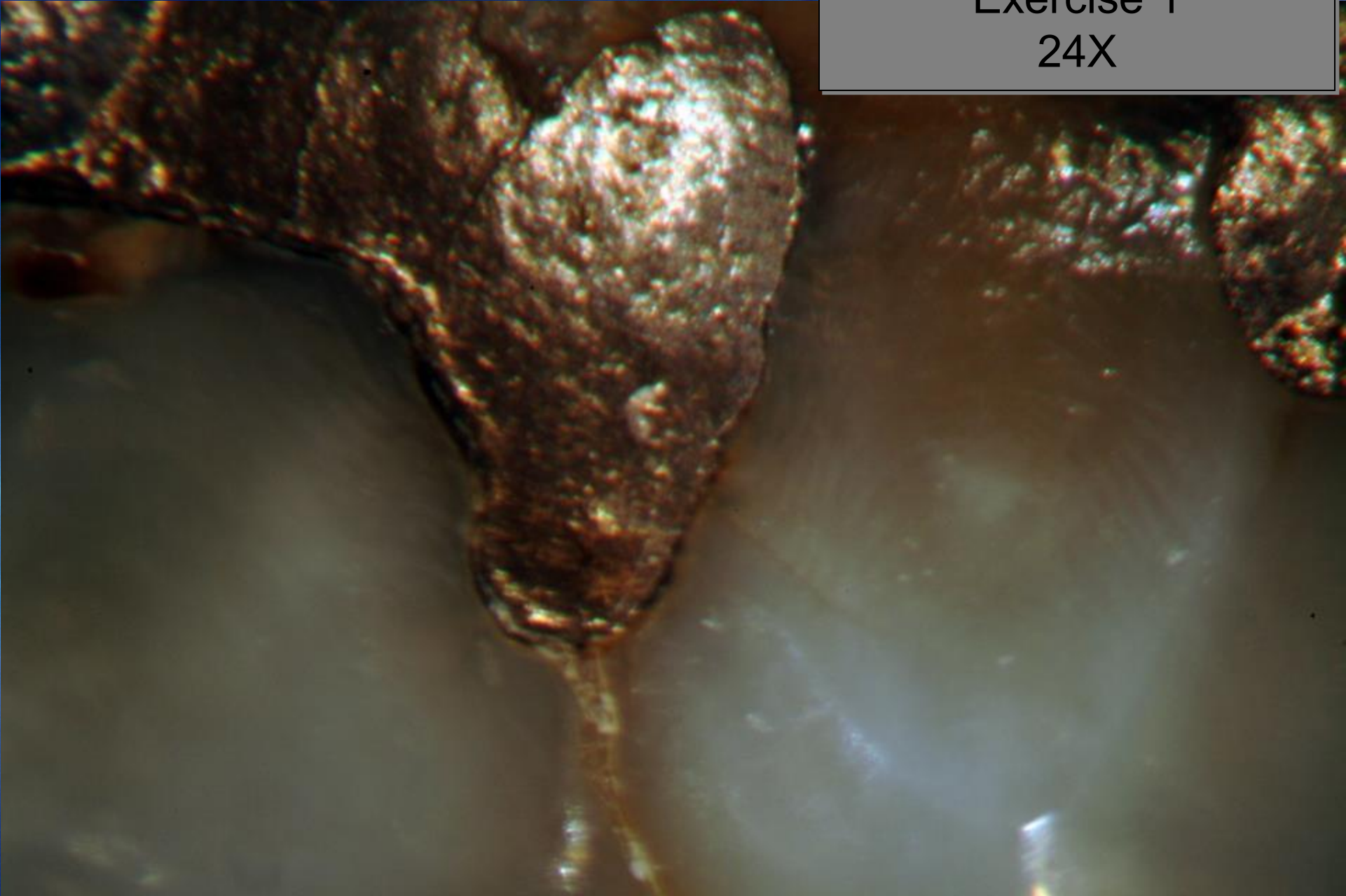


C. Nonlinear cracks that detour from or do not follow natural anatomic grooves

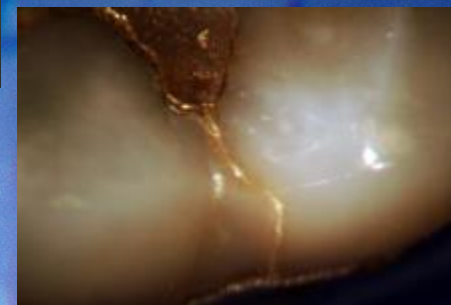
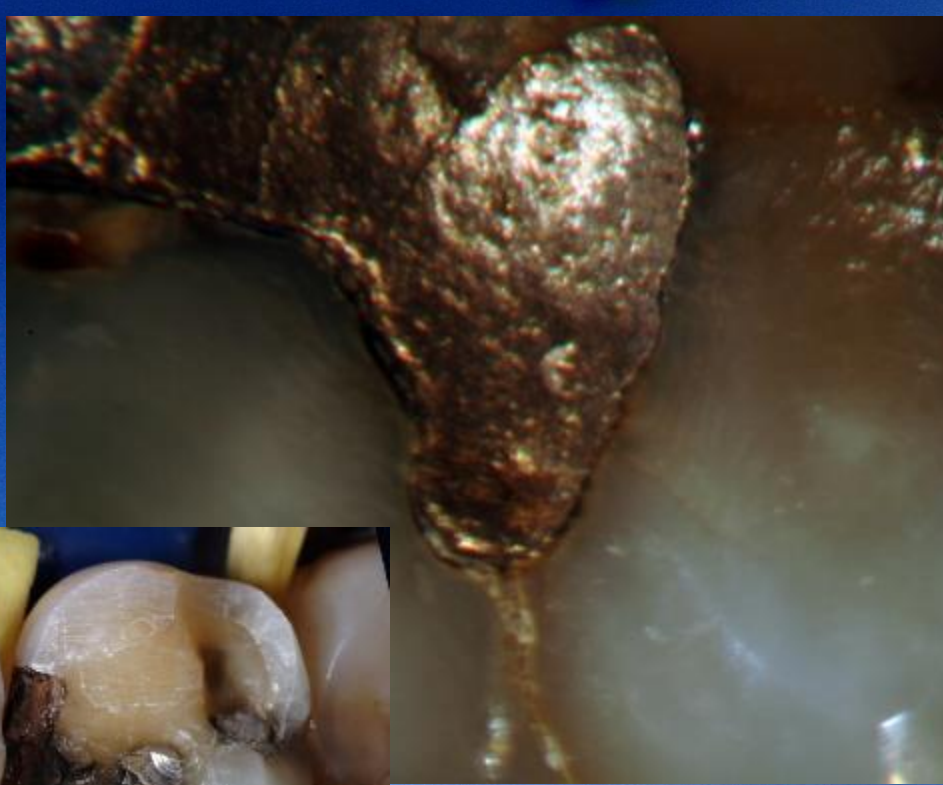




Exercise 1  
24X



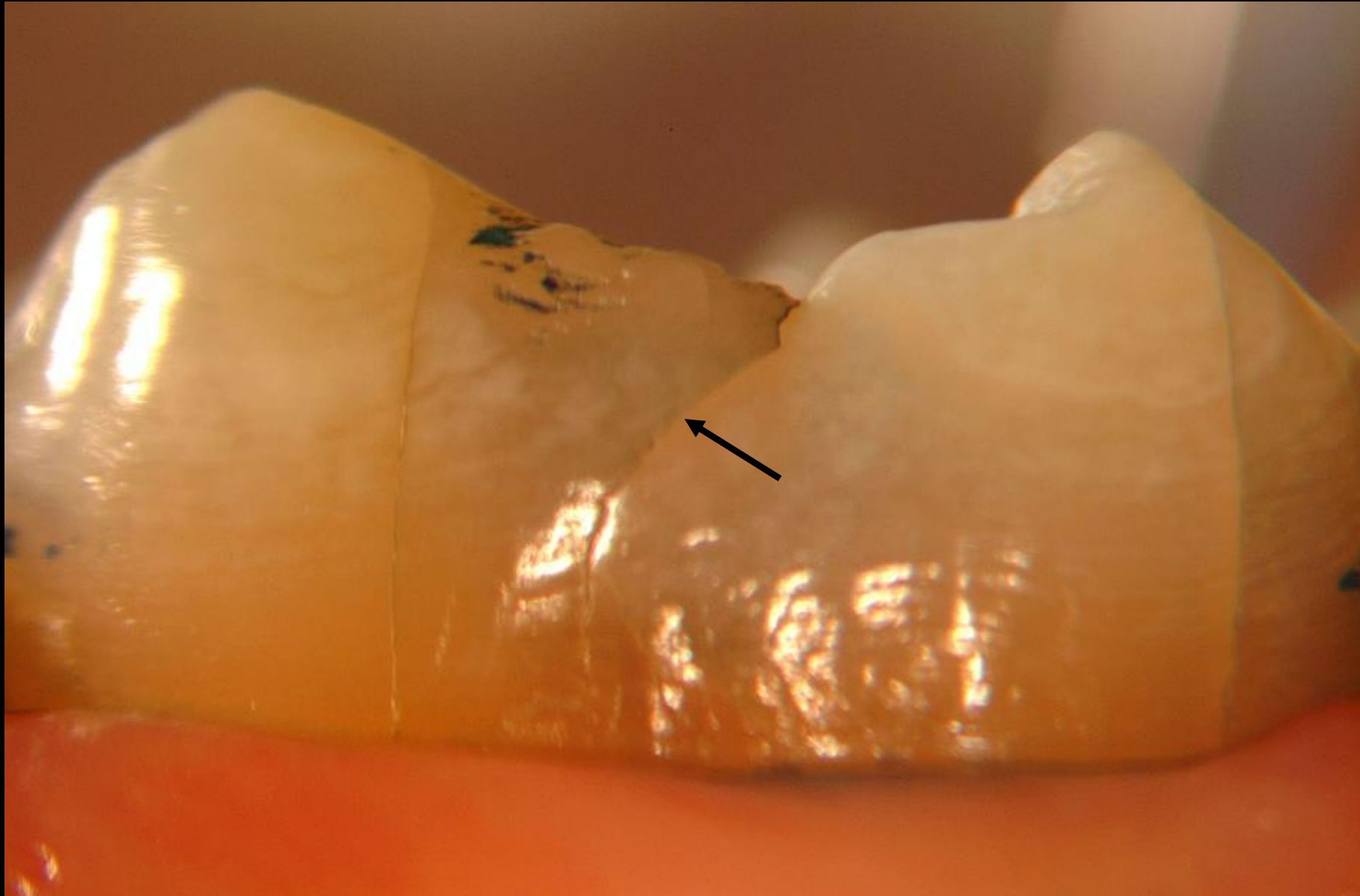




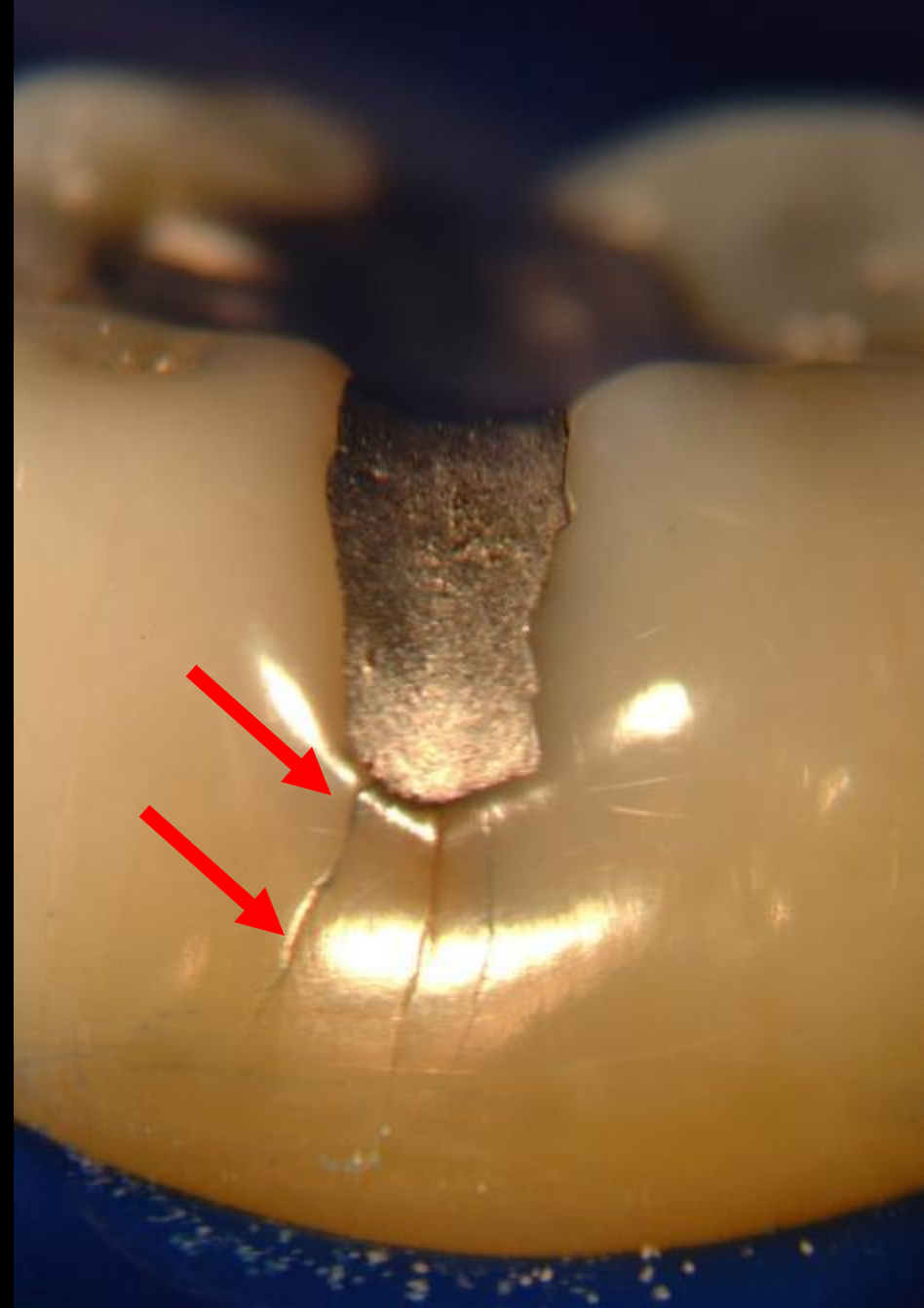
## Type III: Have high risk of underlying pathology

- 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**

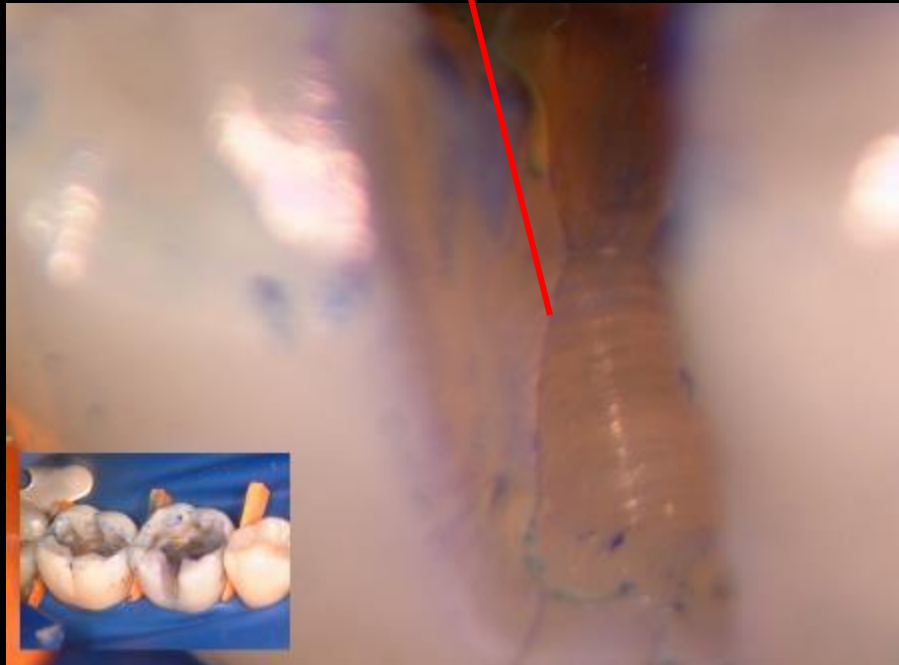
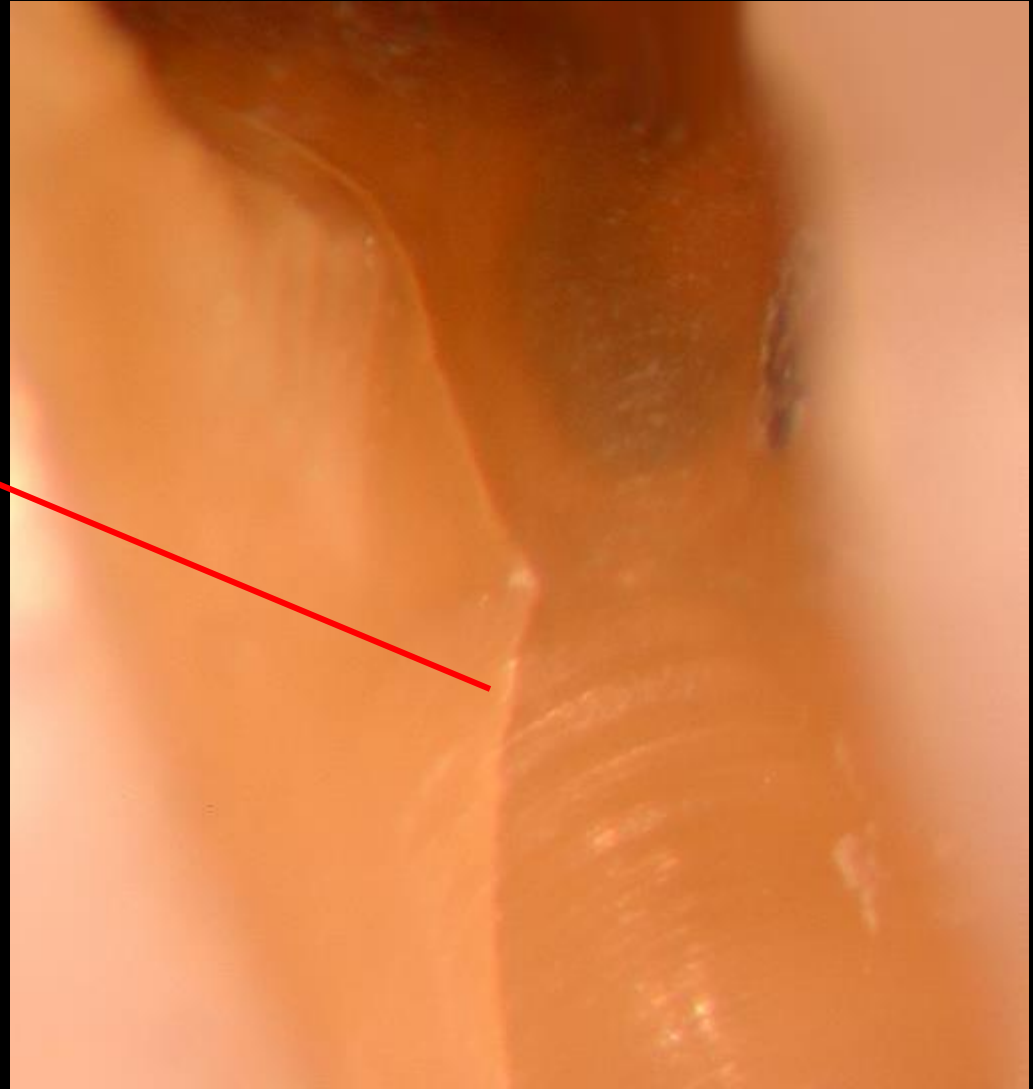
# A. Diagonal cracks



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

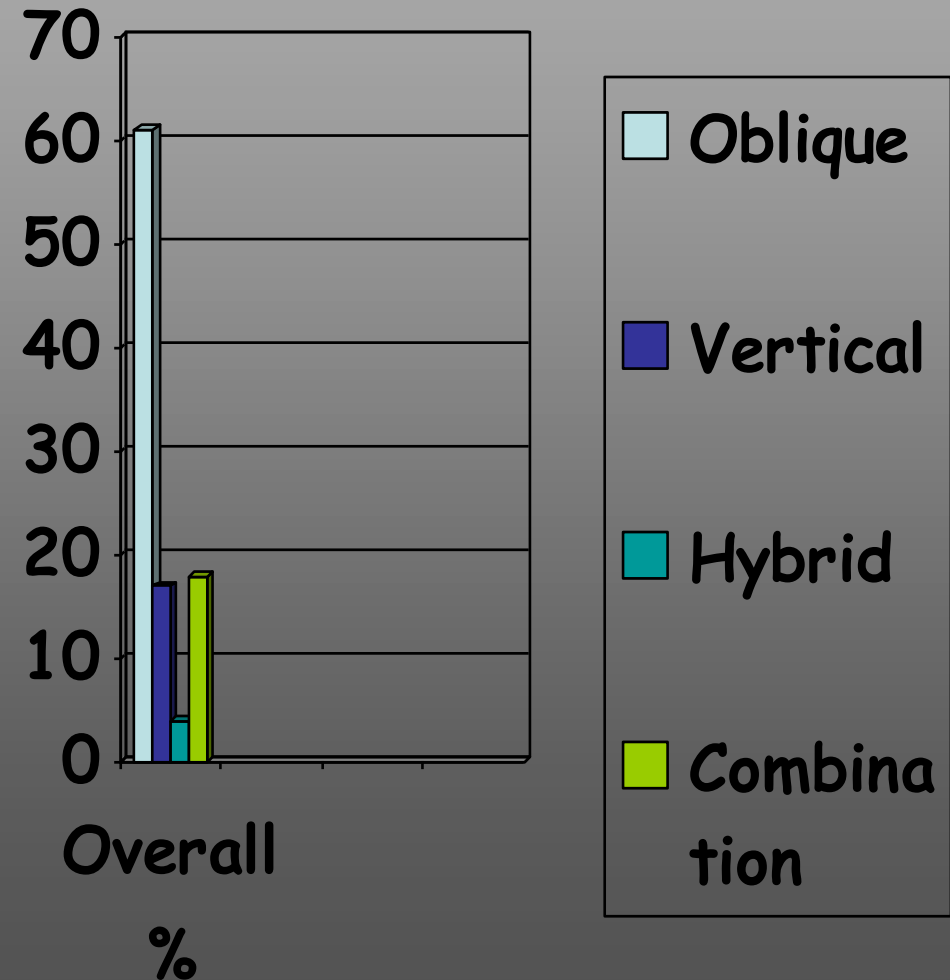


Nomenclature and  
classification of  
enamel cracks



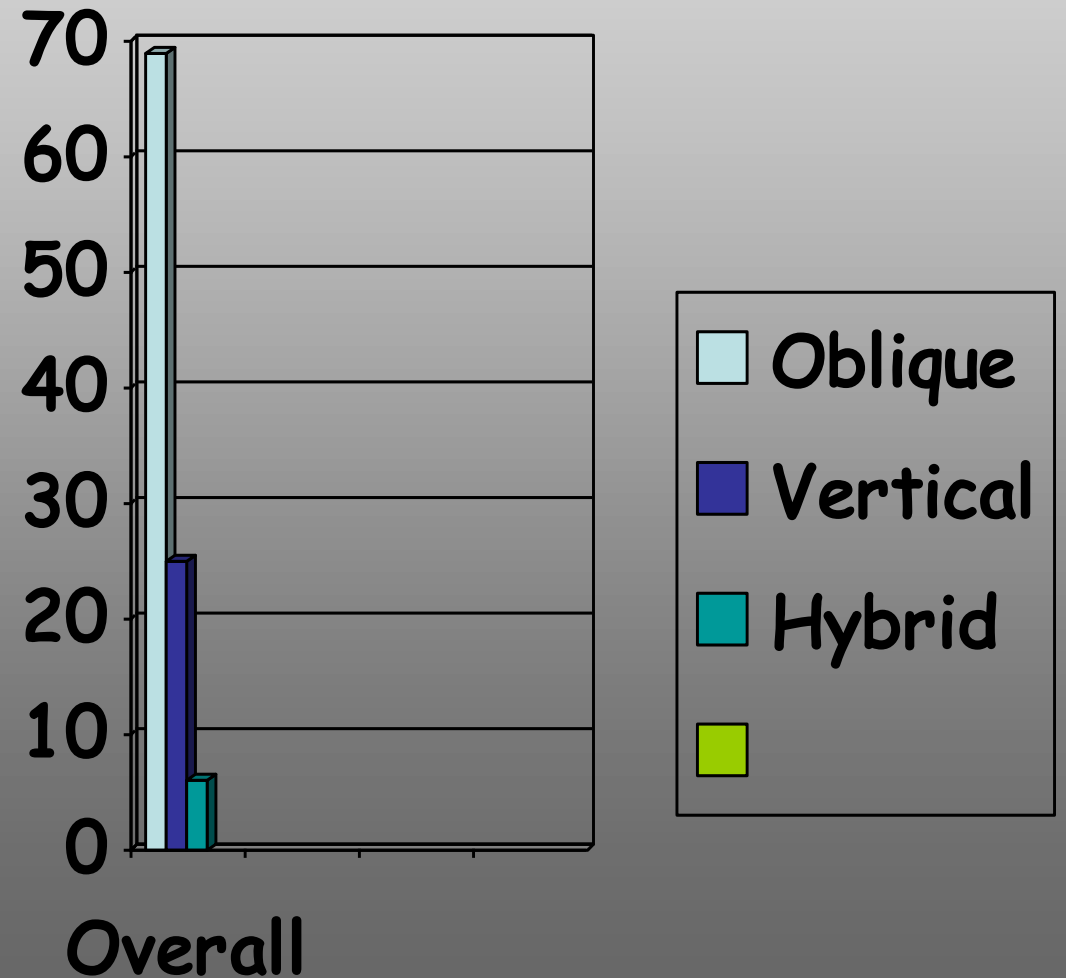
# A Two Year Study 2001-2003

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

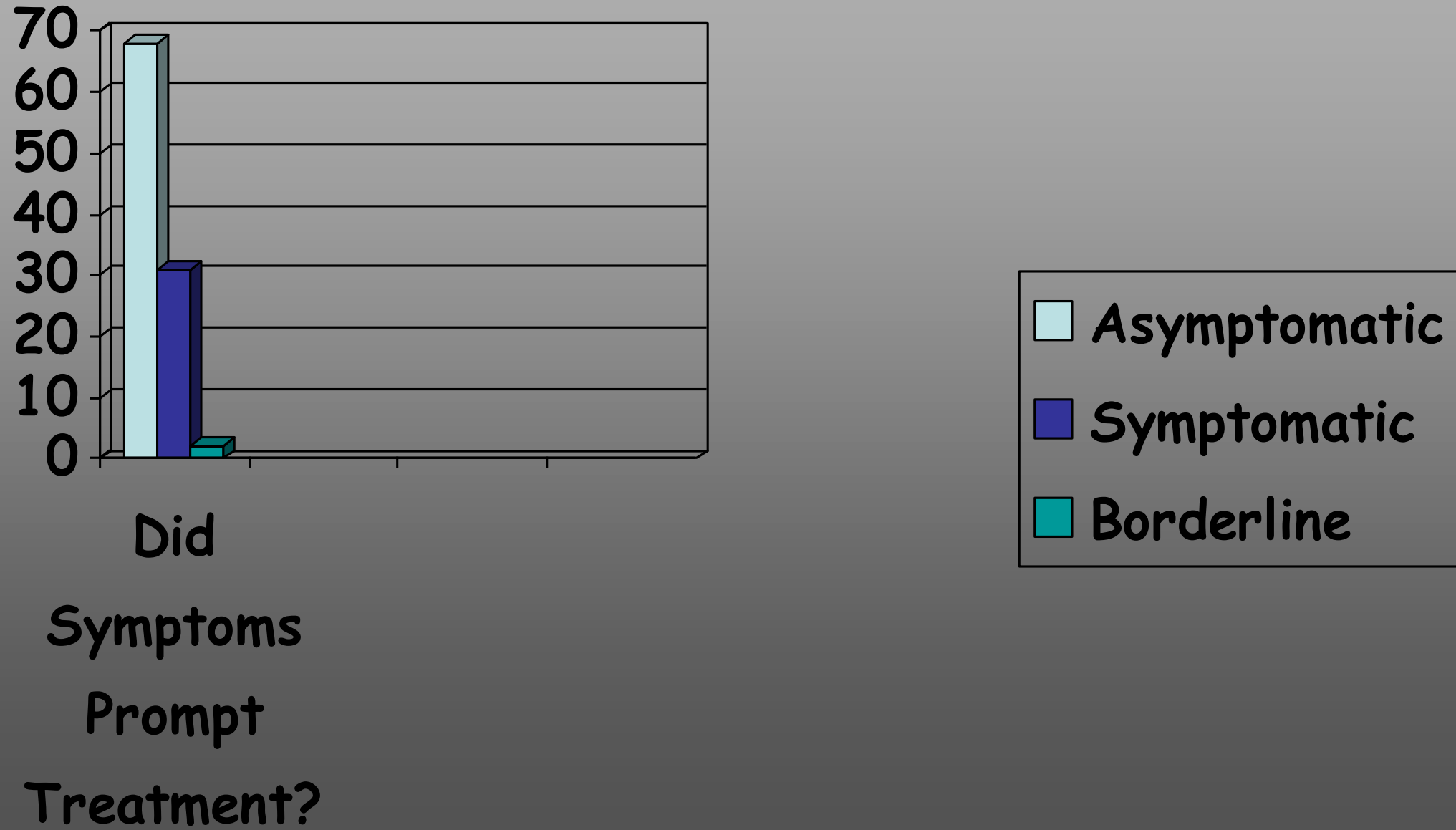


# A Two Year Study

- 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

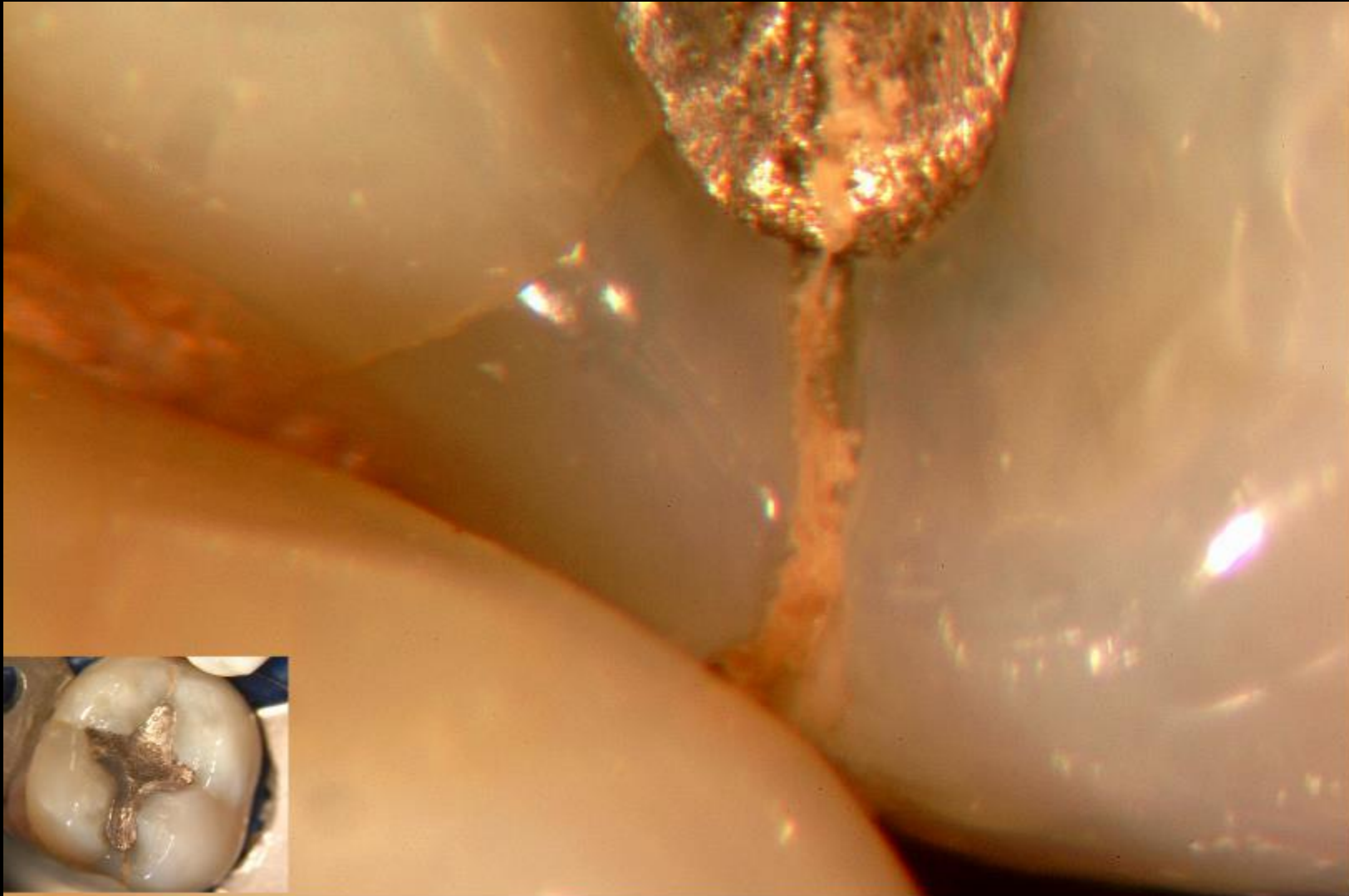


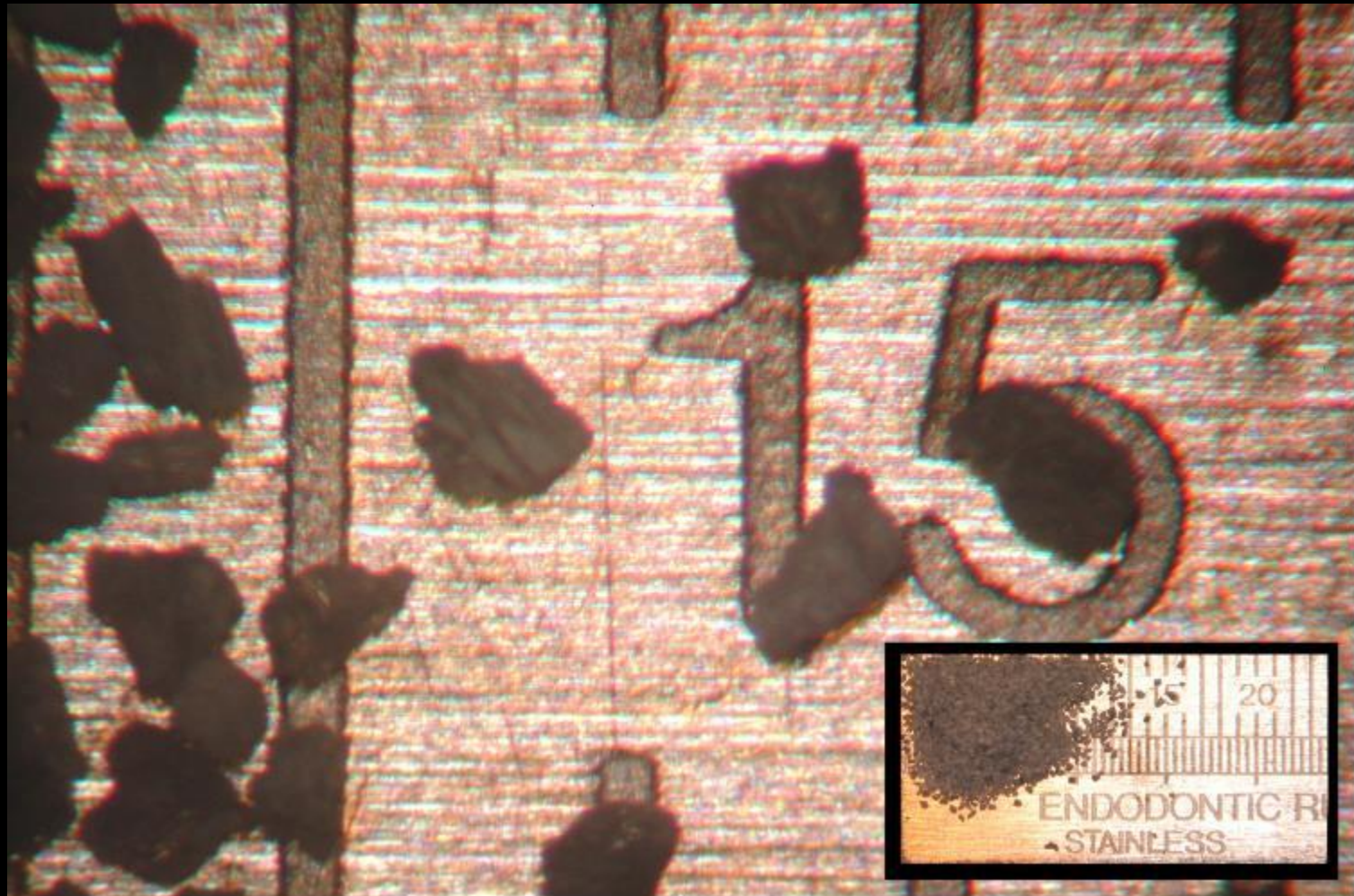
16X

## B. Horizontal cracks



## C. Crack that houses debris





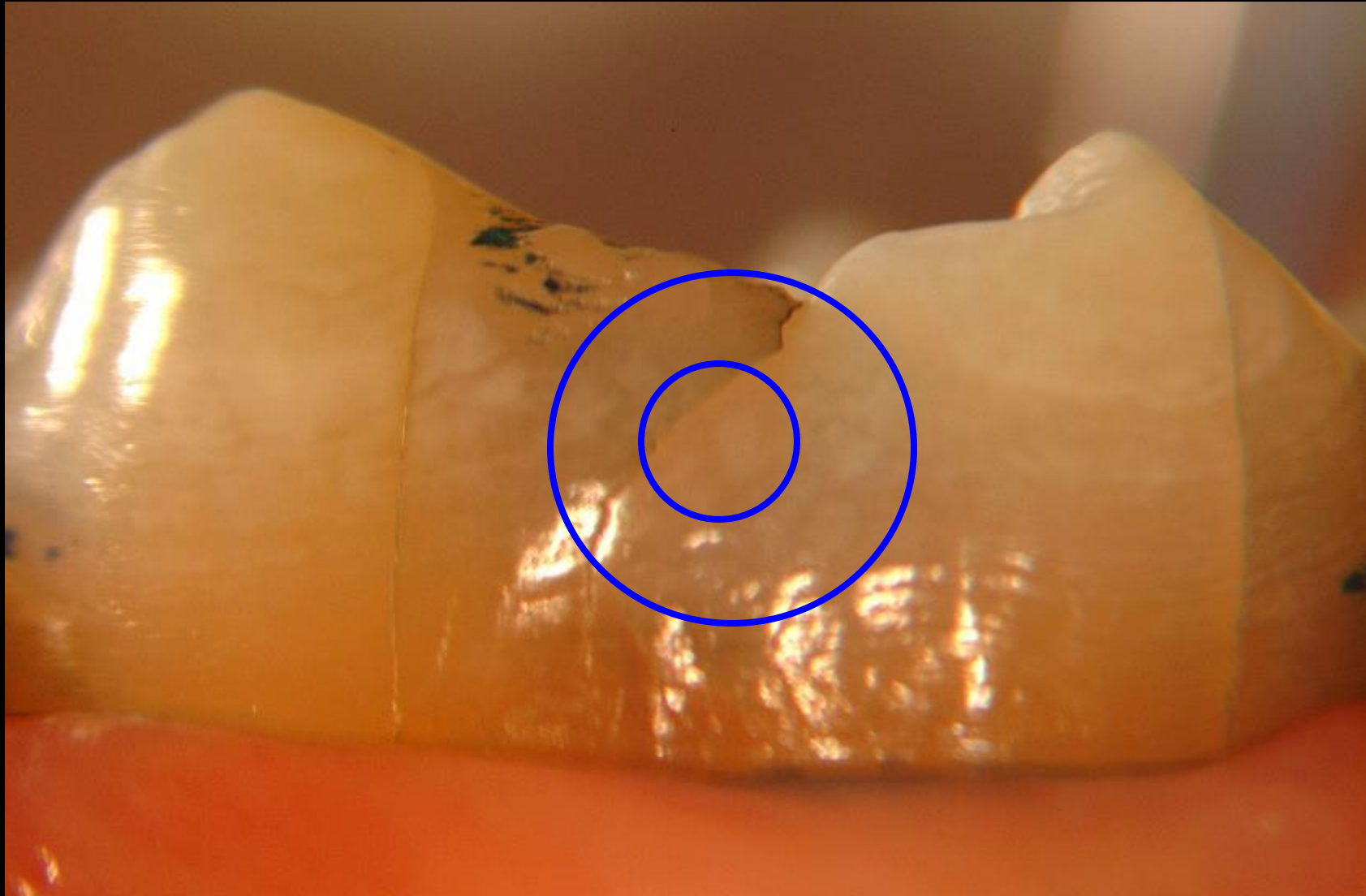
## Type III: Have high risk of underlying pathology

- 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



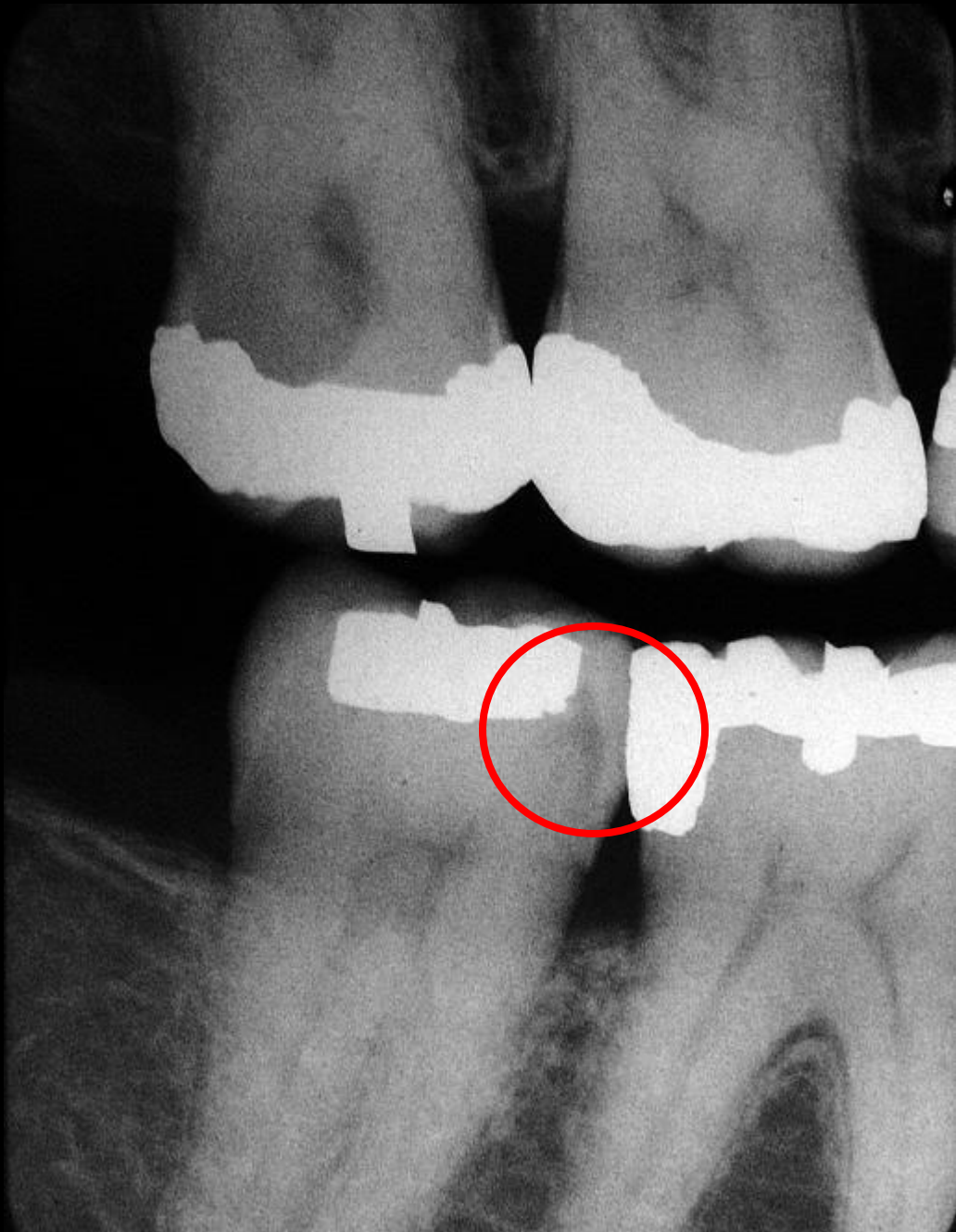


*A Tale of Three Marginal Ridges*



*A Tale of Three Marginal Ridges*



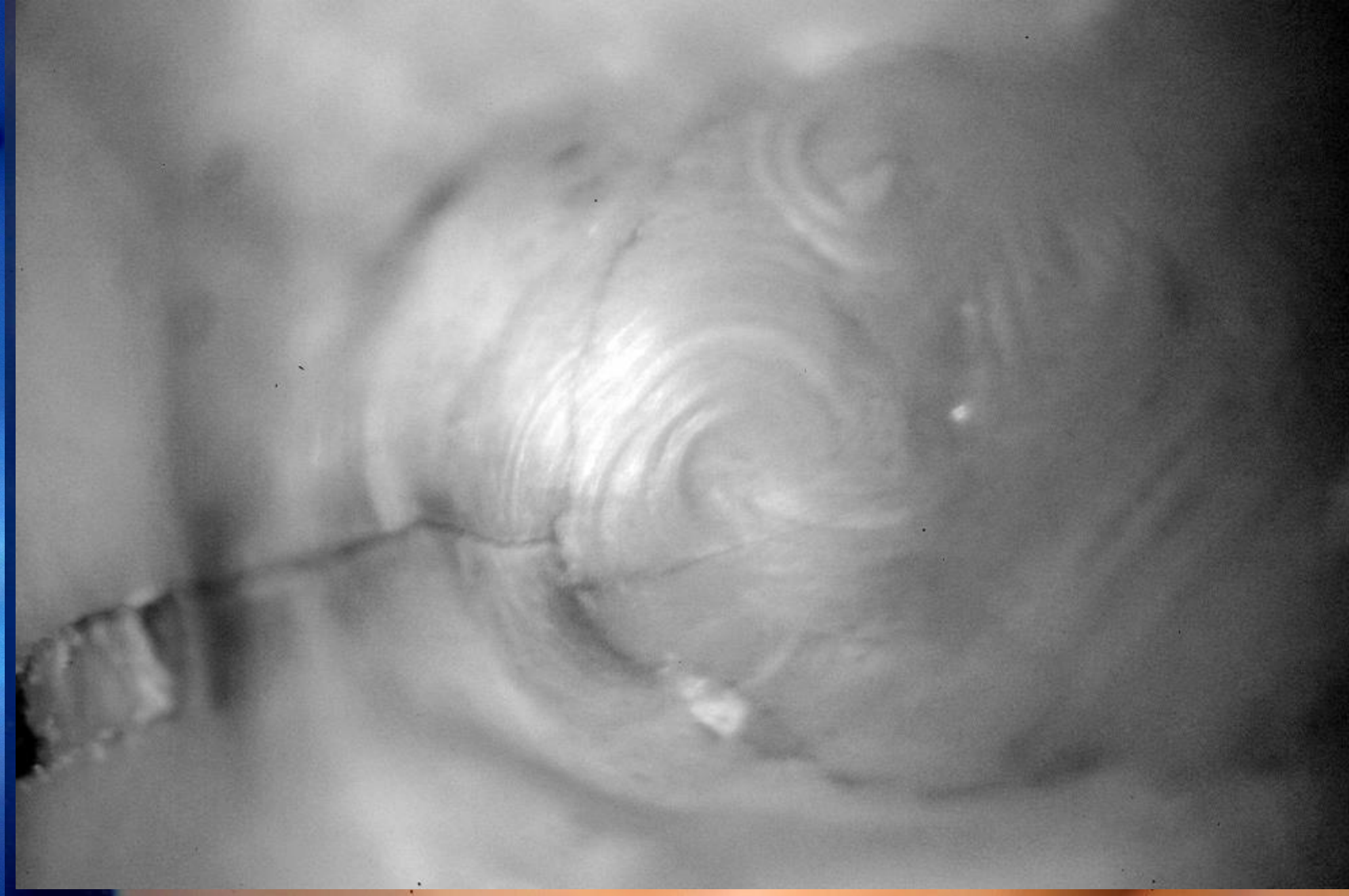


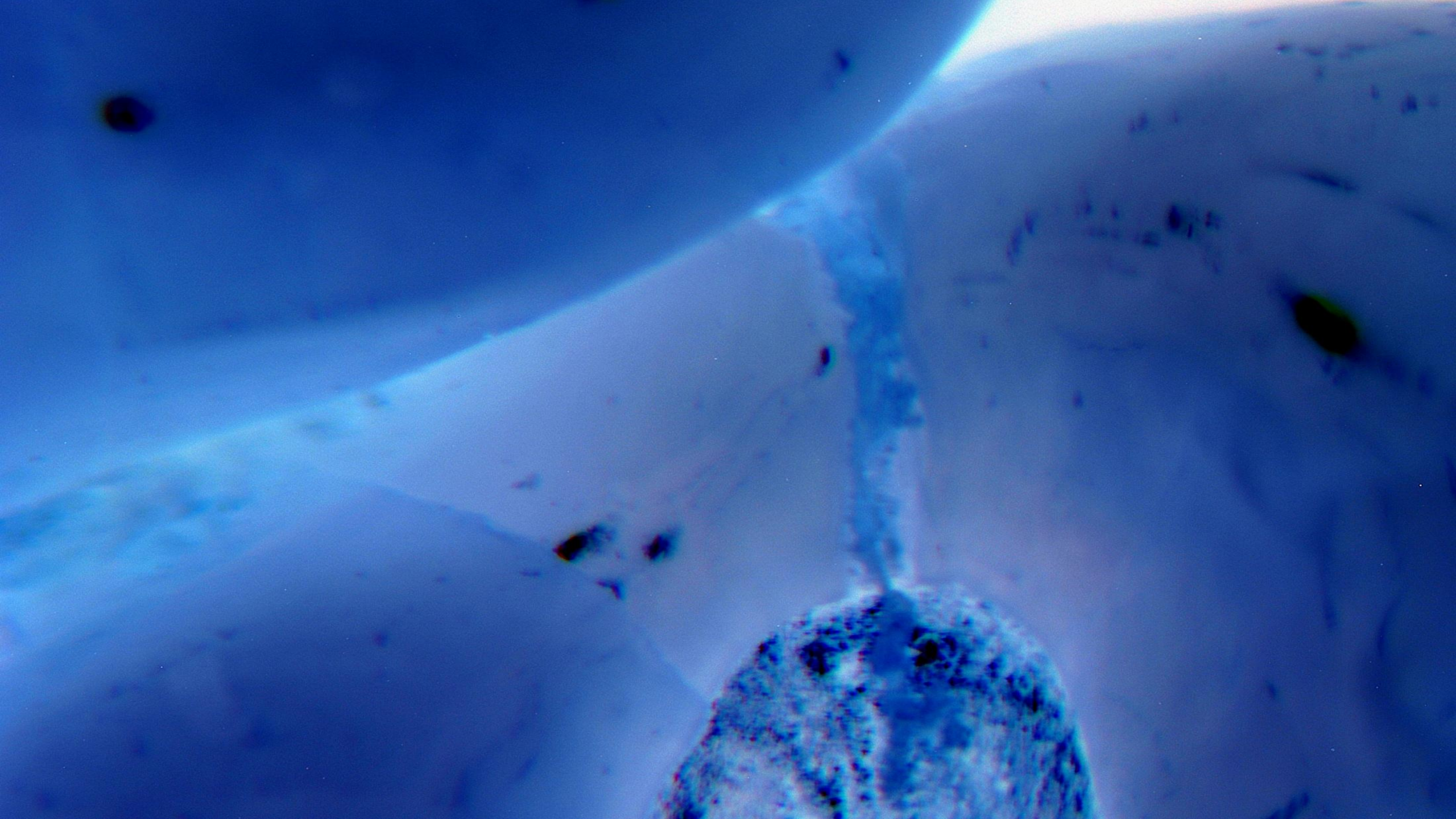


*A Tale of Three Marginal Ridges*



*A Tale of Three Marginal Ridges*





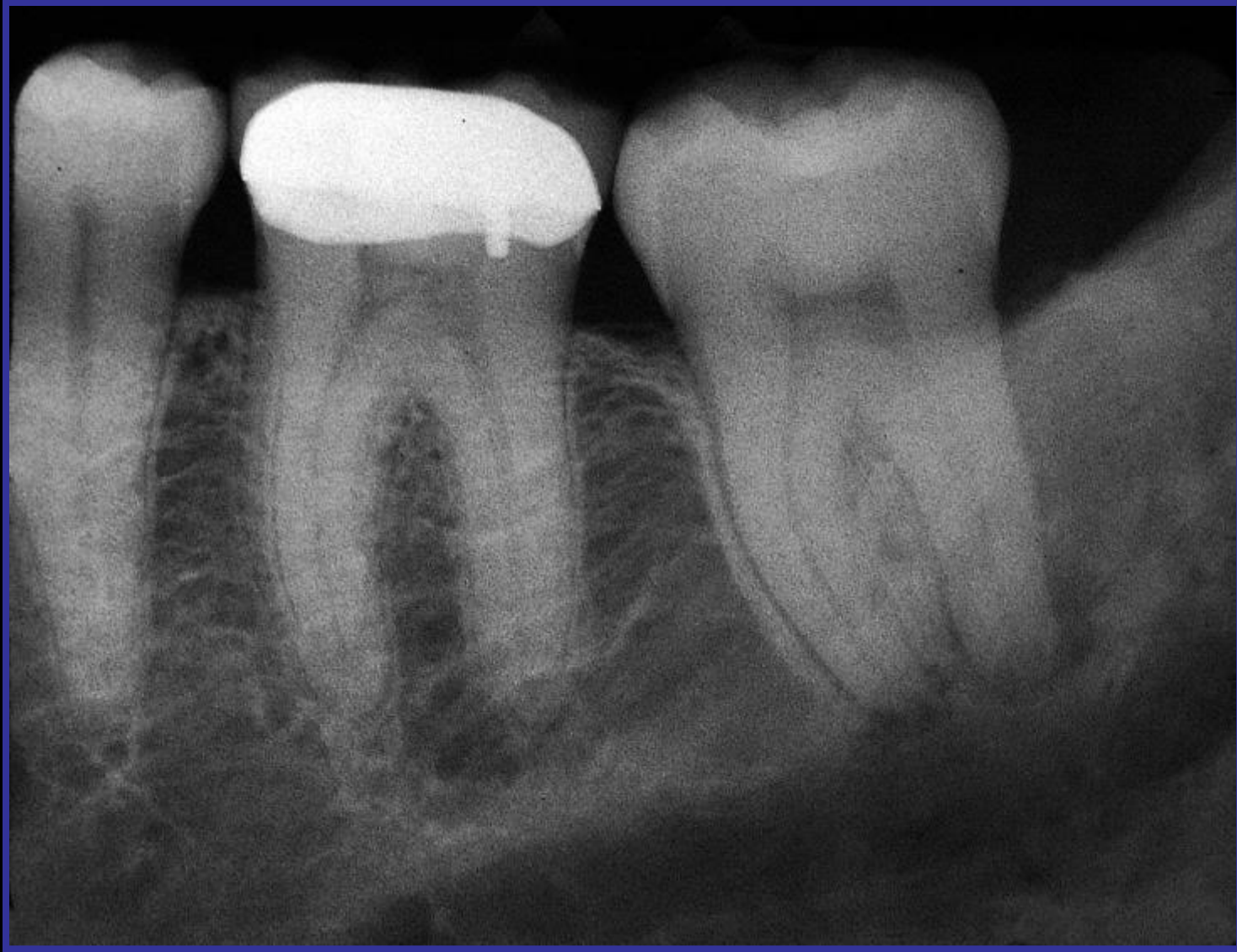


*A Tale of Three Marginal Ridges*

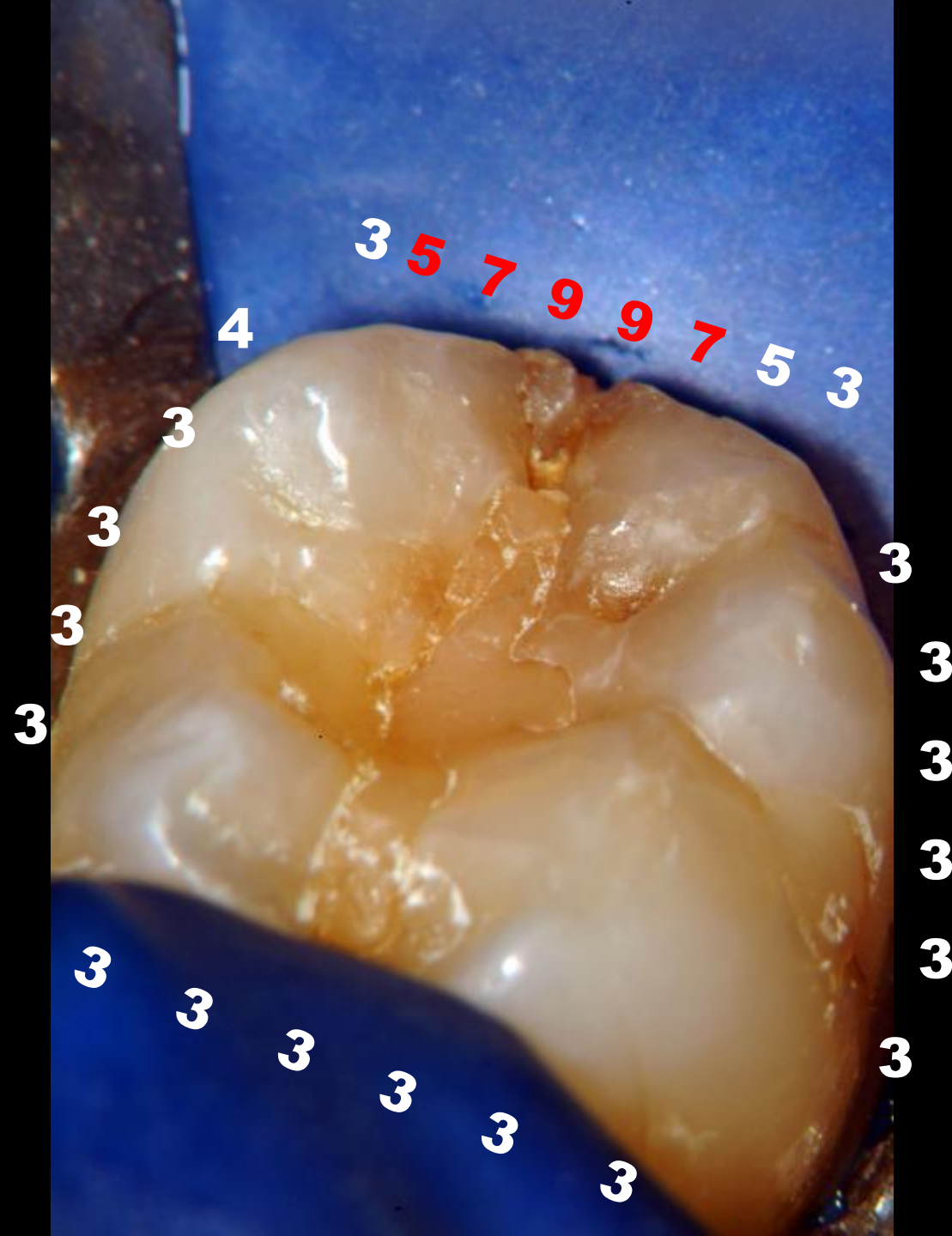


*A Tale of Three Marginal Ridges*

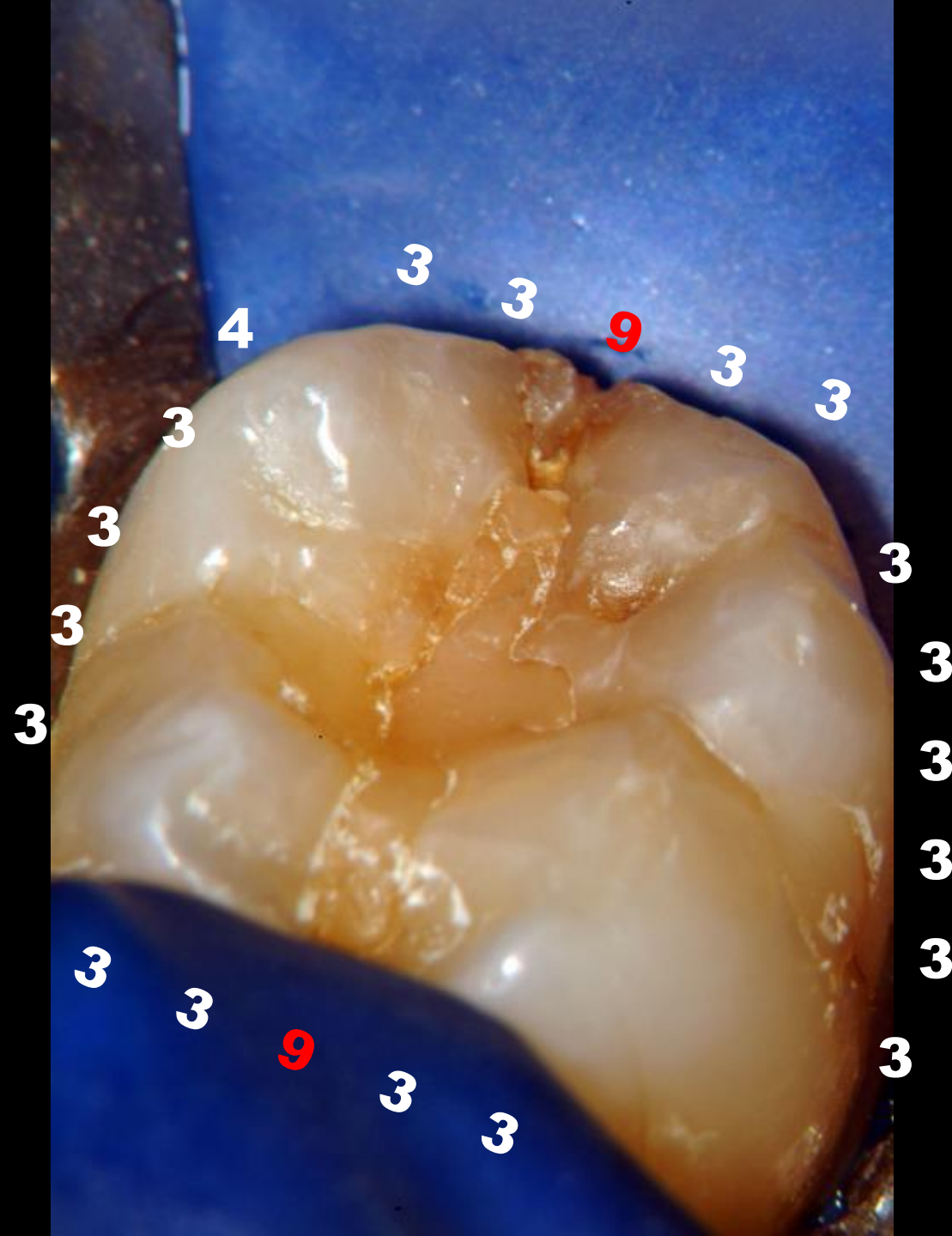




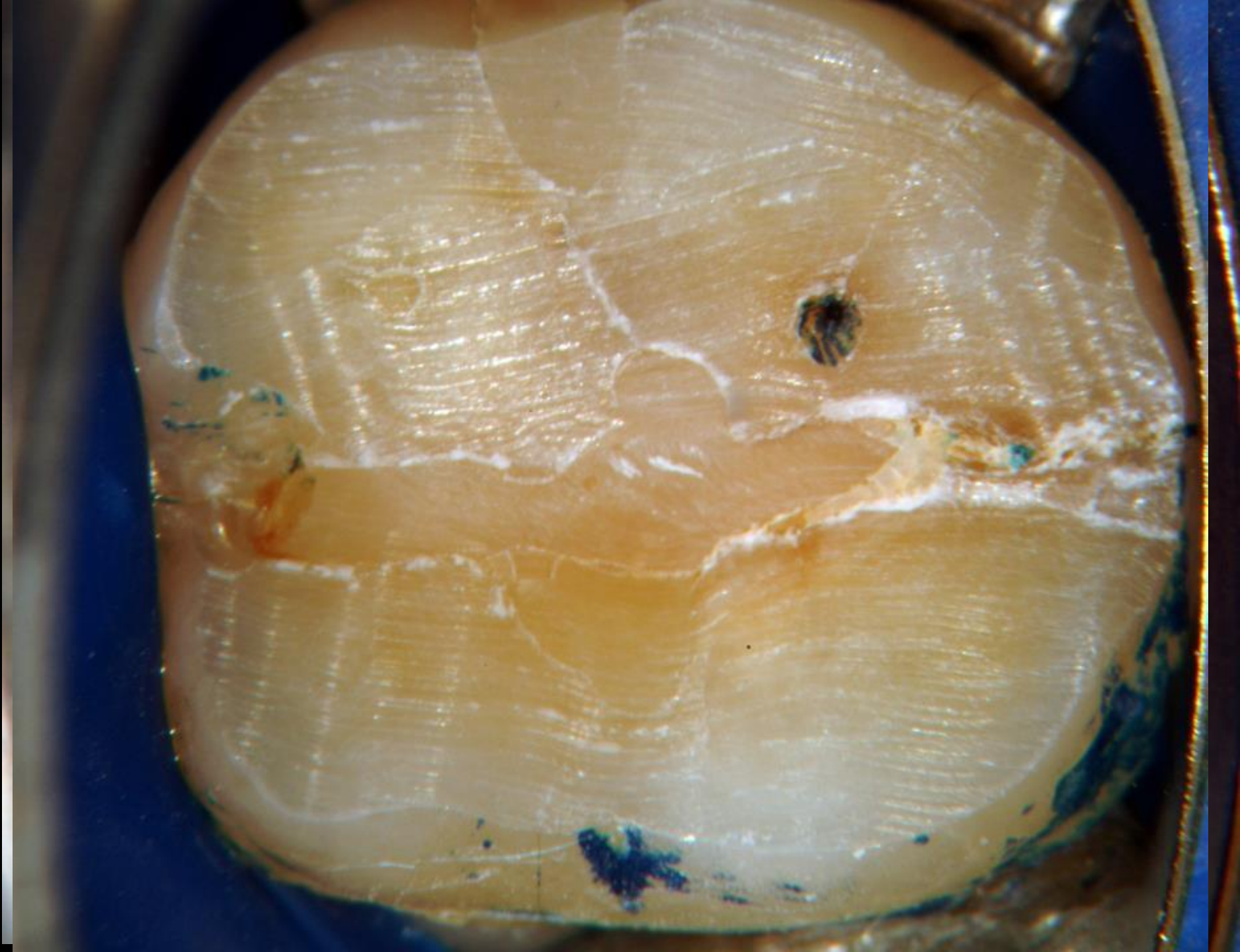
*What  
we  
probed*



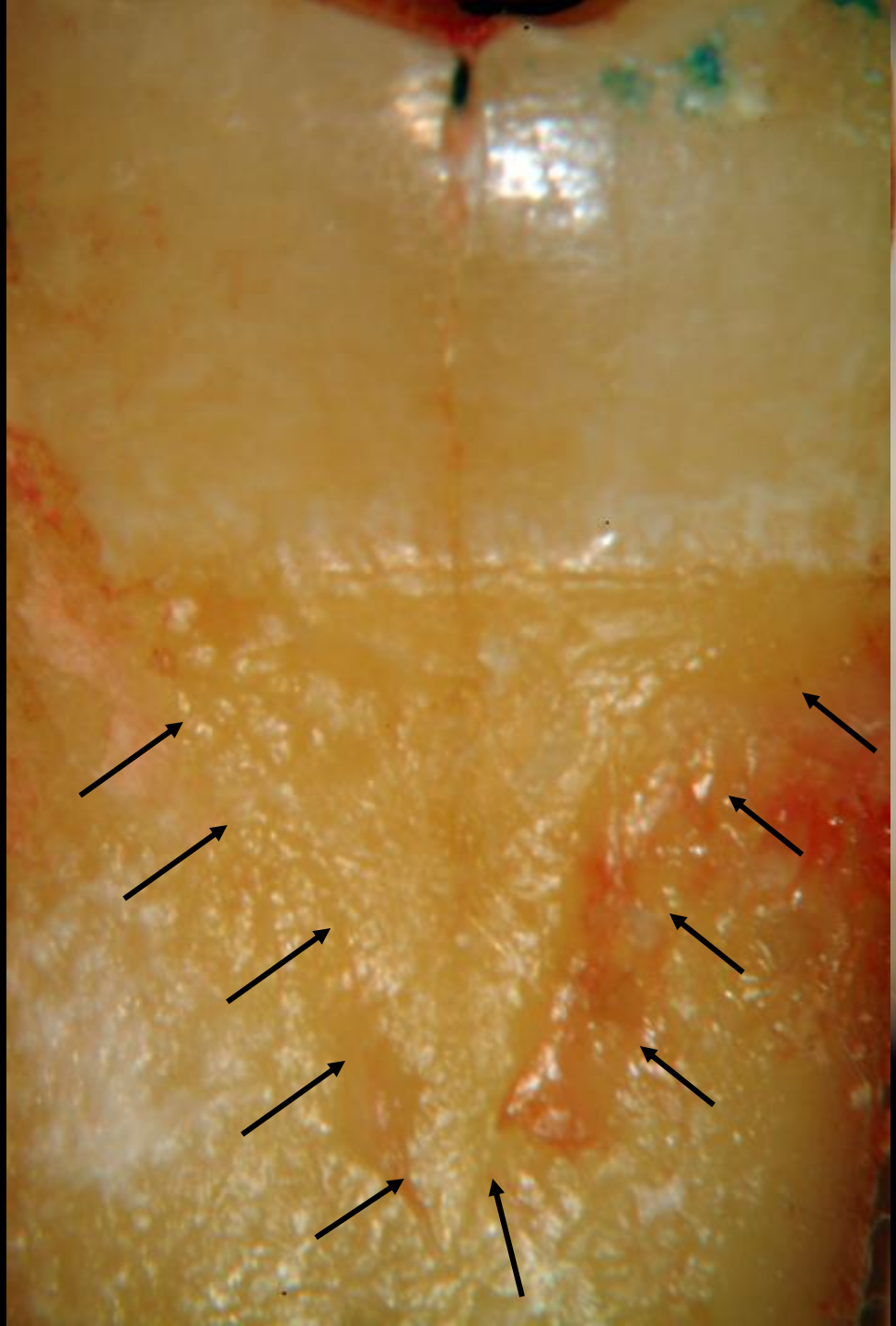
What  
we  
expected





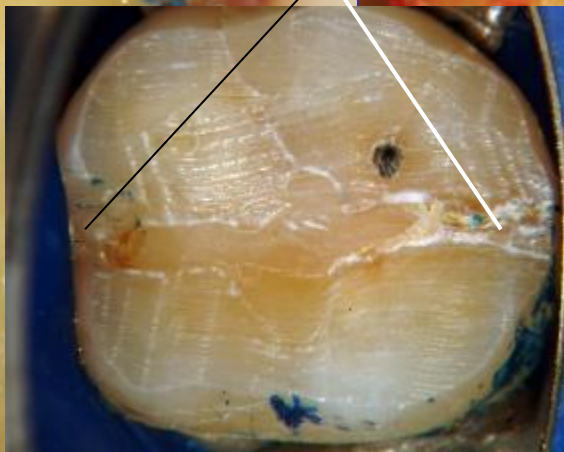
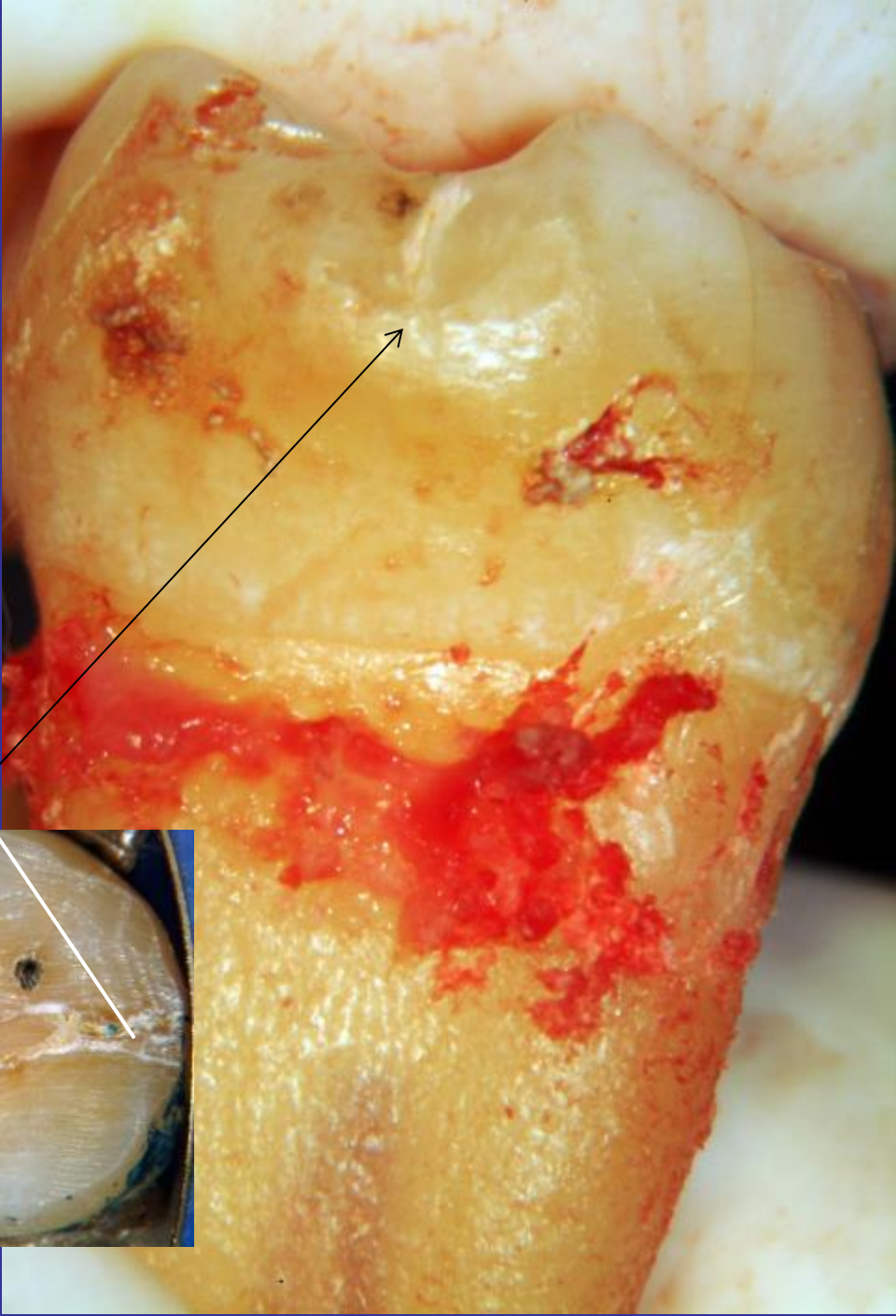
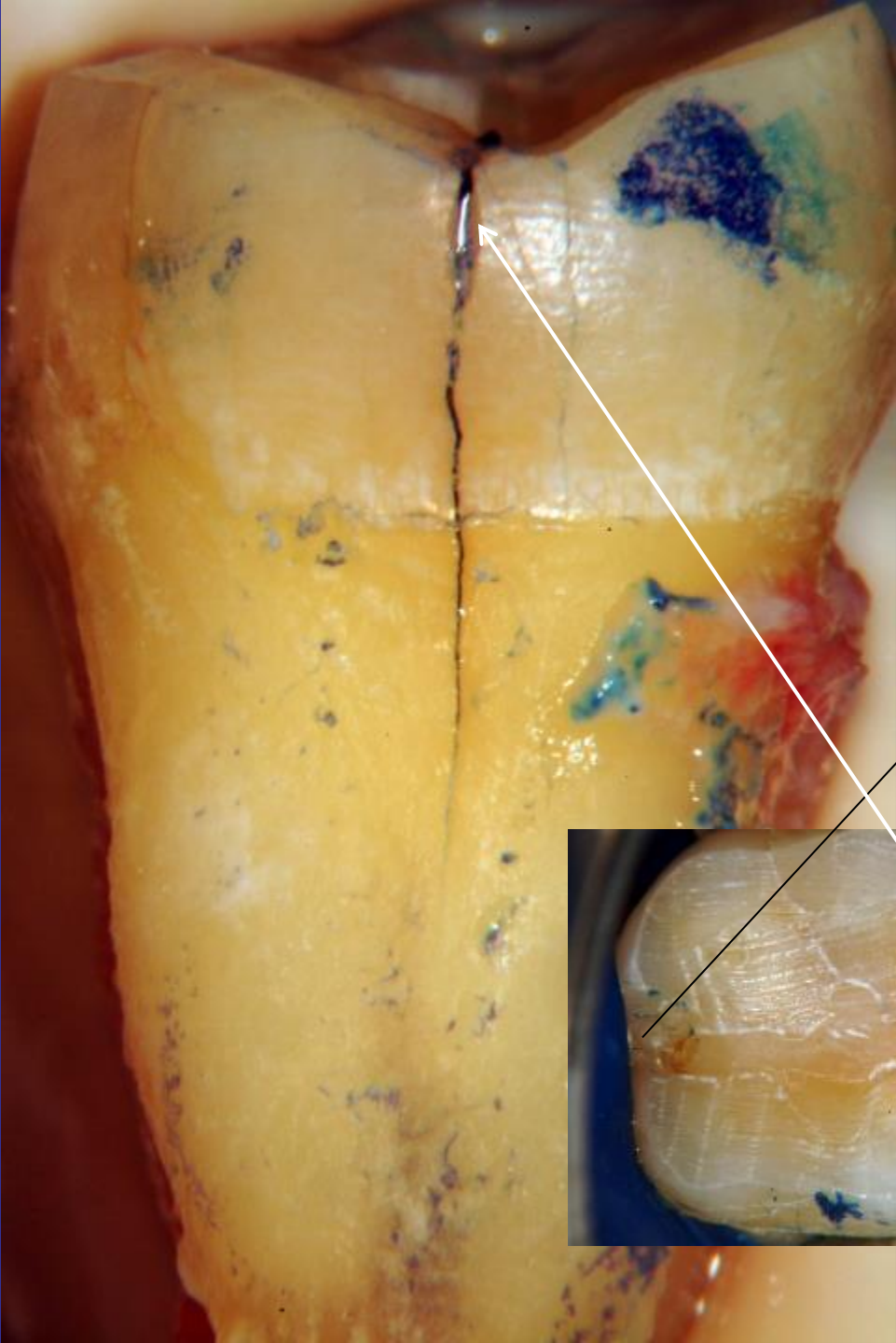




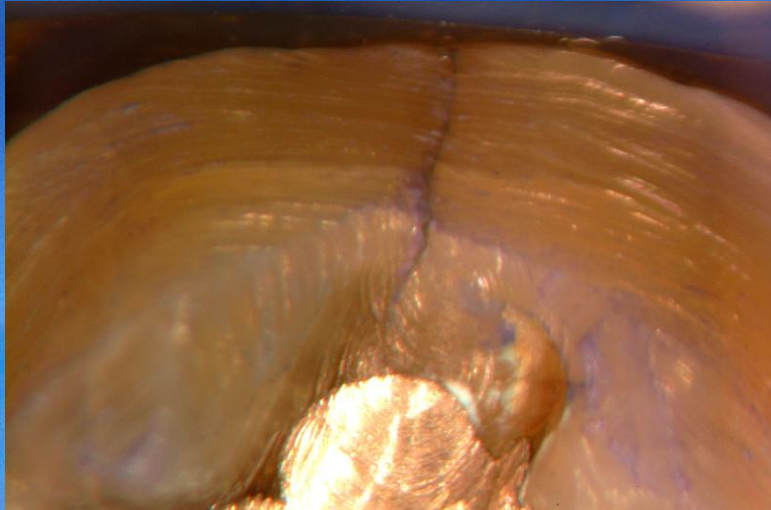






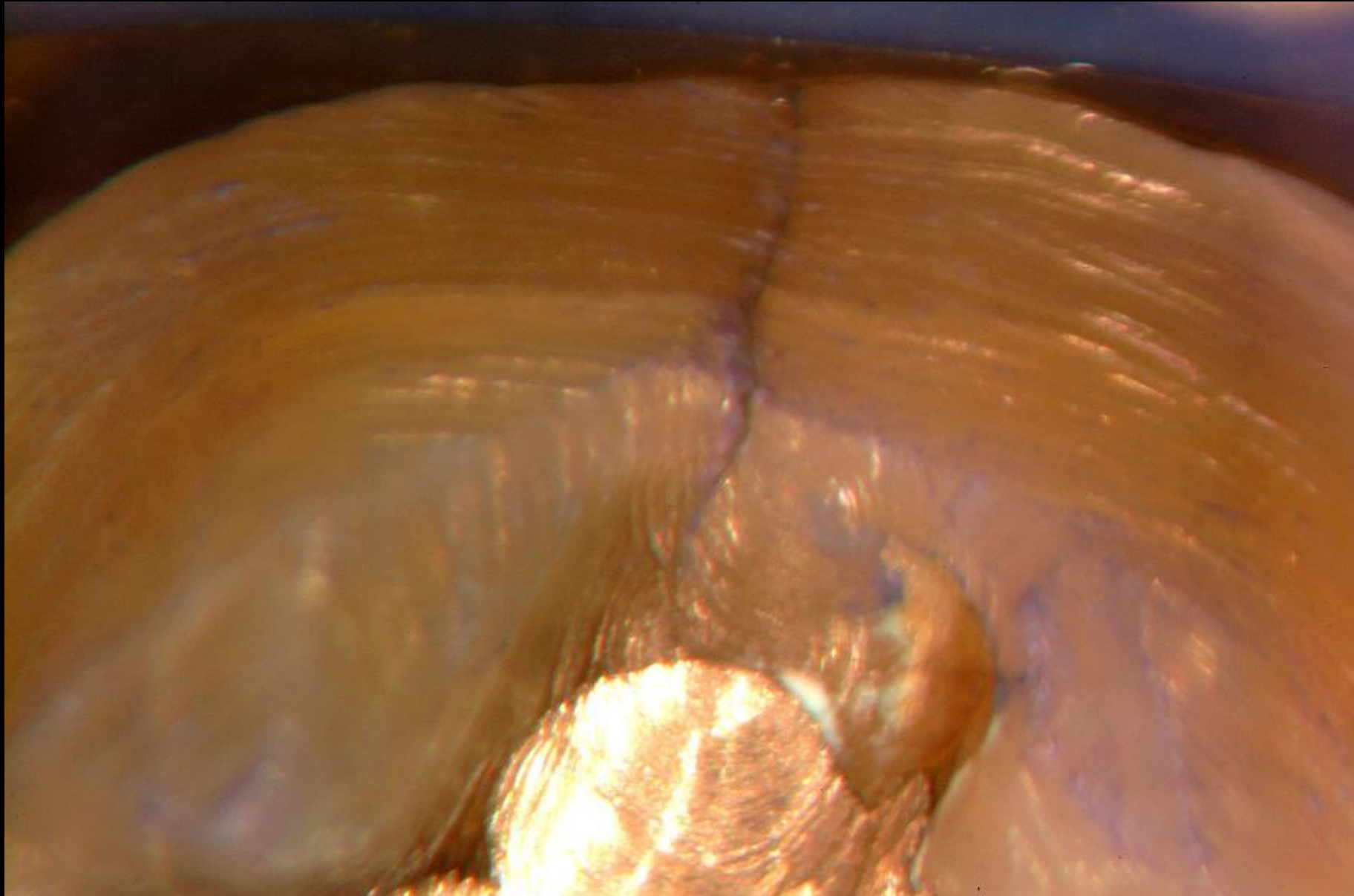


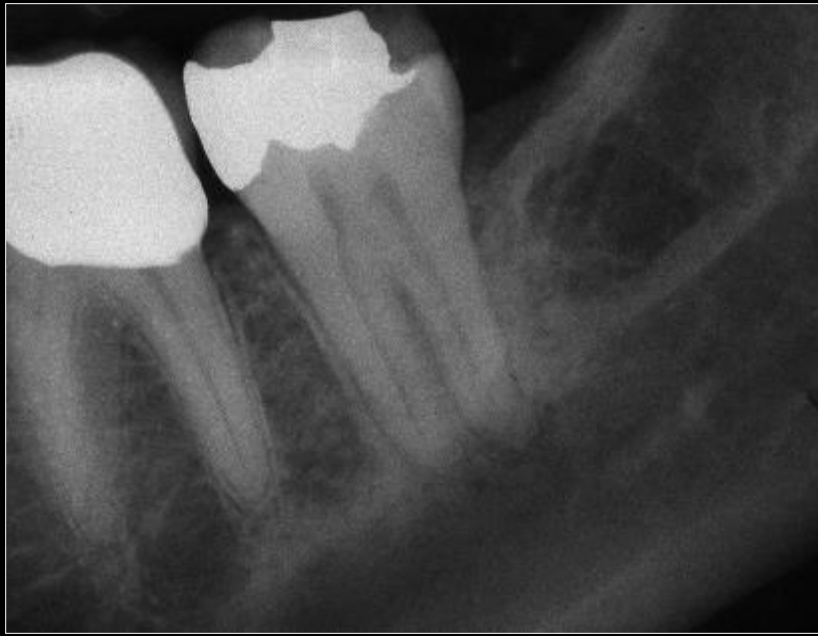
# Incomplete and Complete Fractures



## Case Study

# Occlusal view of distal





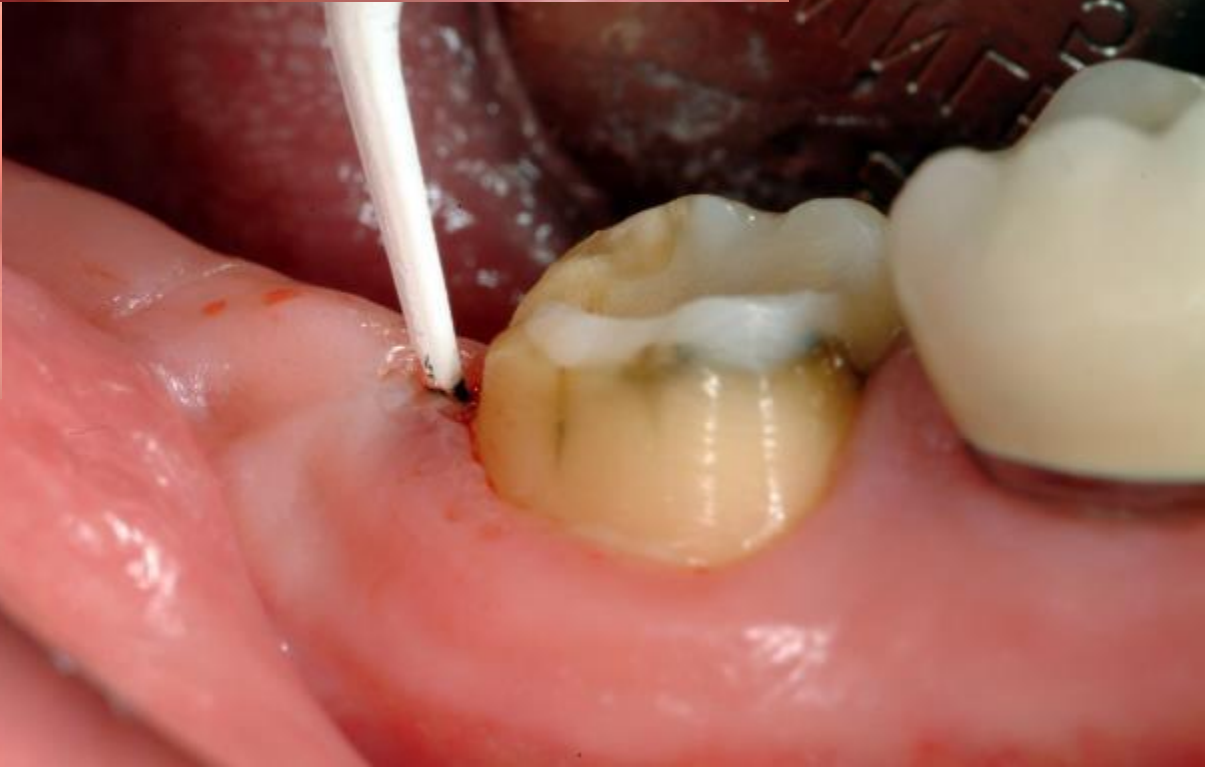
Initial  
appointment



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

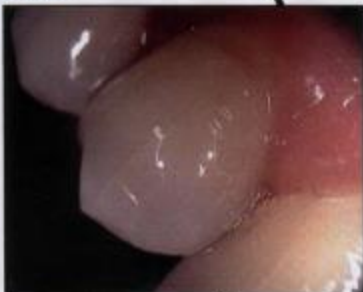
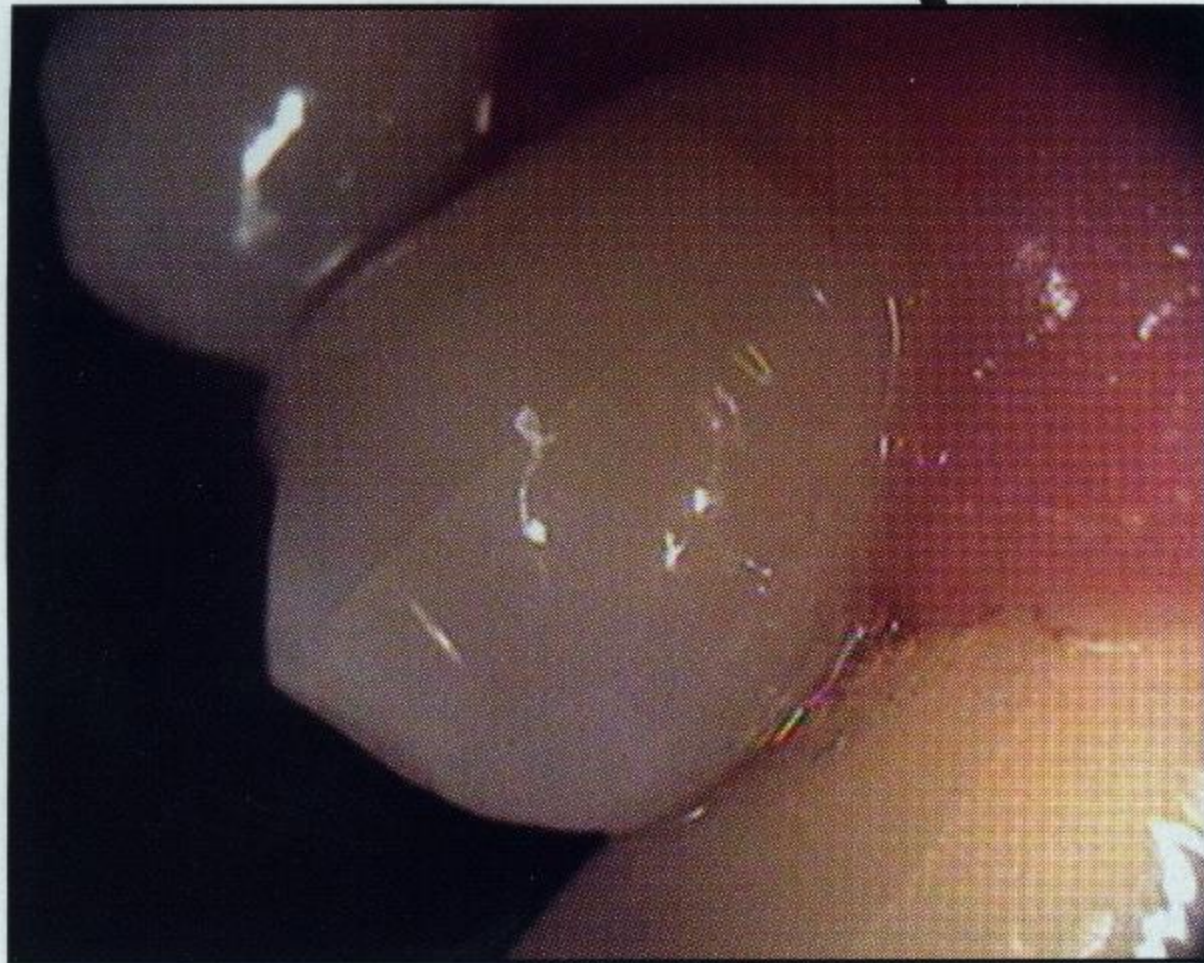
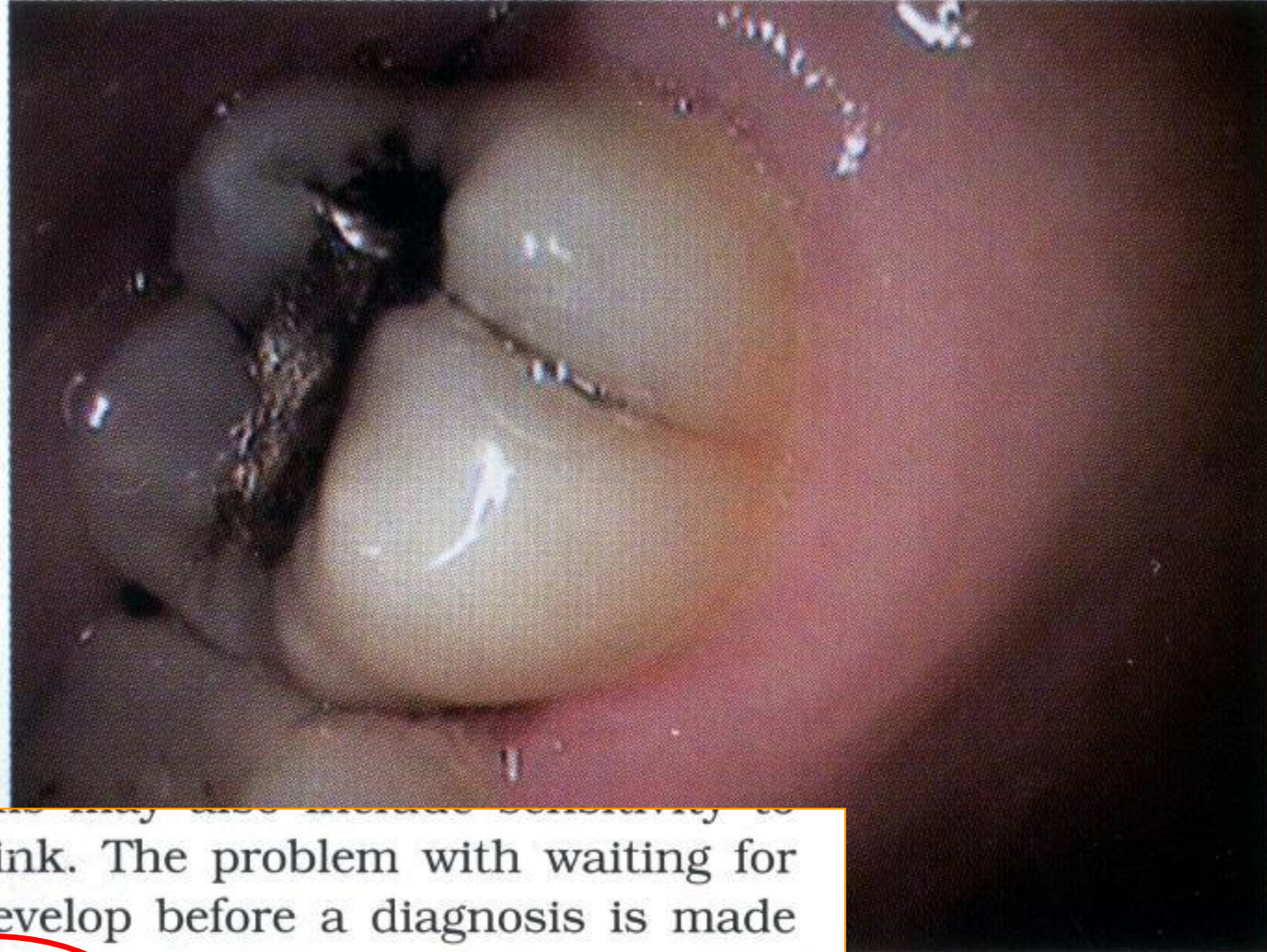


Figure 1



- 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 Clark<sup>5</sup> as end-stage crack progression, requiring more aggressive treatment.

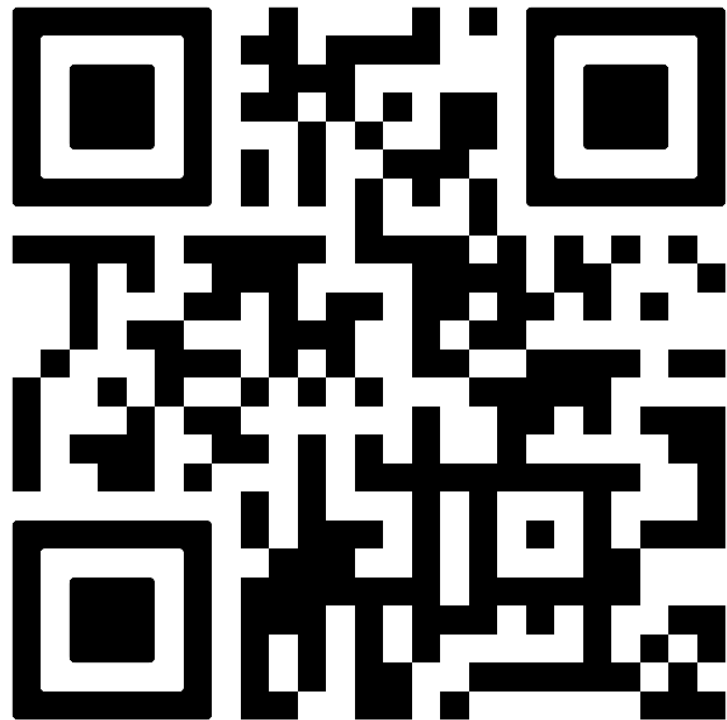
The emergence of the dental microscope has been a tremendous aid in the diagnosis and treatment of cracked teeth. The routine, methodical

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



DR. ALEX FOK

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



# 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.



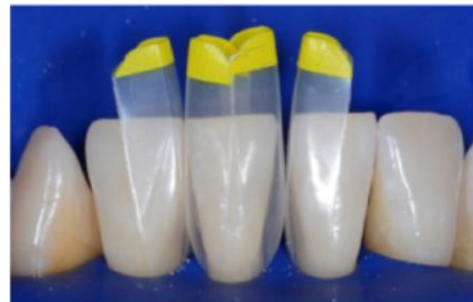
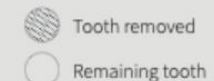
## AN HONEST LOOK AT CROWN PREPARATIONS

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

# ∞ BIOCLEAR

## Stop by convention

# booth #1111

## to...

- ✓ Hear more about Bioclear courses
- ✓ Meet our team of Bioclear experts
- ✓ Order products
- ✓ Register for courses
- ✓ Learn why Bioclear is a BIG DEAL!





# 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

LEARNING CENTER

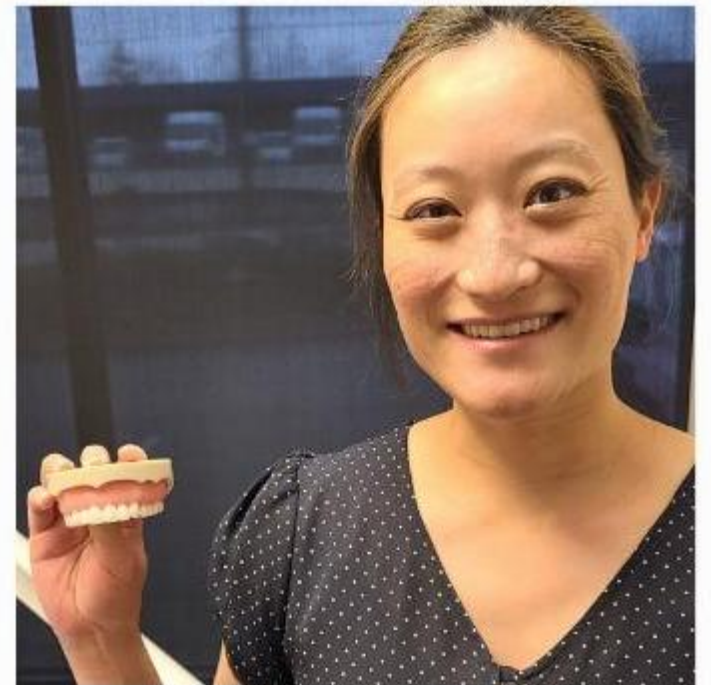
Tacoma USA



BIOCLEAR  
LEARNING CENTER

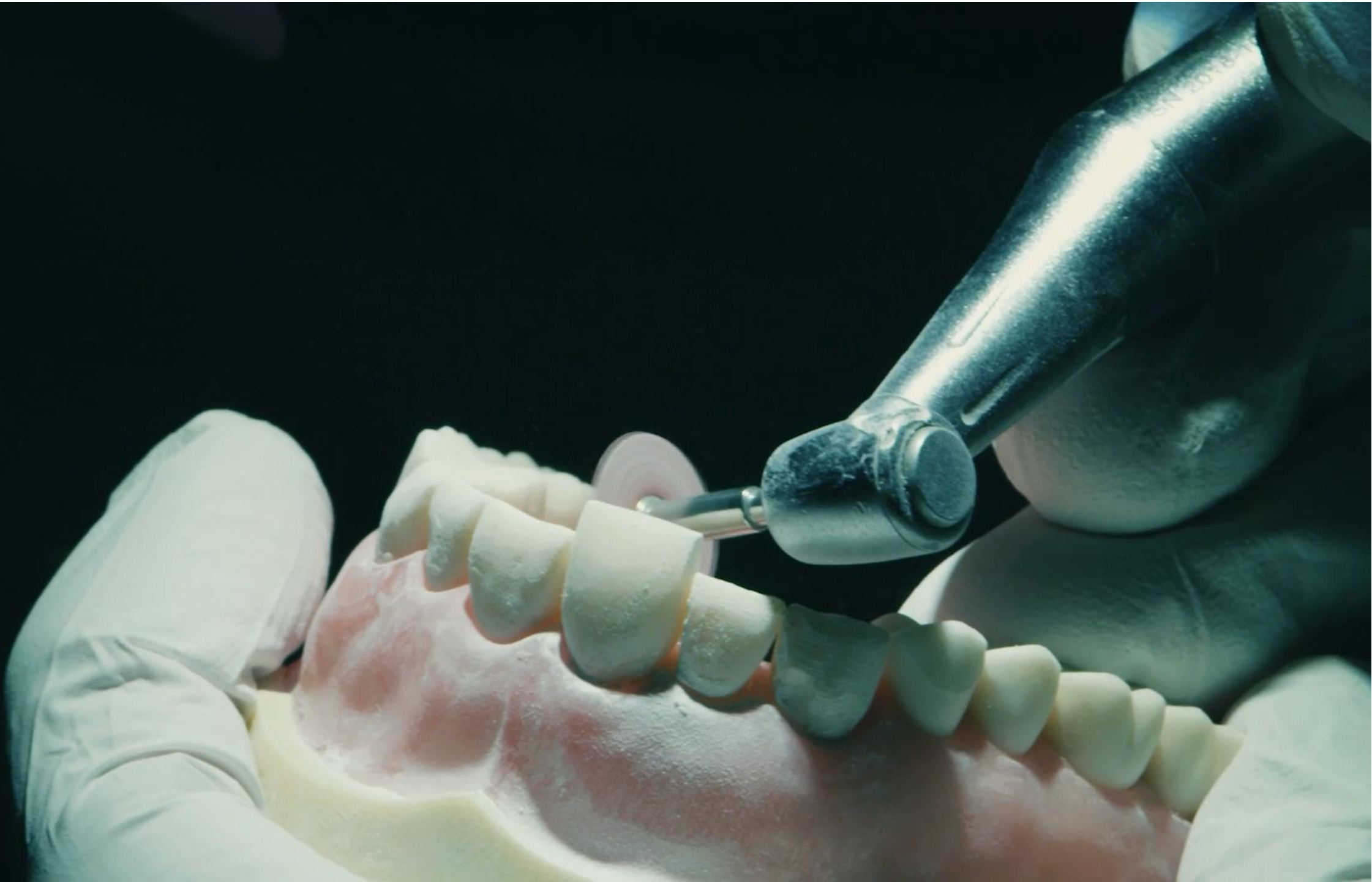






# Last week's attendees at the certification course





# 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
				1	2	3
4	5	6	7	8	9	10
11	12	13	14	15	16	17
18	19	20	21	22	23	24
25	26	27	28	29	30	31

February

S	M	T	W	T	F	S
1	2	3	4	5	6	7
8	9	10	11	12	13	14
15	16	17	18	19	20	21
22	23	24	25	26	27	28

March

S	M	T	W	T	F	S
1	2	3	4	5	6	7
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15	16	17	18	19	20	21
22	23	24	25	26	27	28
29	30	31				

April

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May

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31						

June

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28	29	30				

July

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26	27	28	29	30	31	

August

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23	24	25	26	27	28	29
30	31					

September

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27	28	29	30			

October

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18	19	20	21	22	23	24
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November

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22	23	24	25	26	27	28
29	30					

December

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6	7	8	9	10	11	12
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20	21	22	23	24	25	26
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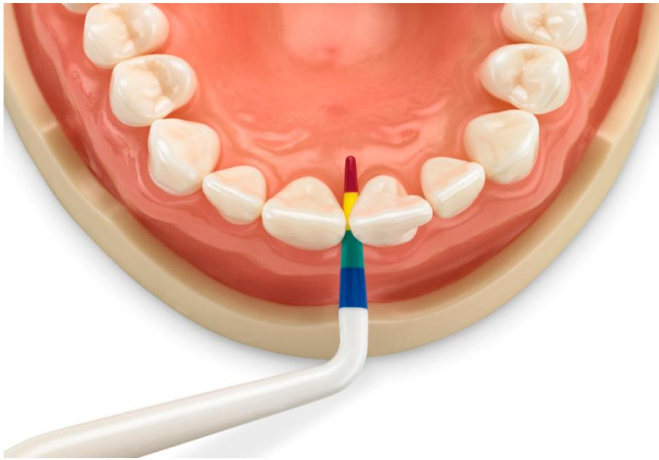
Treat yourself to a weekend with  BIOCLEAR

# 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:

Washington DC  
May 8<sup>th</sup> 2026



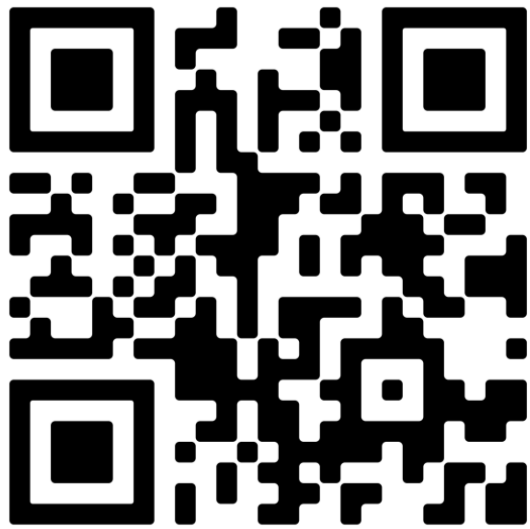
Orange Beach  
April 24<sup>th</sup> 2026



Denver  
October 9<sup>th</sup> 2026



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local BT Course!



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**BEFORE**



**AFTER**



**BEFORE**



**AFTER**

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**Course Code:6573**

**Stop by convention**

**booth #1111**

**to...**

- ✓ Hear more about Bioclear courses
- ✓ Meet our team of Bioclear experts
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