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

featuring

BIOCLEAR


Disclosures:
Dr. Clark has financial interest in Bioclear

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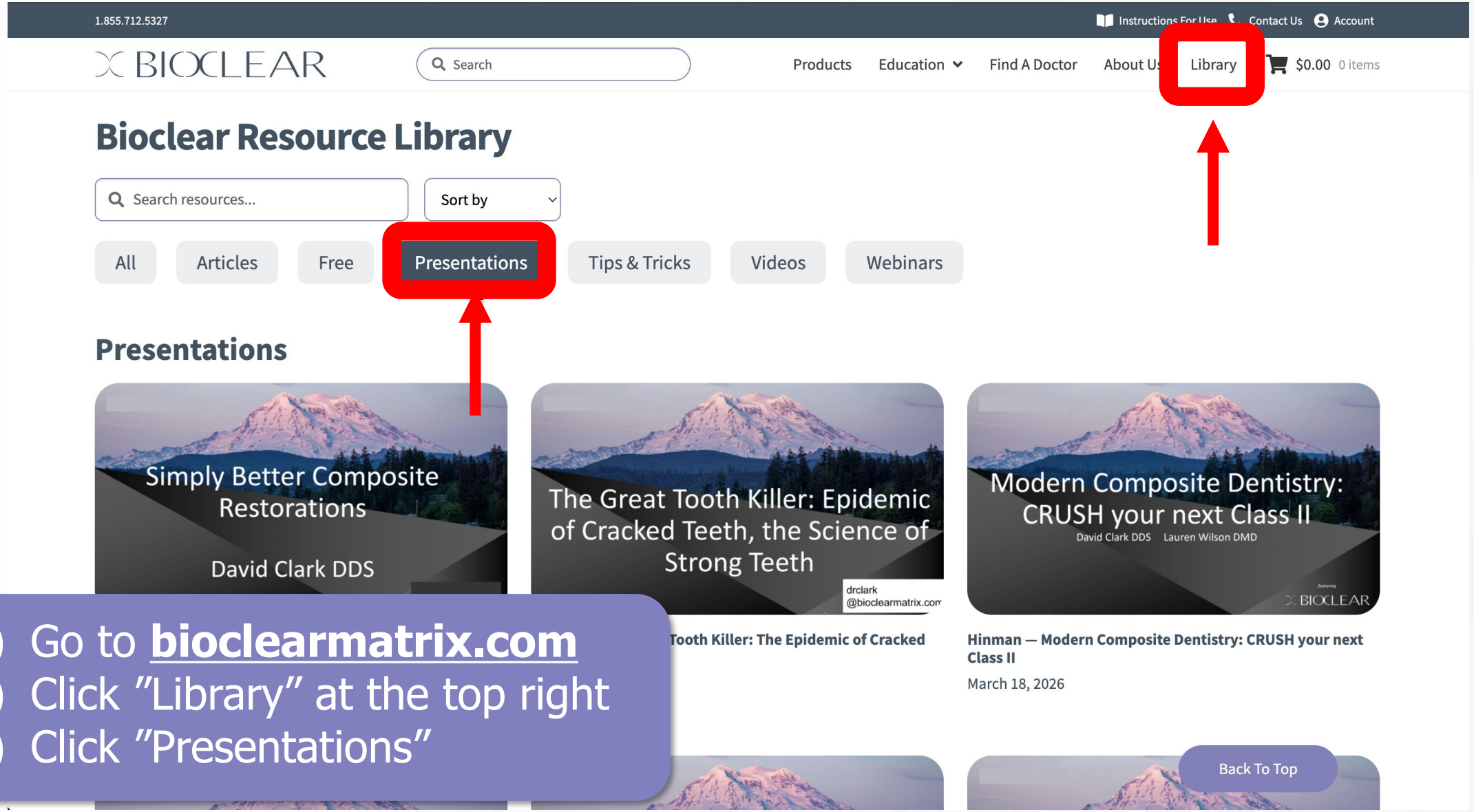

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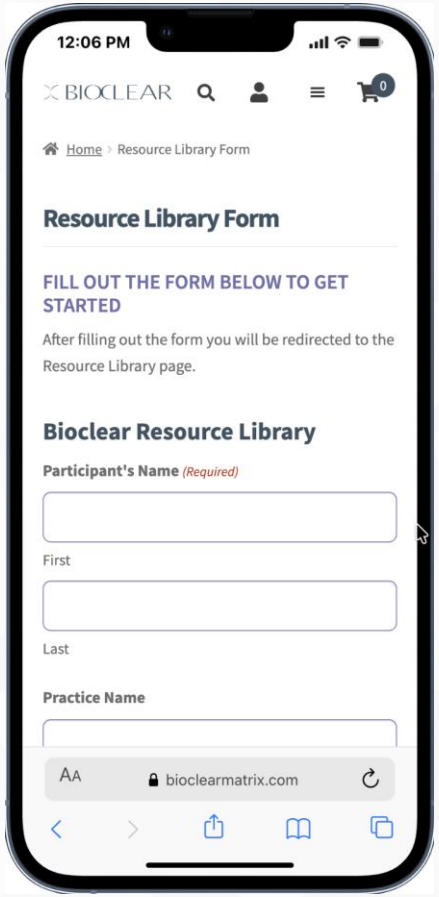

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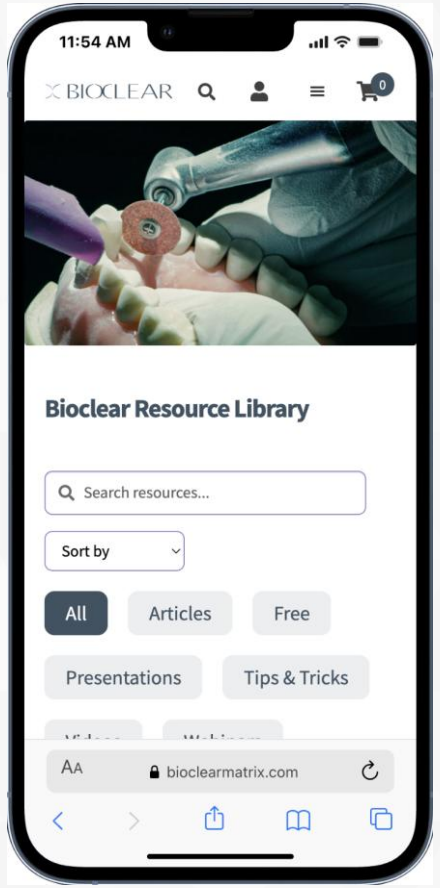

Dental schools/GPR integrating the Bioclear Method

Roseman University of Health Sciences

Loma Linda University School of Dentistry

Université de Montréal

McGill

University of Alberta

The University of Iowa College of Dentistry & Dental Clinics

Western

NOVA Southeastern University College of Dental Medicine

ATSU Missouri School of Dentistry & Oral Health

MUSC Medical University of South Carolina

UT Health San Antonio

Minnesota Dentistry

Celebrate Our Past 100 Dalhousie Dentistry Embrace The Future

UNC Dentistry

University of New England


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

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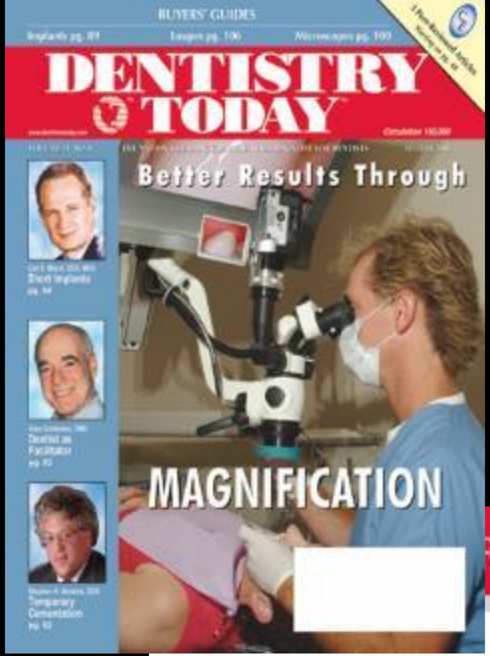
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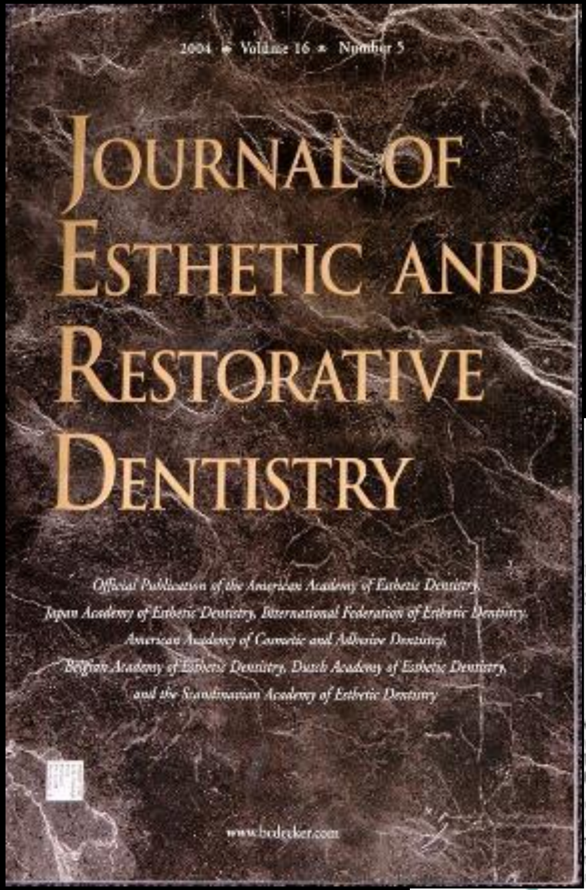
The Epidemic of Cracked and Fracturing Teeth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nitive Diagnosis of Early Enamel and Dentinal
cks Based on Microscopic Evaluation
CLINICAL SIGNIFICANCE

THE SCIENCE OF STRONG RESTORED TEETH

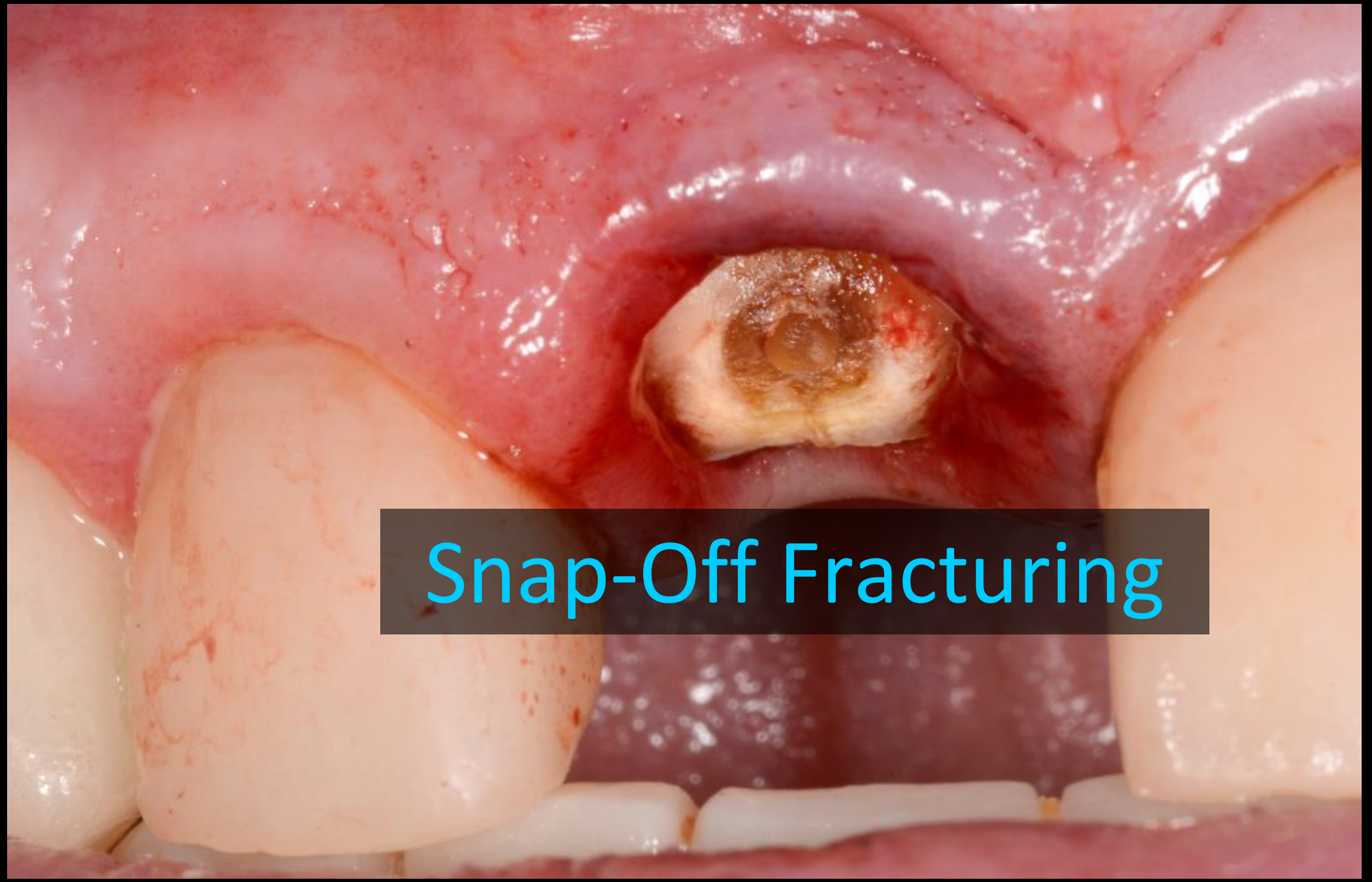
DR. DAVID CLARK

DR. ALEX FOK

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

In this case-based lecture today we explore:

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

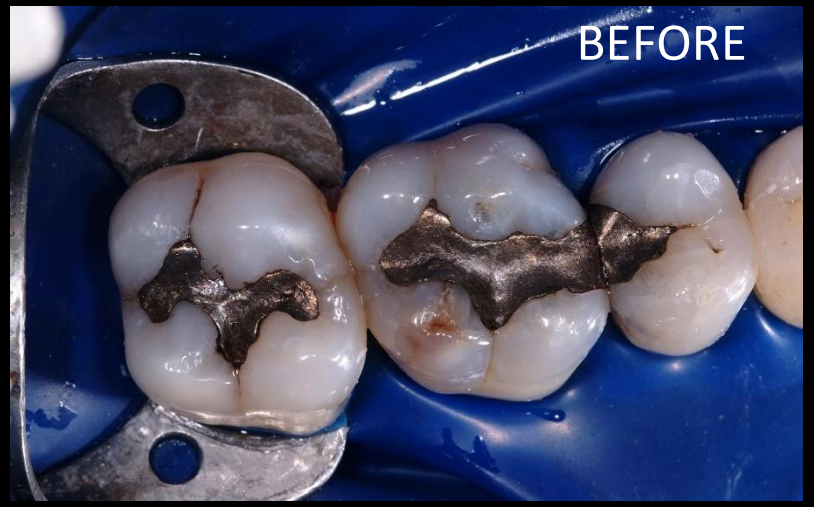

Snap-Off Fracturing

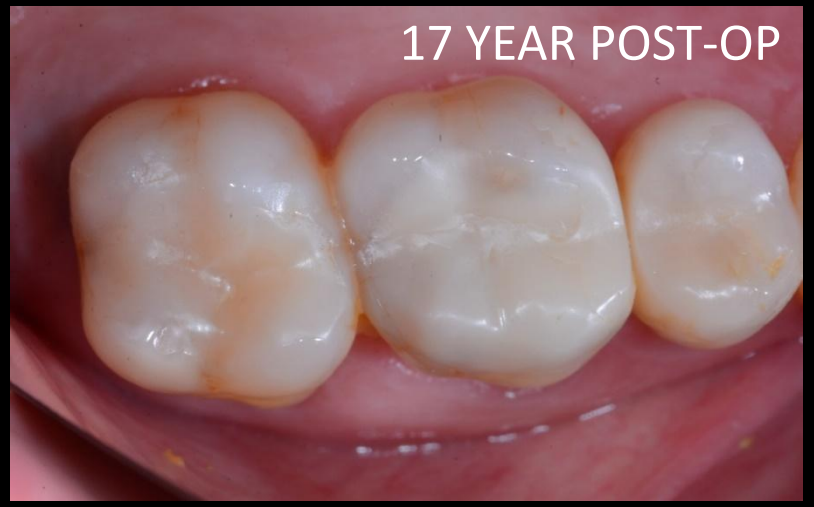
Today's Summary

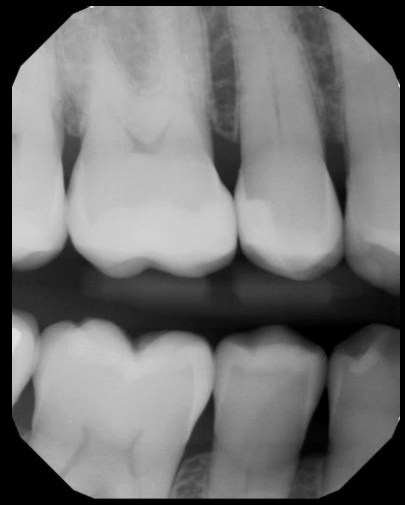
- Why things break…
- Modern cavity preparations
- Injection Overmolding as a 3rd option
- FEA of loading of teeth & composite
- Long term outcomes & case studies of composite overlays for cracked teeth
- When to endo, when to extract.

Modern Approach to Composite Restorations

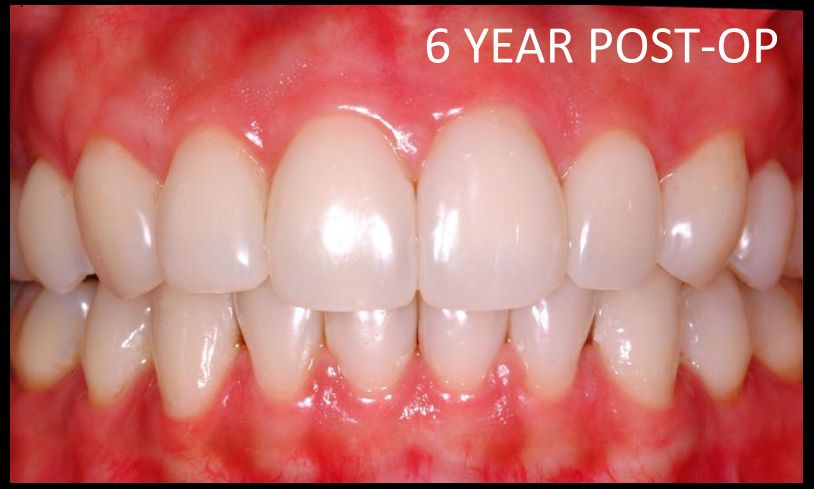
Posterior Restoration

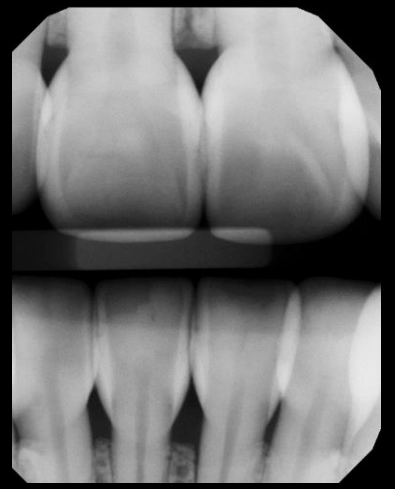






Black Triangle

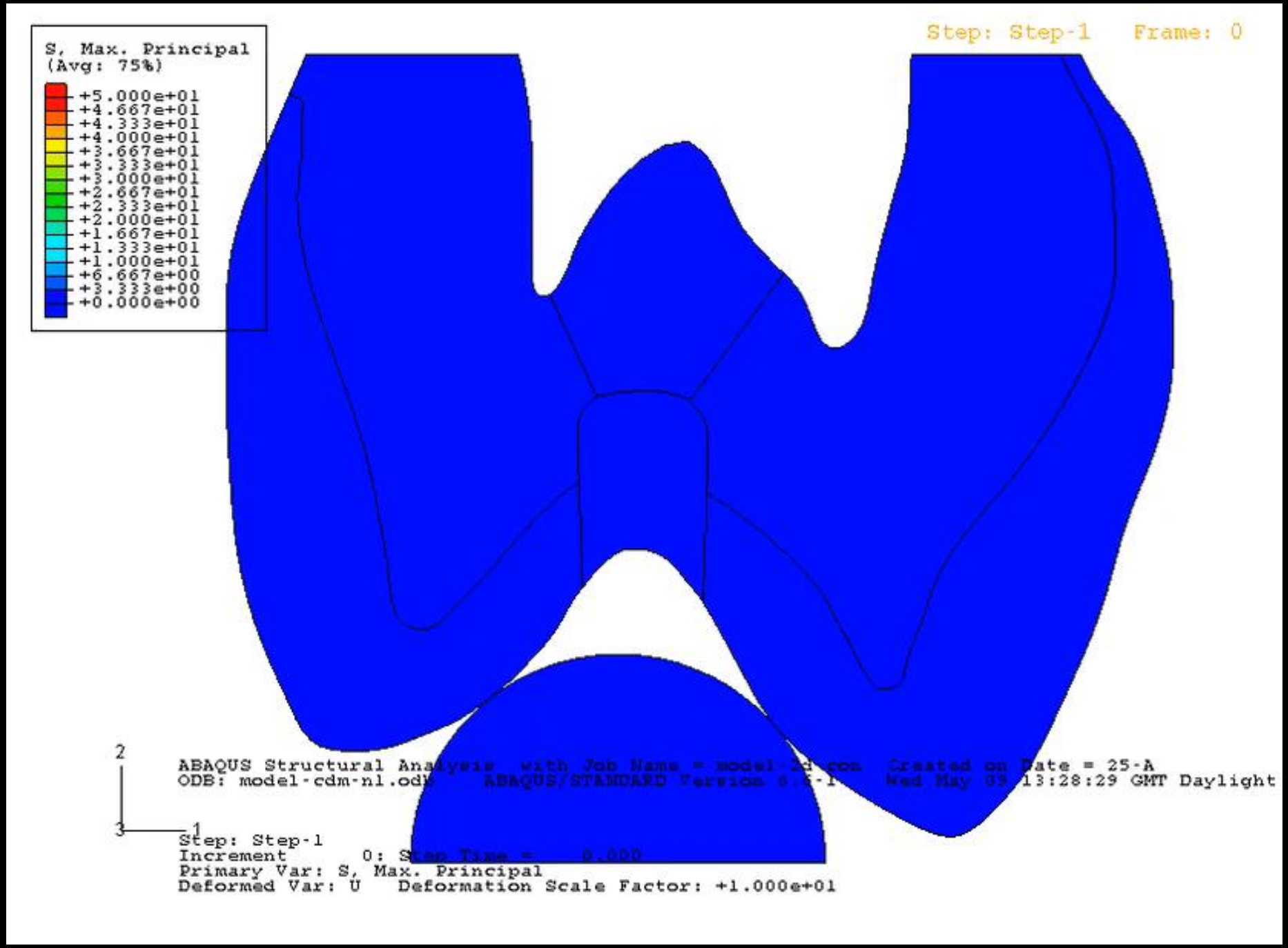


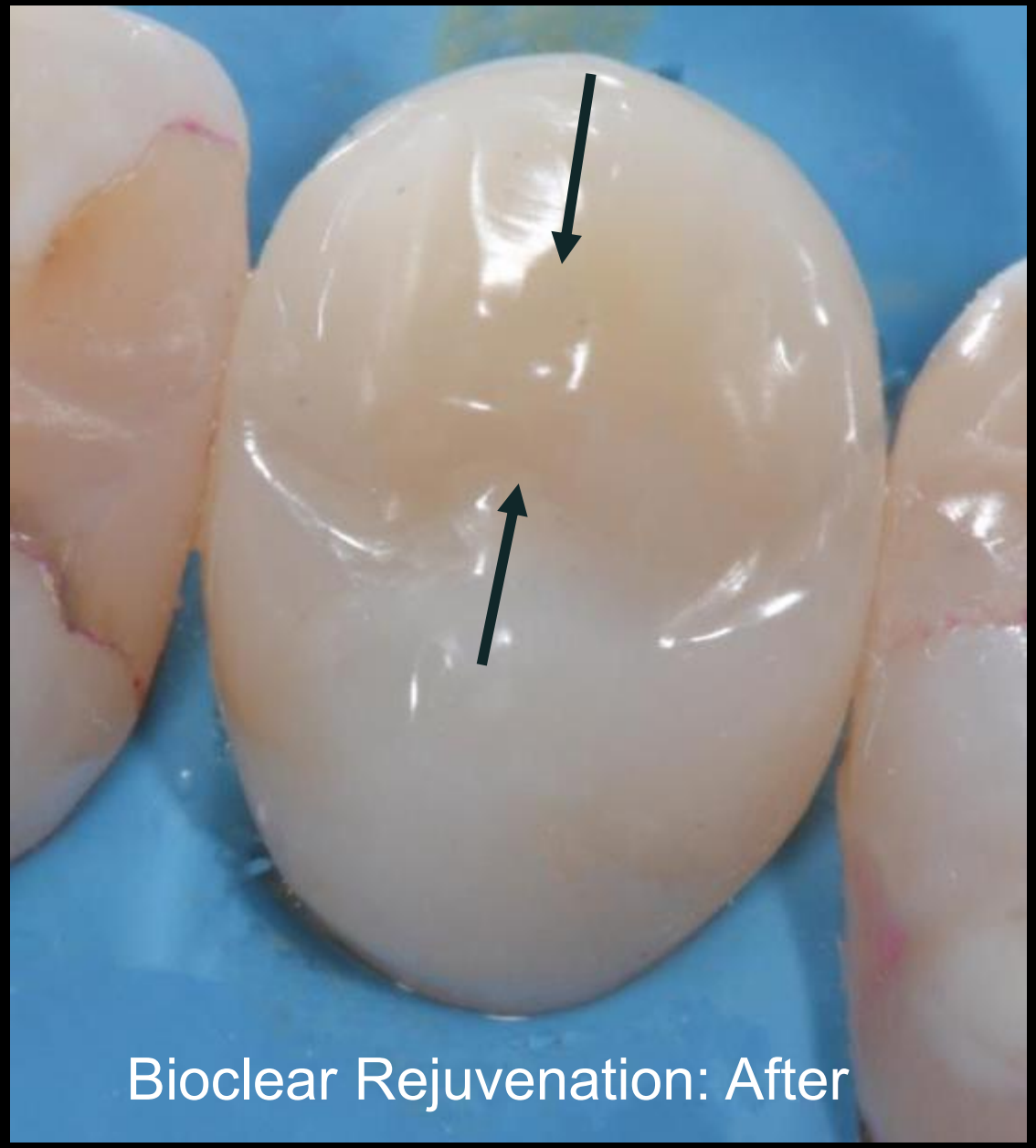


Glossary

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

Epidemic of Cracked Teeth


S, Max. Principal
(Avg: 75%)
+5.000e+01
+4.667e+01
+4.333e+01
+4.000e+01
+3.667e+01
+3.333e+01
+3.000e+01
+2.667e+01
+2.333e+01
+2.000e+01
+1.667e+01
+1.333e+01
+1.000e+01
+6.667e+00
+3.333e+00
+0.000e+00
Step: Step-1
Frame: 0
2
3
1
Step: Step-1
Increment 0: Step Time = 0.000
Primary Var: S, Max. Principal
Deformed Var: U Deformation Scale Factor: +1.000e+01

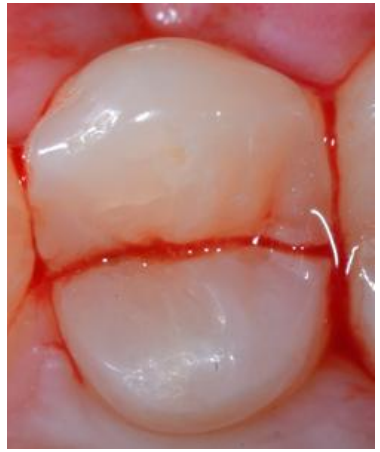


Courtesy Dr. Charlie Regalado

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

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

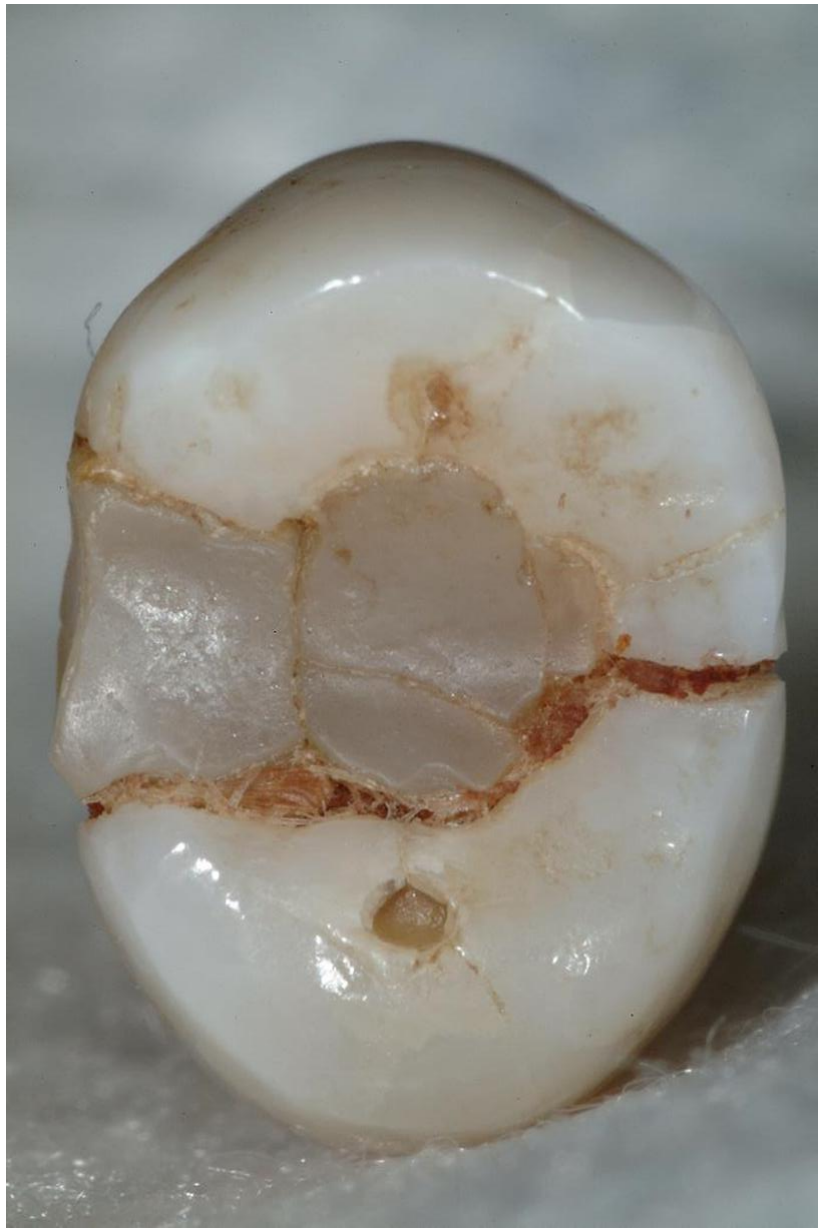
2021: Catastrophic fracture tooth #5. Virgin Tooth



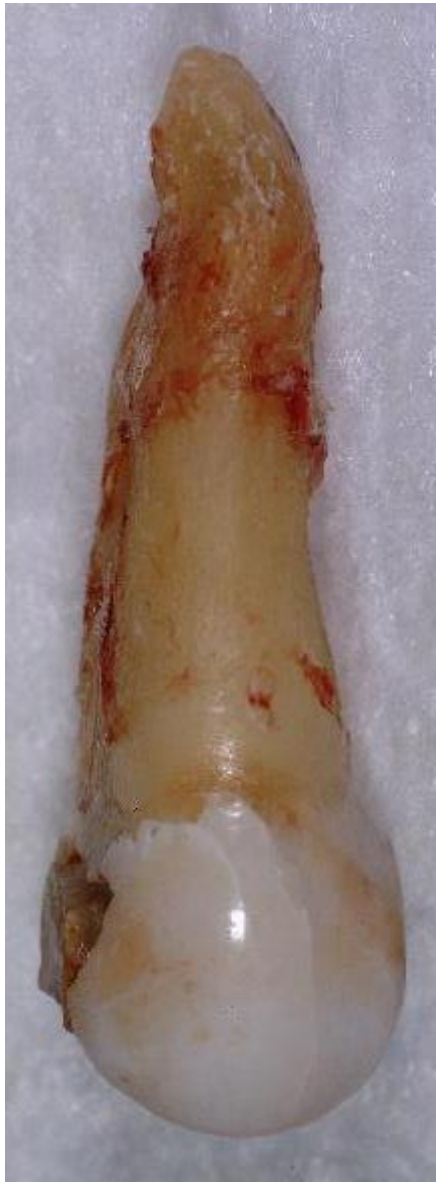
Case Study 1 “Joe”: **Contrateral bicuspids fracture nine years apart**

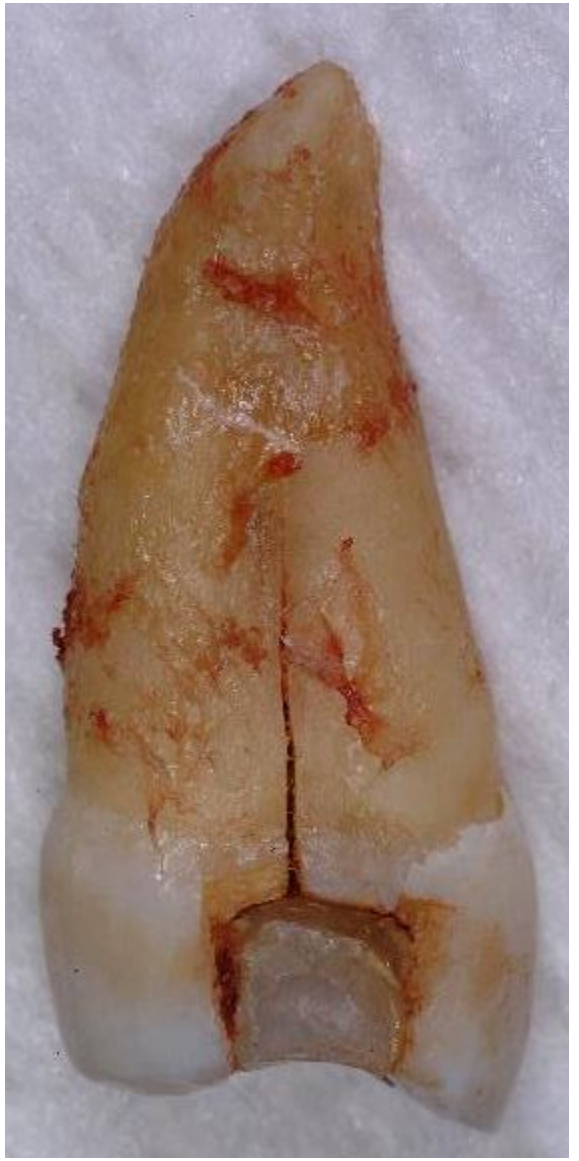
2012: Catastrophic fracture tooth #12. Endo tooth w/ traditional Class II Resin Restoration

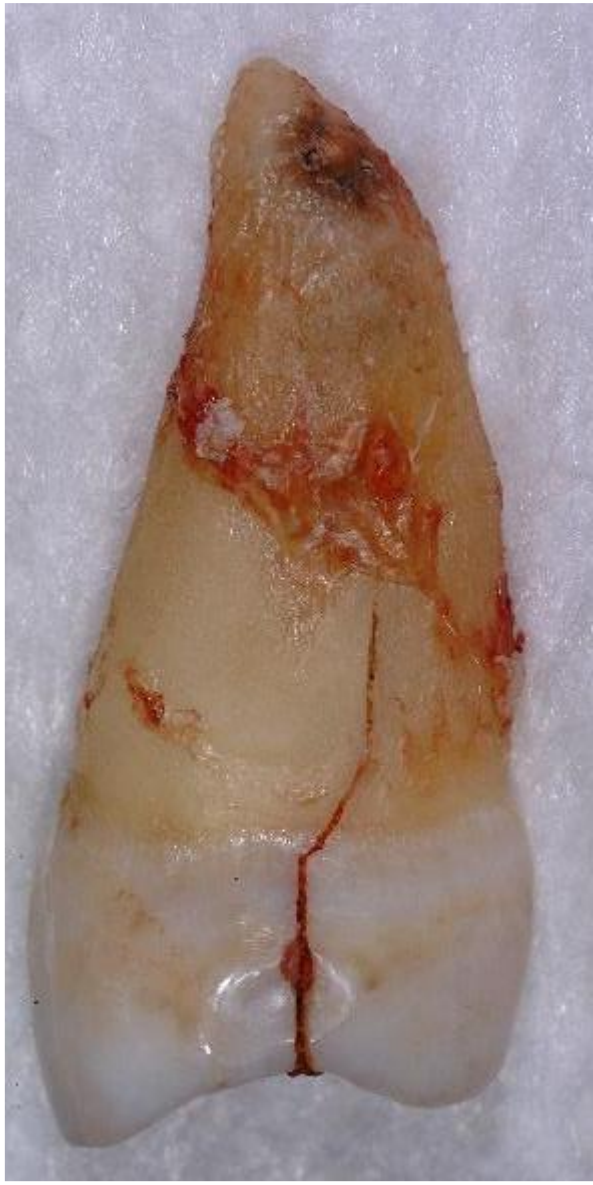
Case Study Joe bilateral bicuspid fractures



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

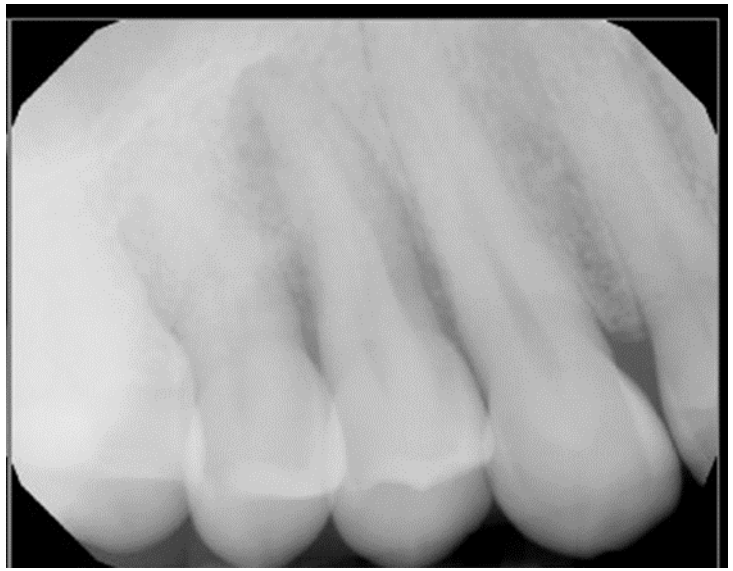
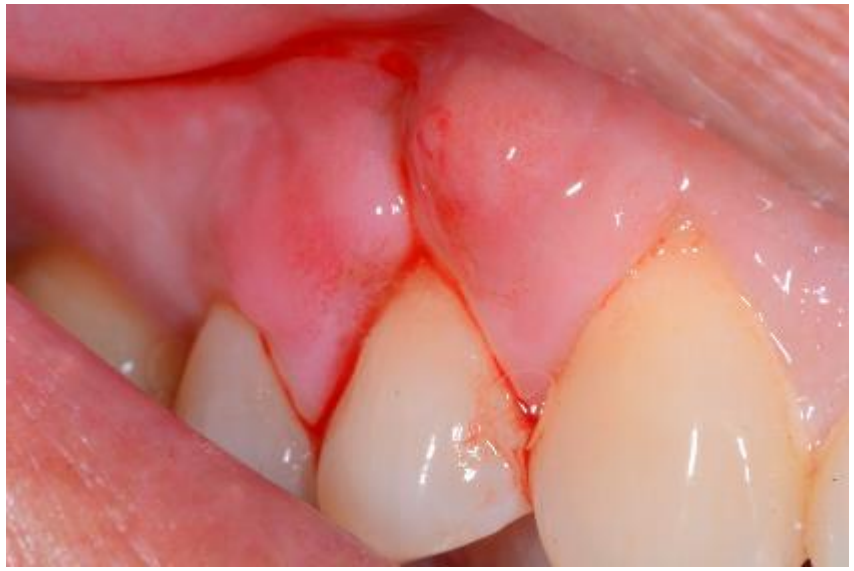
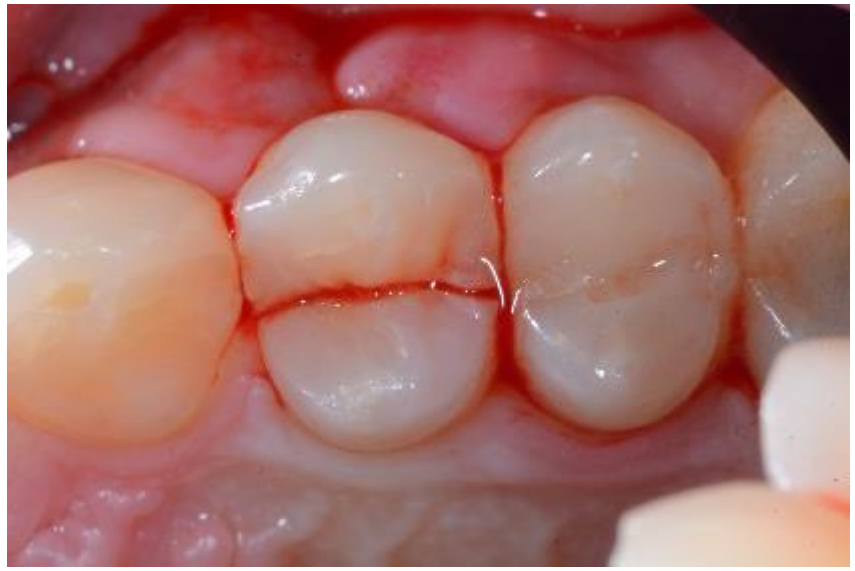






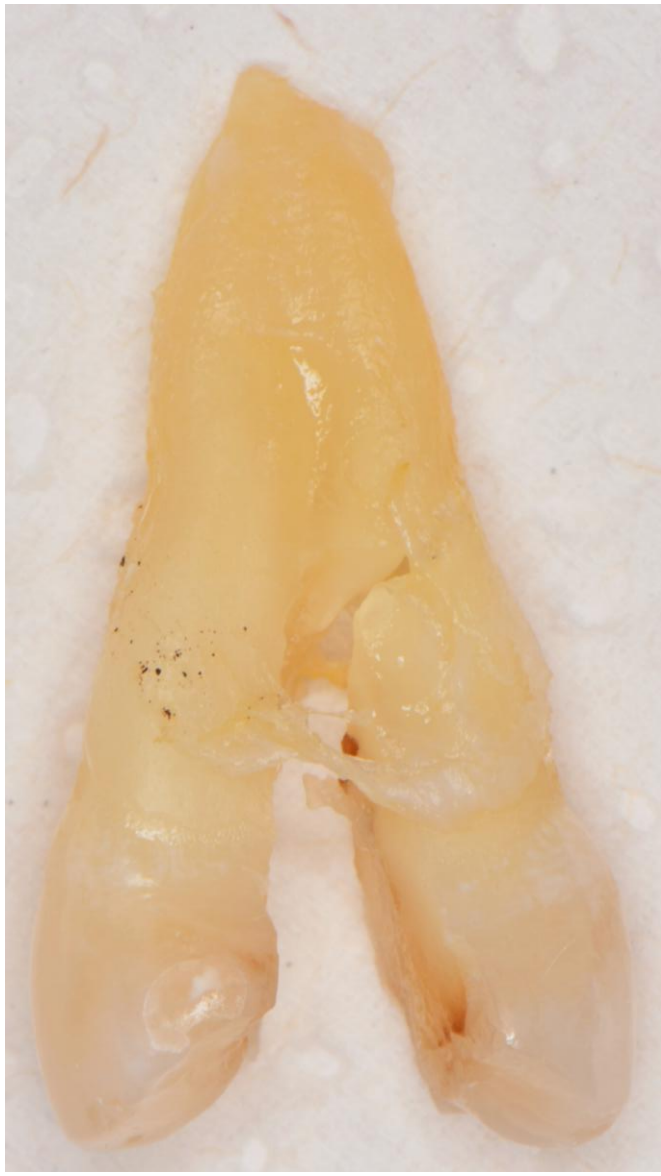
Case Study Joe bilateral bicuspid fractures

2021: Catastrophic fracture of #5. Virgin Tooth

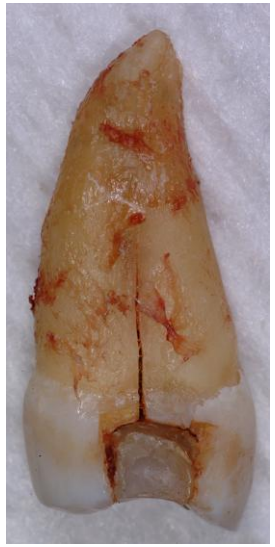
Case Study Joe bilateral bicuspid fractures

2021: Catastrophic fracture #12. Virgin Tooth

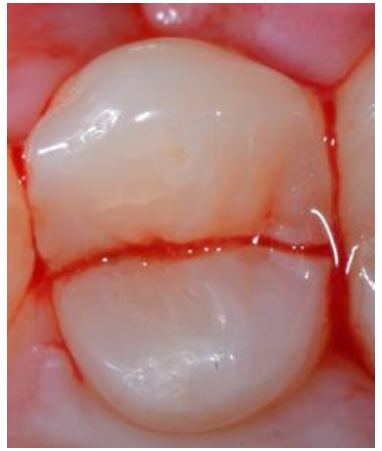


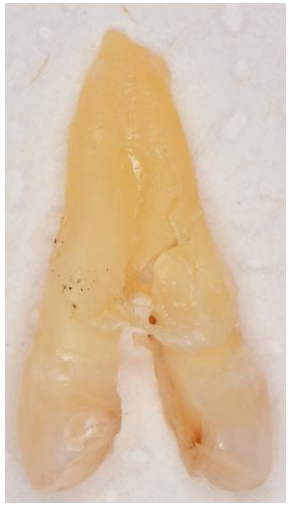
Case Study “Joe”: Discussion

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



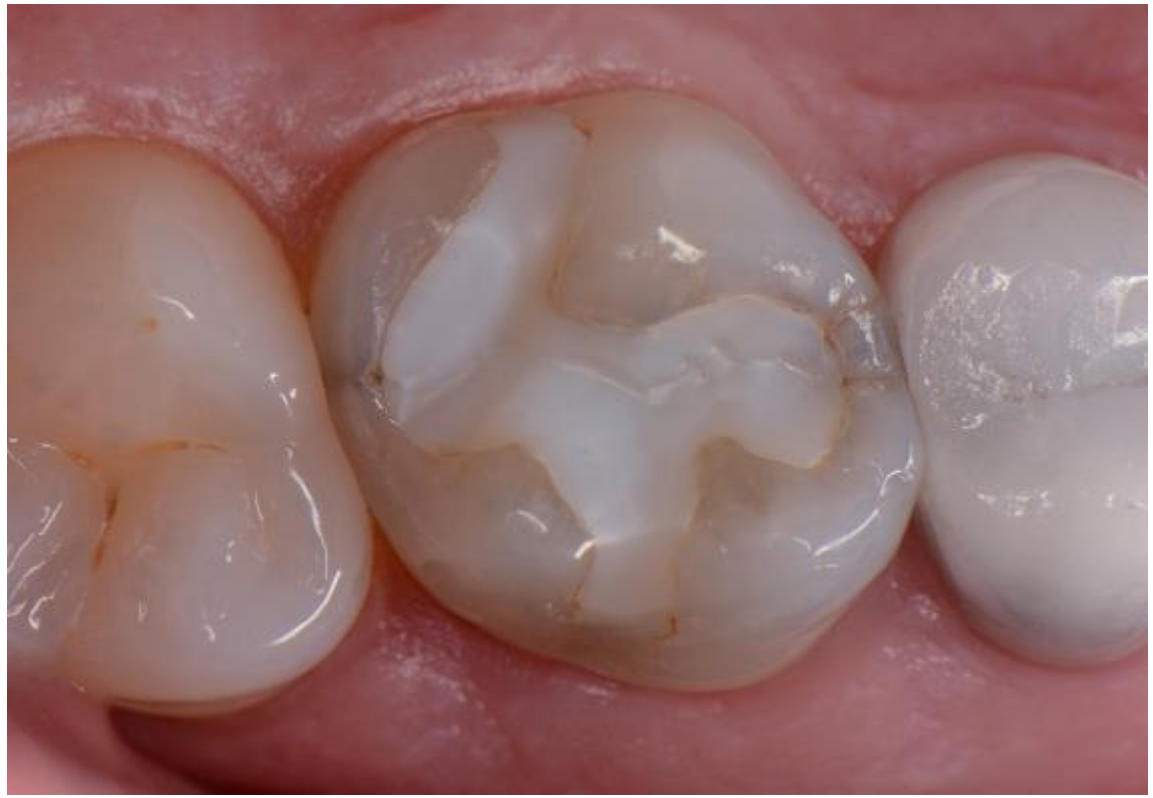
2021: Catastrophic fracture tooth #4. Virgin Tooth





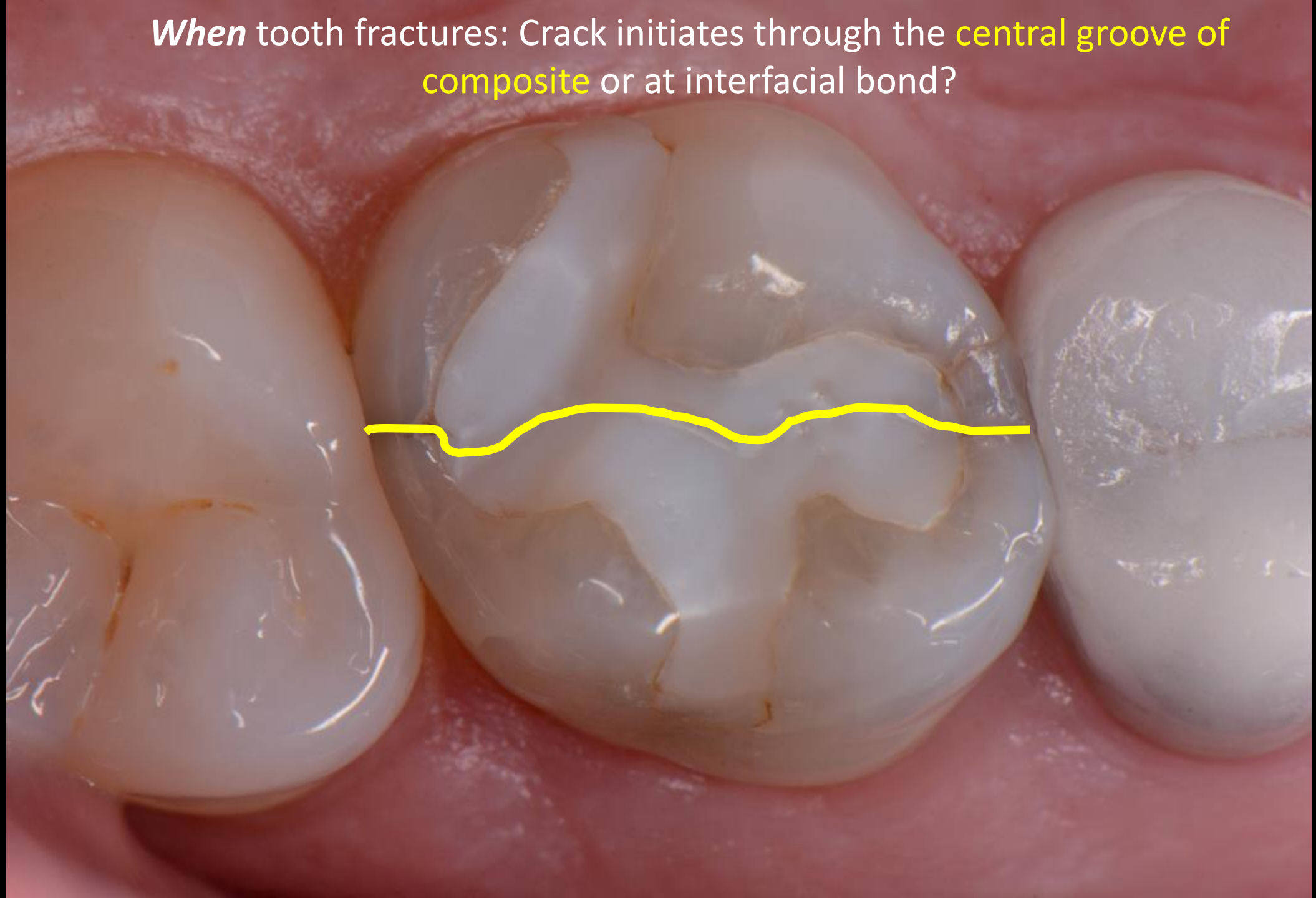
Case Study “Sue”: Traditional Parallel Walled Cavity Preparation (PWCP) 10 years post operative

2021: Asymptomatic tooth at New Patient Examination

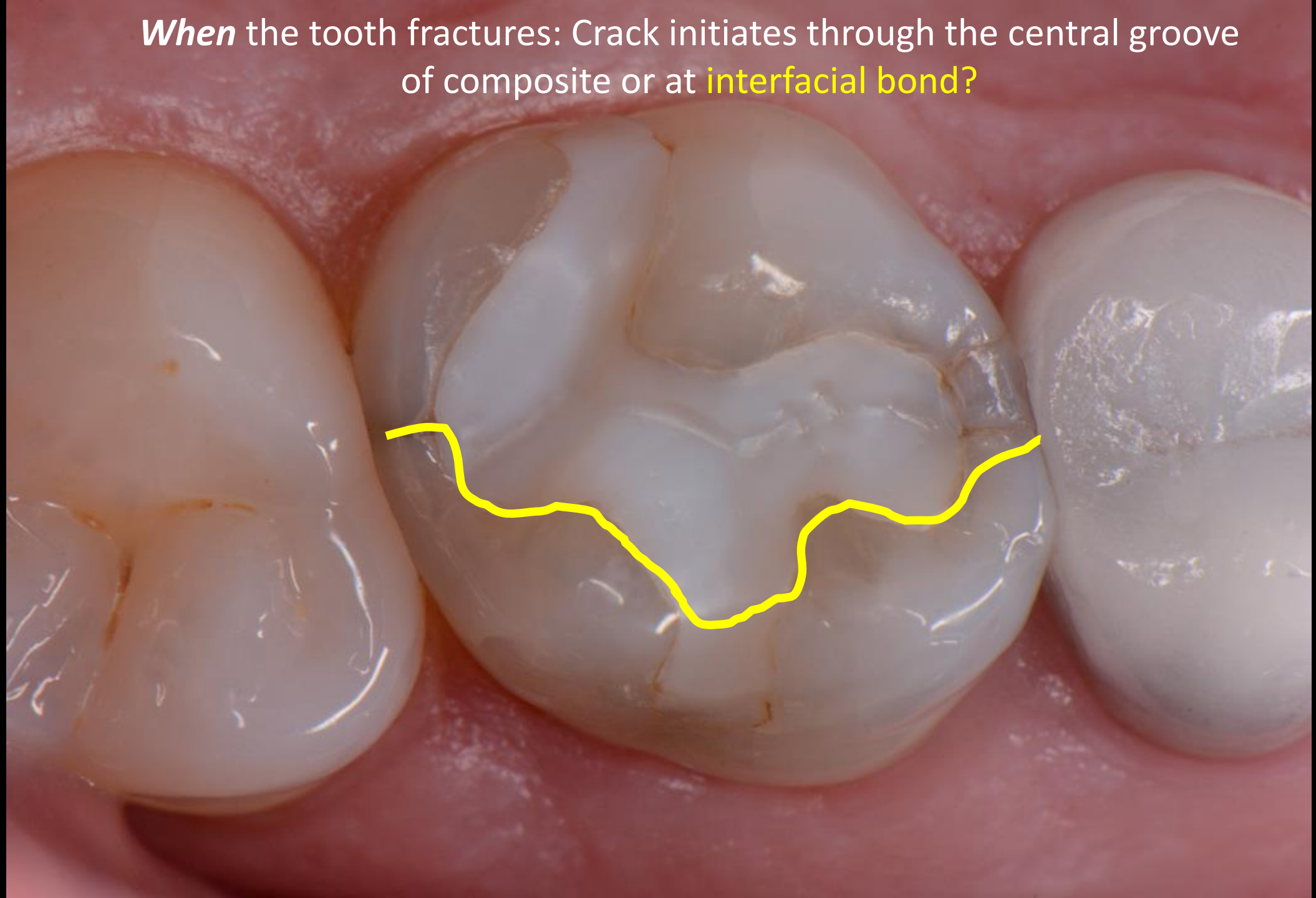


When the tooth fractures: Crack initiates at the central groove of composite or at interfacial bond.

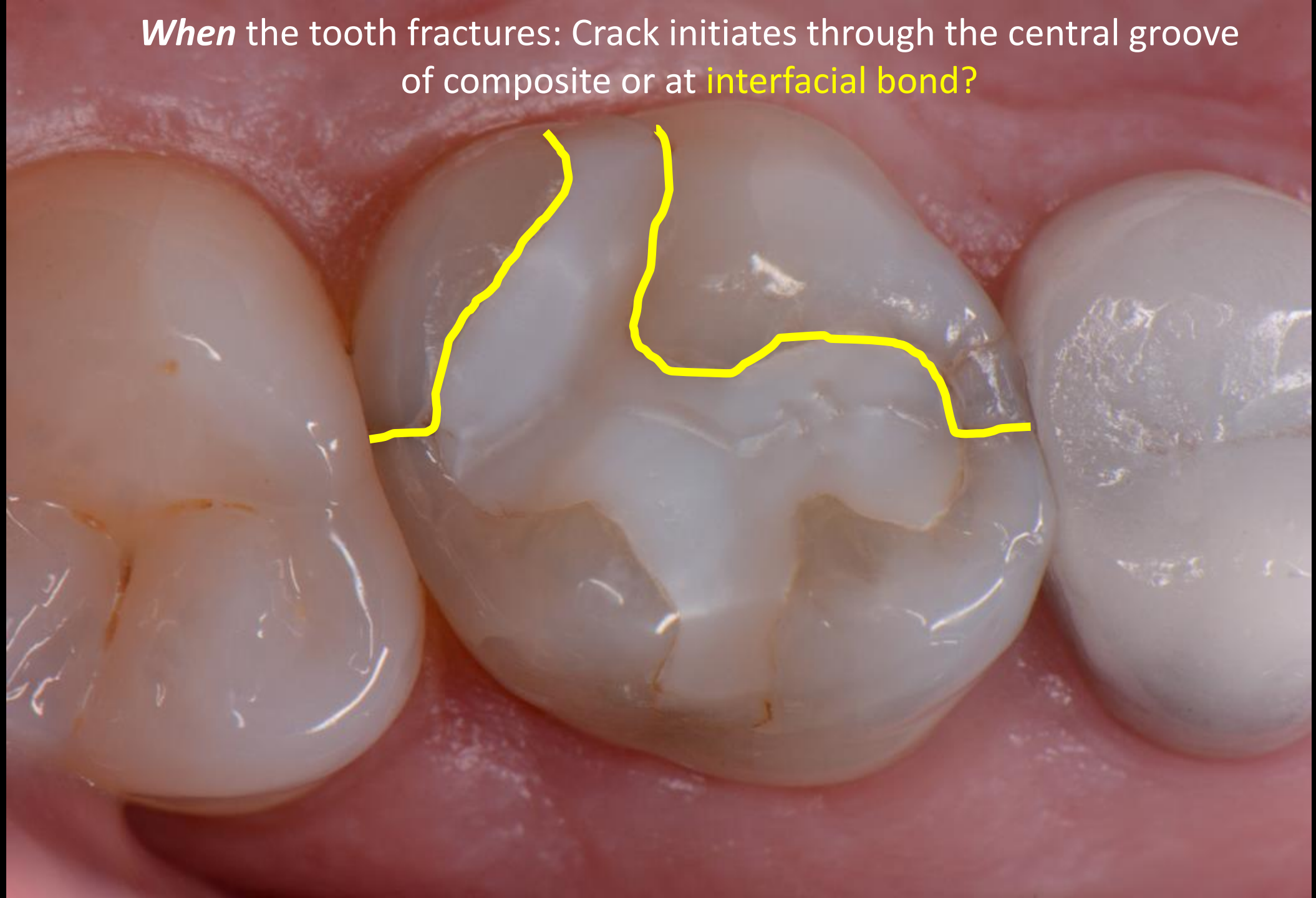
When the tooth fractures: Crack initiates through the central groove of composite or at interfacial bond?

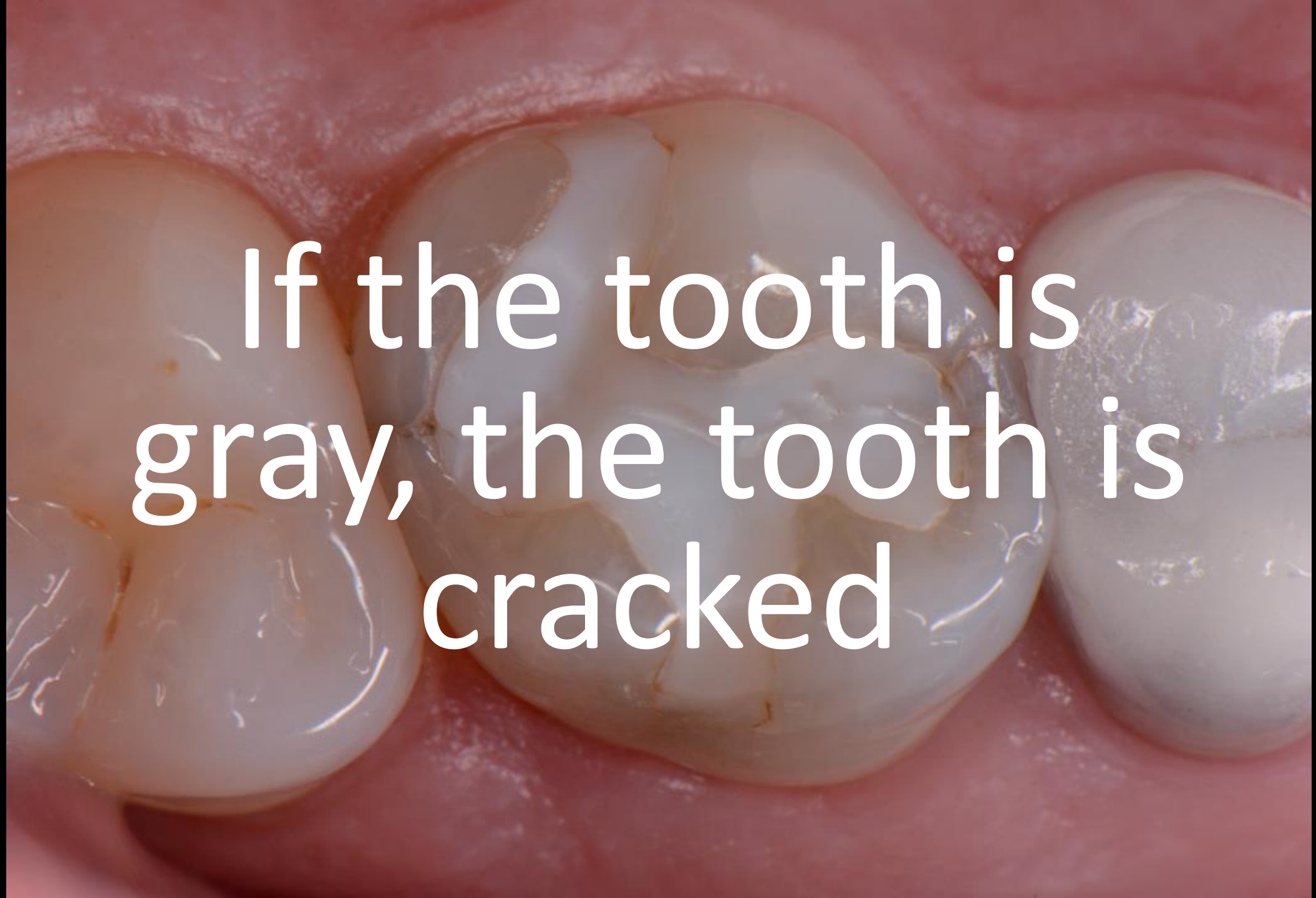

When tooth fractures: Crack initiates through the central groove of composite or at interfacial bond?

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



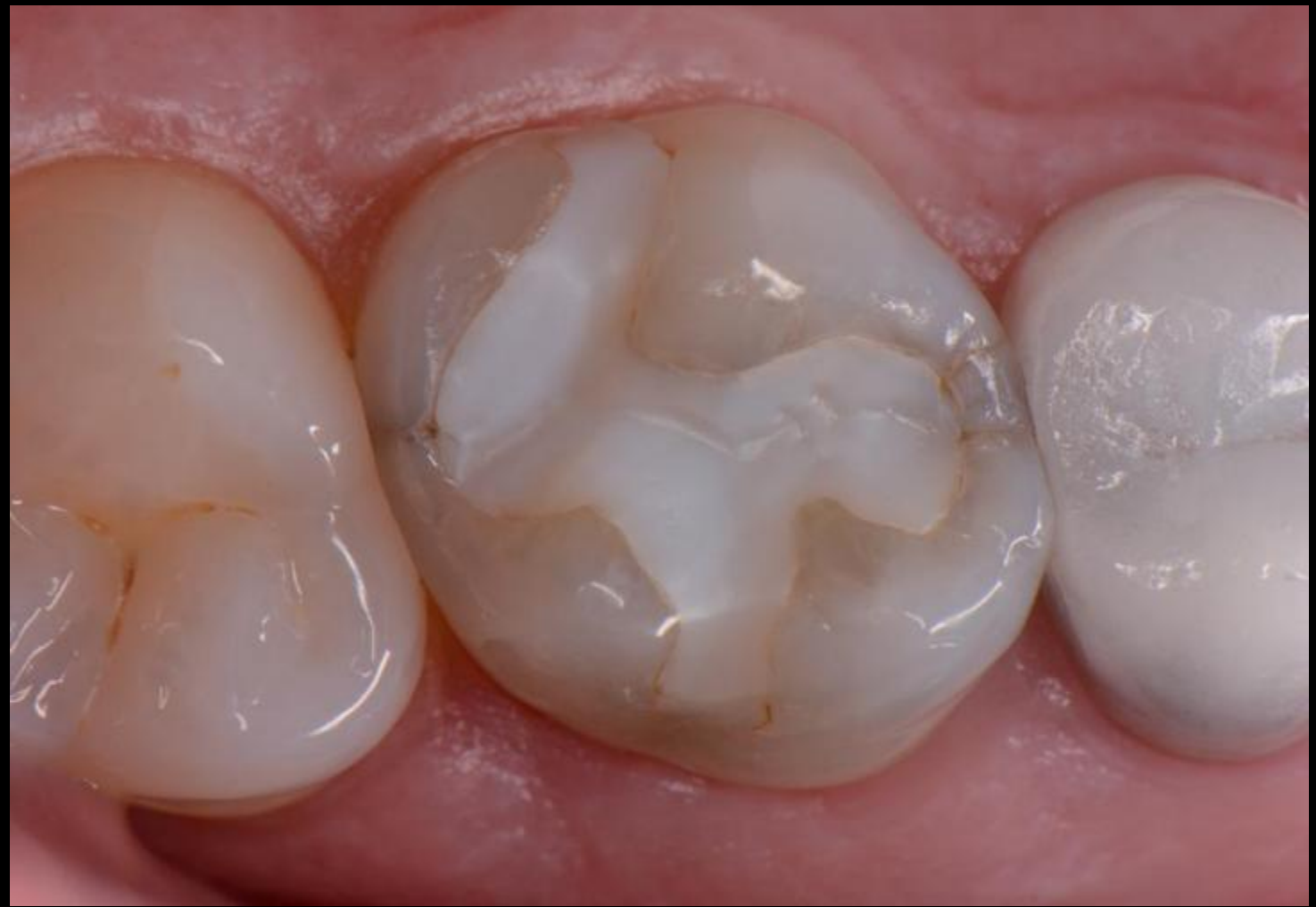
When the tooth fractures: Crack initiates through the central groove of composite or at interfacial bond?




If the tooth is gray, the tooth is cracked

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

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



Studies Supporting the Bioclear Method

Complete

- Comparing Conventional to Saucer-Shaped Cavity Designs

  Dr. Alex Fok, BEng, PhD, MSc
  Dr. Hooi Pin Chew, BDS, PhD, FDSRCS
  MN Dental Research Center for Biomaterials and Biomechanics

- Comparison of Class II Adaptation and Placement Times

  Dr. Richard Price, BDS, DDS, MS, FDS RCS, FRCD(C), PhD
  Dept. of Clinical Dental Sciences & Biomedical Engineering Dalhousie University

- Effect of Preheating/Fatiguing/Thermocycling on Mechanical Properties

  Taiseer A. Sulaiman, DDS, PhD
  Assistant professor, Division Director of Operative Dentistry and Biomaterials, UNC School of Dentistry

- 3M Extraction and Pulp Temperature Testing

  Brad Bagley, PhD, DABT Advanced Toxicology Specialist

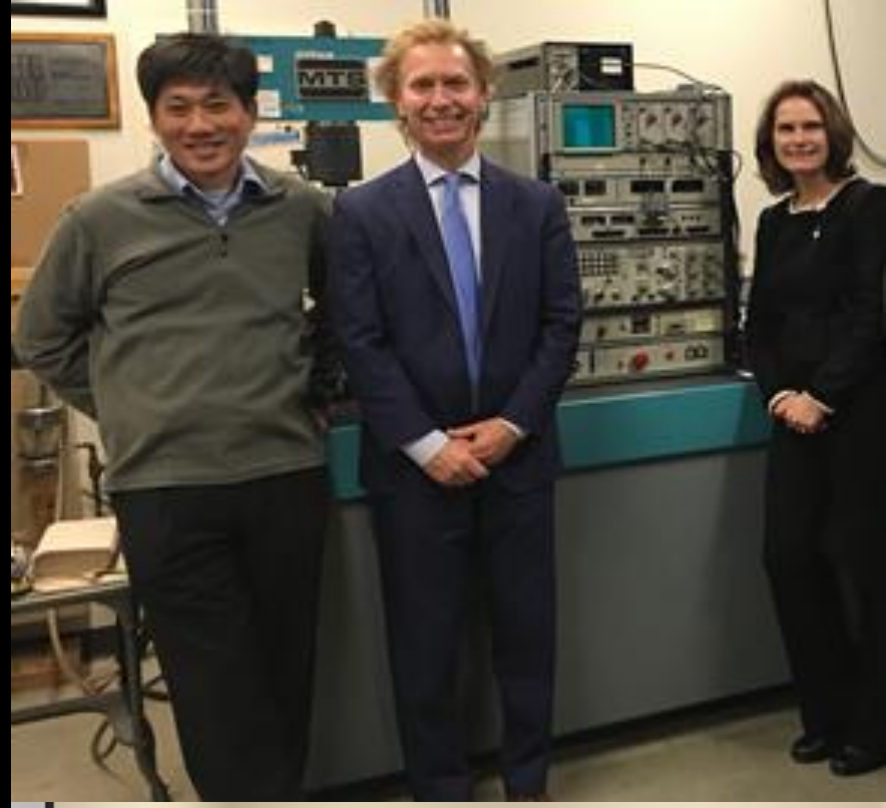
- 3M Material Property Testing Including Injection Molding

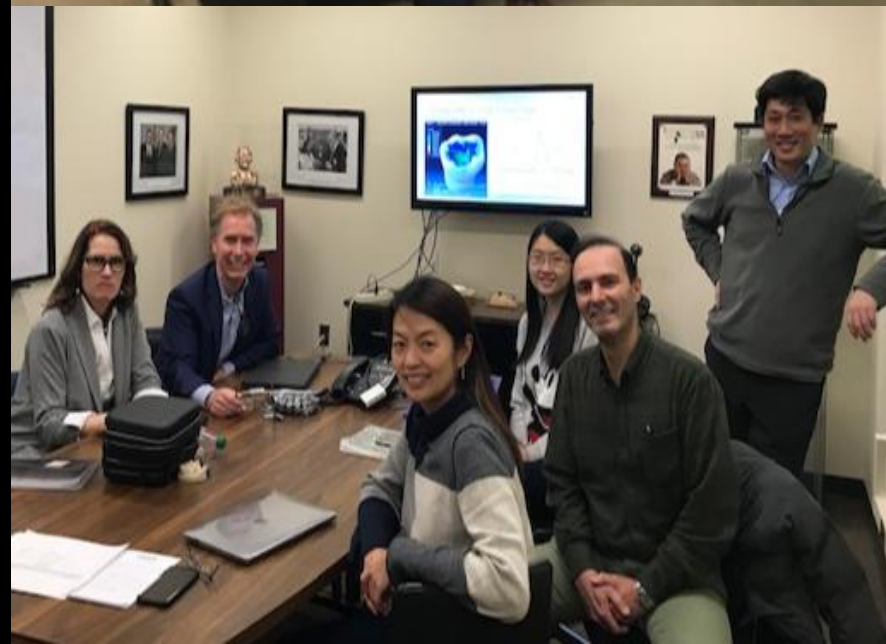
  Timothy D. Dunbar, Ph.D. Advanced Product Development Specialist

In Process

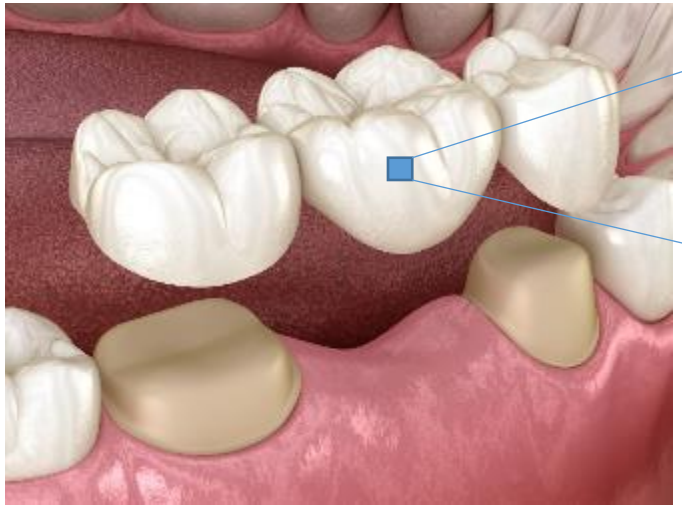
- Biofilm Adhesion Study

  Sabrina F. Sochacki, DDS, MS, PhD
  Indiana University School of Dentistry

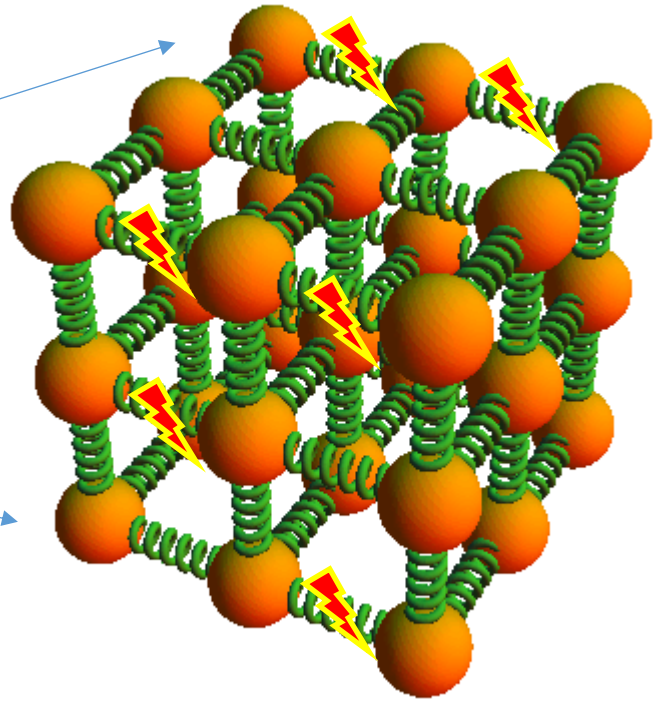


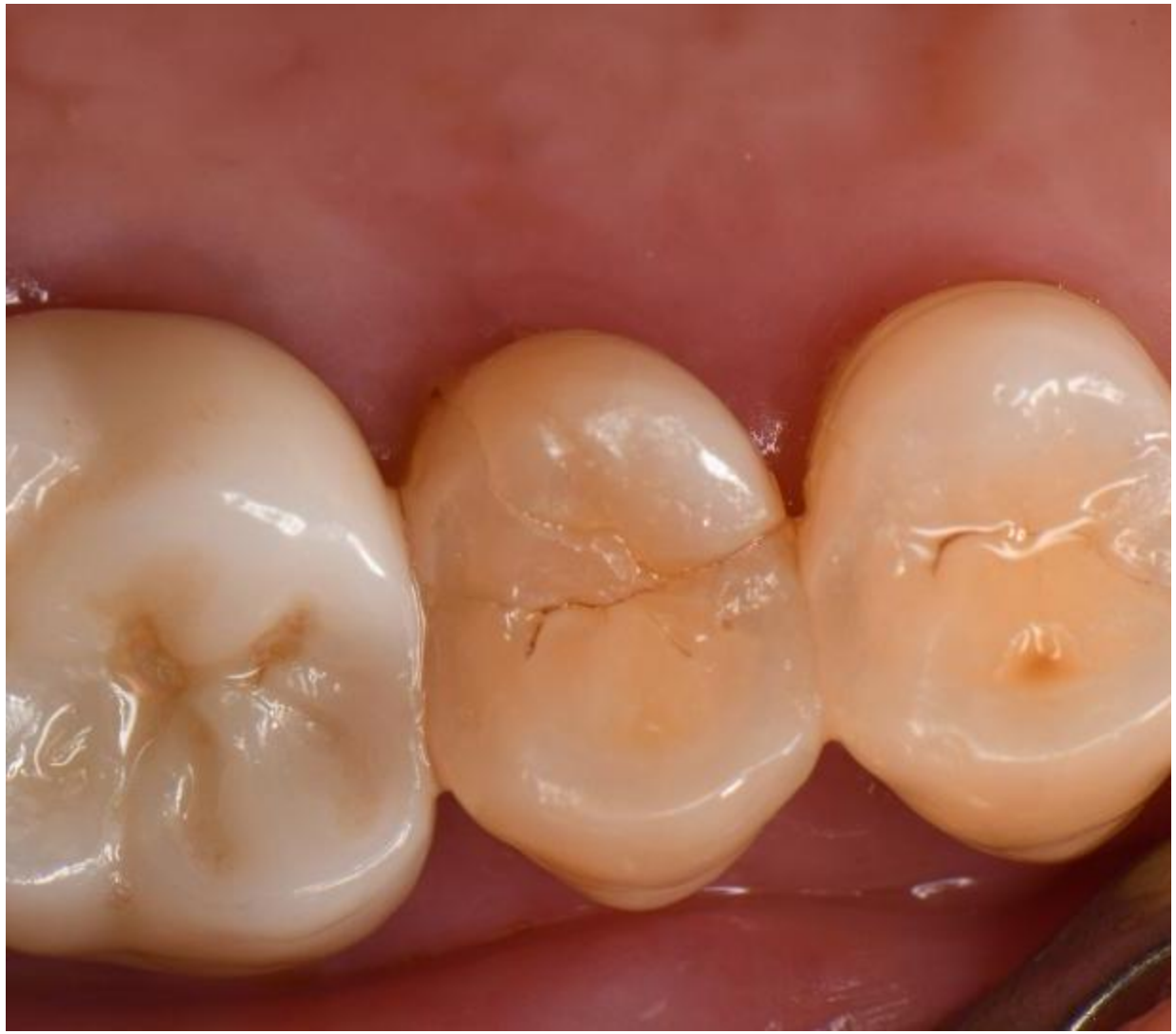


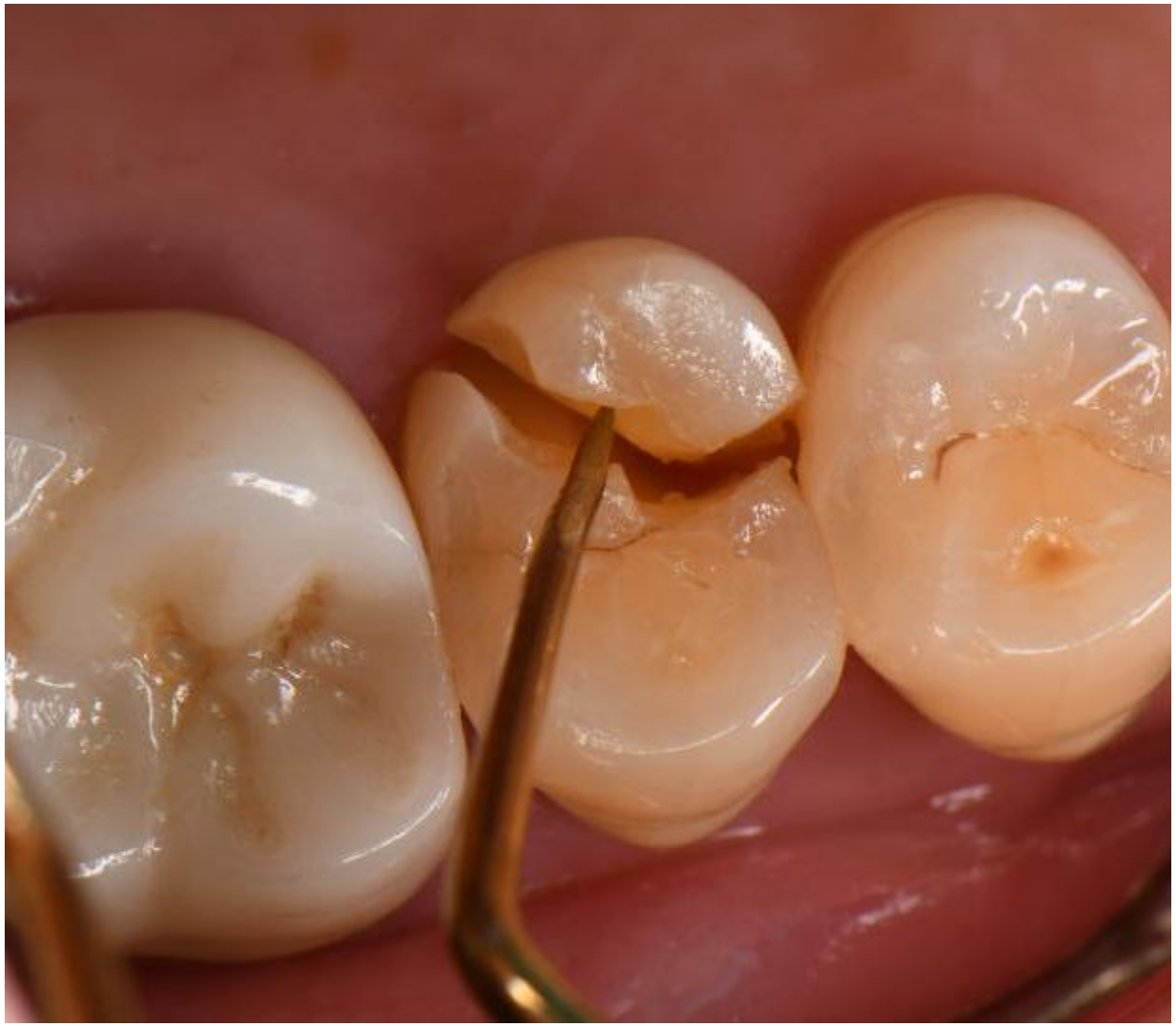
Basics of Solid Mechanics



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

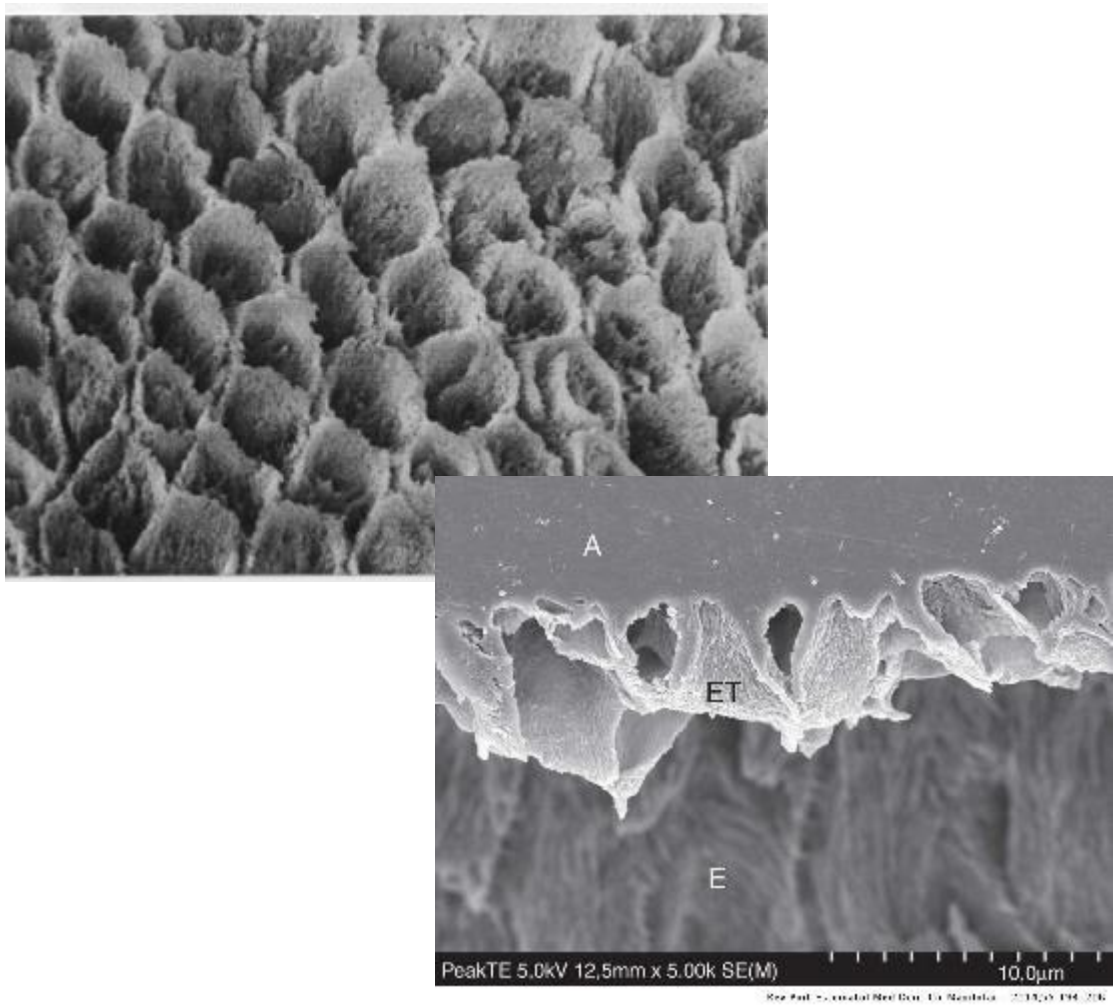


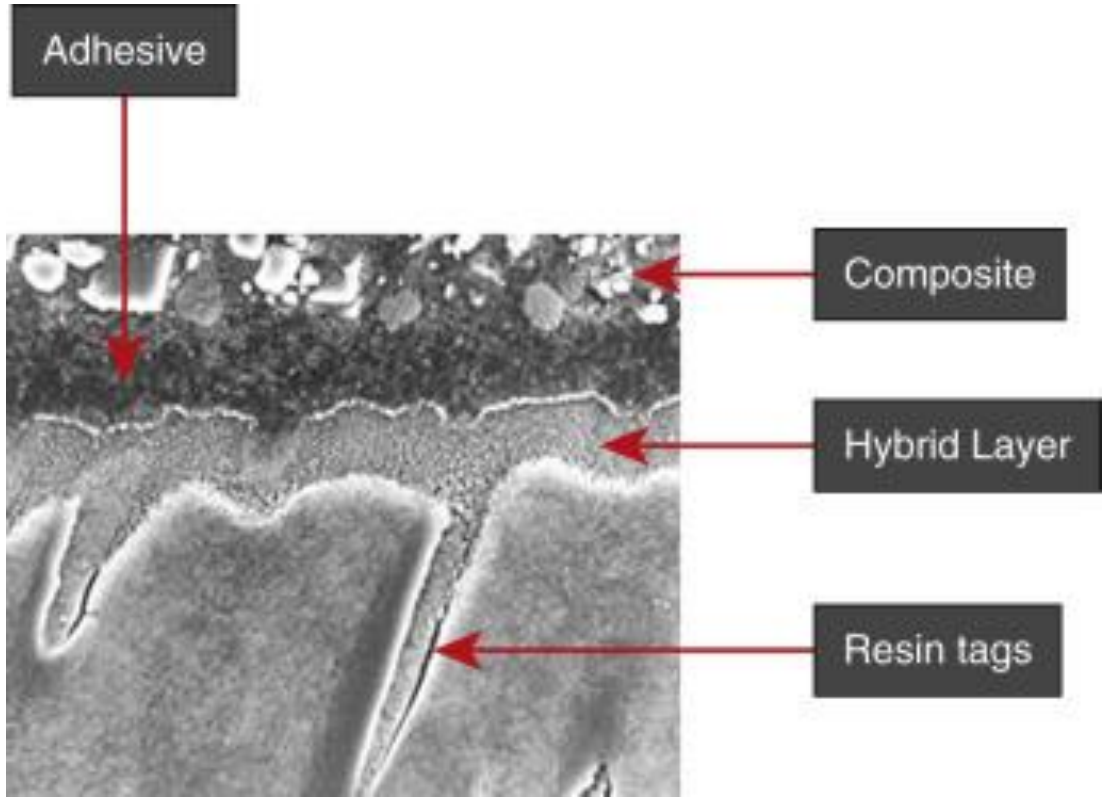




Enamel vs. Dentin Bonding

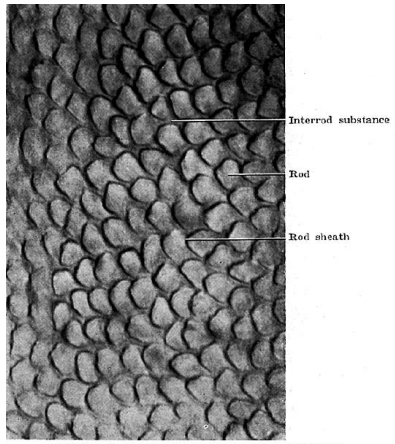
Bonding to enamel is mostly micromechanical.



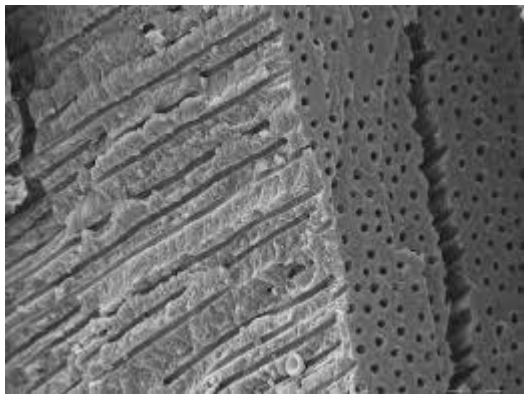


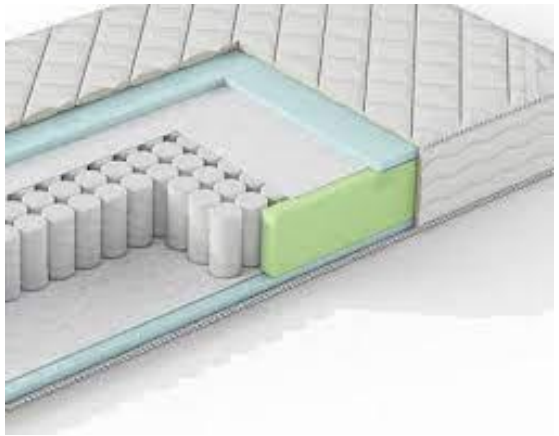
Bonding to dentin is more complicated, involving a hybrid layer and exposed collagen that are prone to enzymatic attack.

Anisotropy : tooth tissues



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

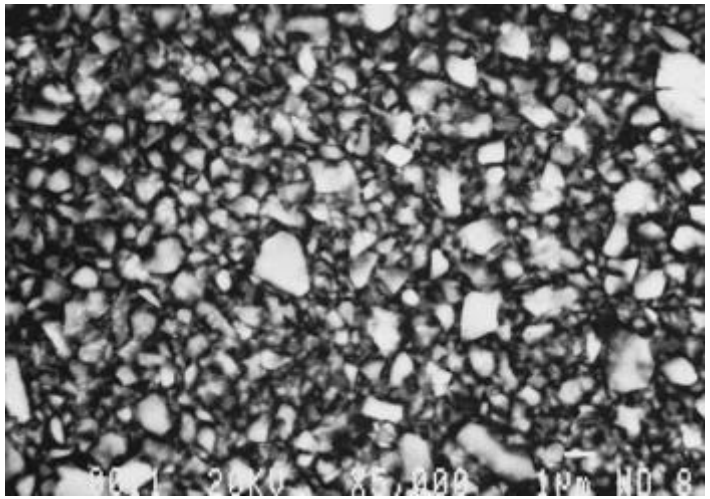


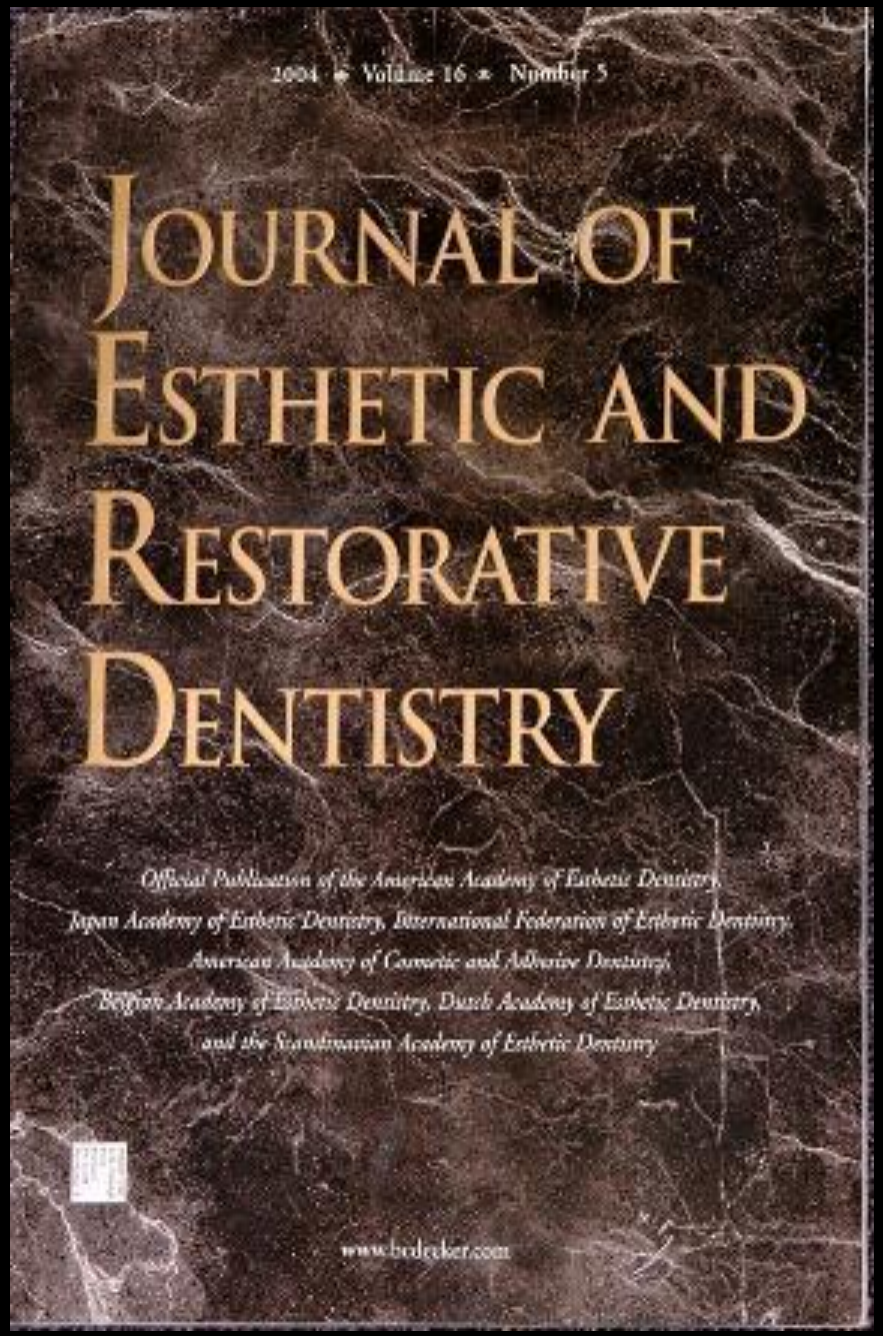


No bending stresses

vs.

Isotropy: resin composite





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

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

ABSTRACT

The diagnoses of cracked teeth and incomplete coronal fracture have historically been symptom based. The dental operating microscope at ×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 destruction 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 ×16 magnification. The significance of enamel cracks as they relate to dentinal cracks is detailed.

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

Microscopic and surgeon-driven diagnoses have been the accepted modalities for cracked teeth. The inherent limitations of the lack of visual confirmation result in diagnosis that often come too late in the treatment process. One lasting first impression of vision through a clinical microscope is the staggering array of cracks that exist within tooth structures. Traditional visualization (unaided or ocular assisted) limits the clinician's ability to assess the presence or severity of the majority of these cracks (Figure 1).

At extreme magnification levels (×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 clues can lead restorative dentists to more appropriate early treatment of compromised teeth before devastating fractures, pulpal involvement, and periodontal breakdown occur. The value of early diagnosis of the structural breakdown of teeth will become even more significant with our aging population coupled with increased tooth retention in this population.

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†Co-owner/director, Newport Coast Oral Facial Institute, Newport Beach, CA; clinical professor, Restorative Dentistry, USC School of Dentistry, Los Angeles, CA, USA
‡Co-owner/director, 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**

Nomenclature and classification of enamel cracks

Where are we with cavity shapes?

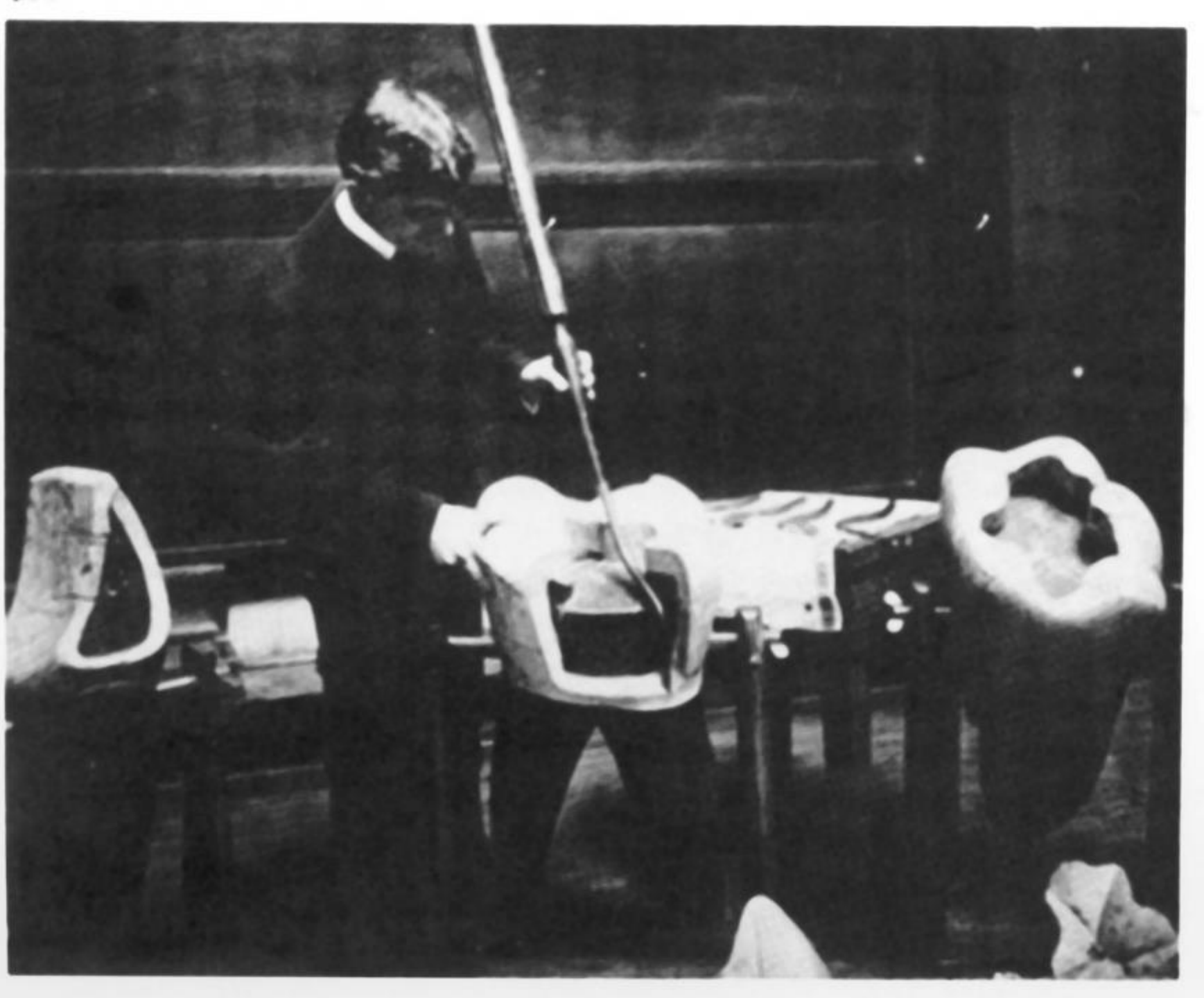
1890

G. V. Black,
M.D., D.D.S.,
Sc.D., LL.D.,

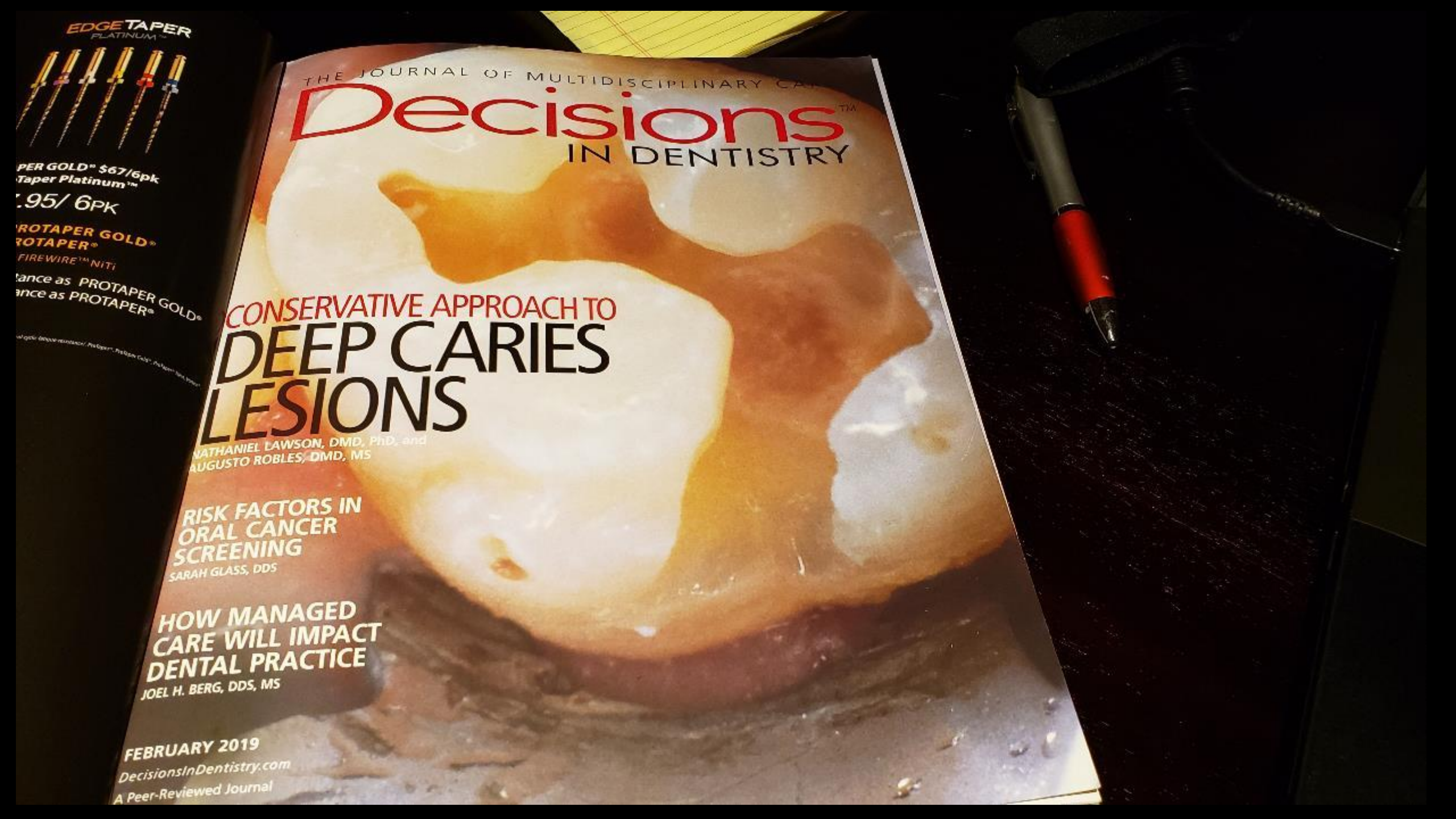
1836-1915

Mortice and Tenon Joints

Necessary for Mechanical Retention of Amalgam




FARM TOUGH
Husqvarna


EDGETAPER
PLATINUM
PER GOLD" $67/6pk
Taper Platinum™
.95/ 6PK
ROTAPER GOLD®
ROTAPER®
FIREWIRE™ NiTi
tance as PROTAPER GOLD®
ance as PROTAPER®
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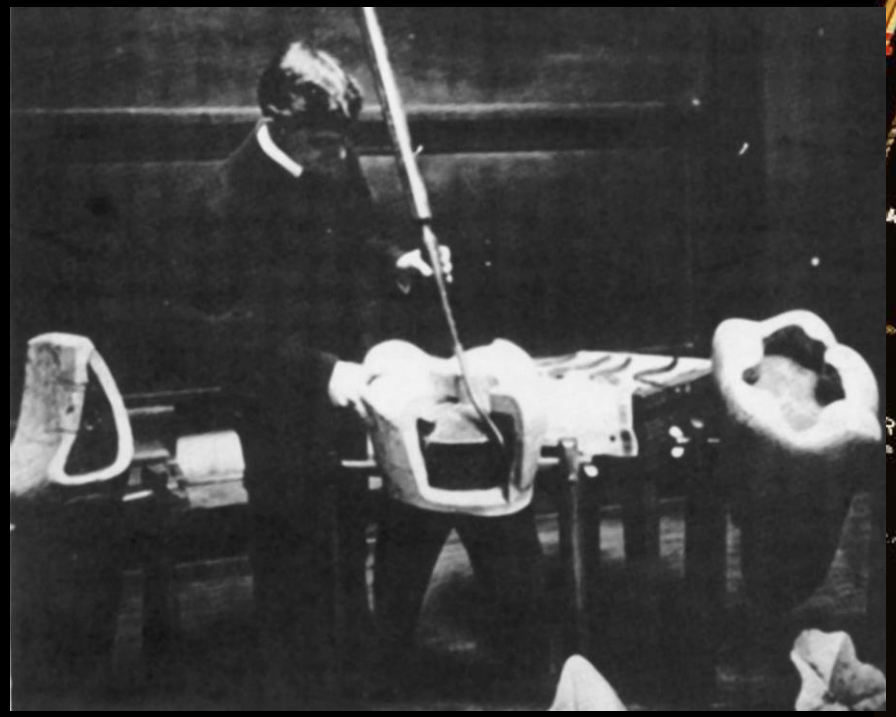
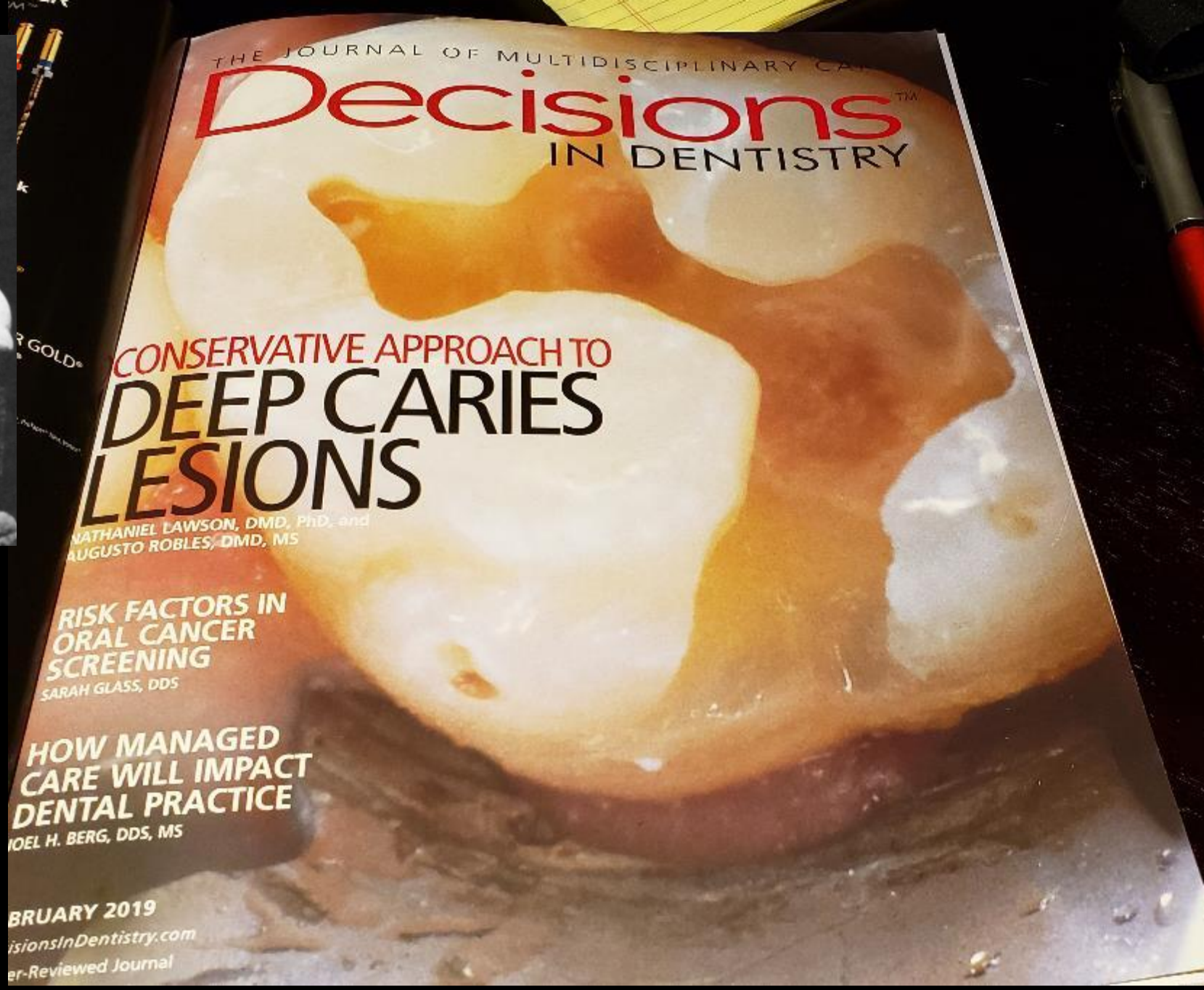
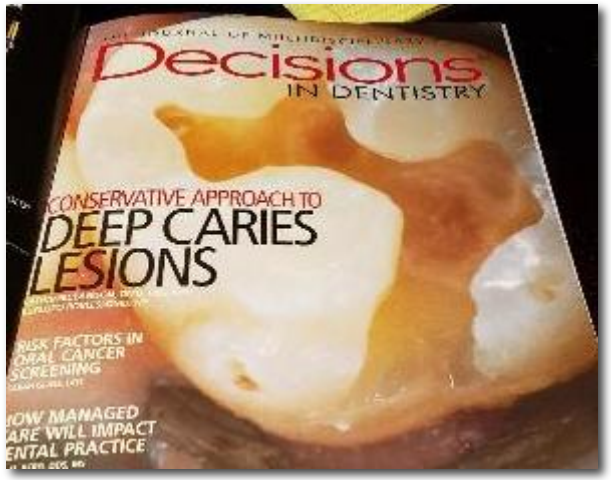


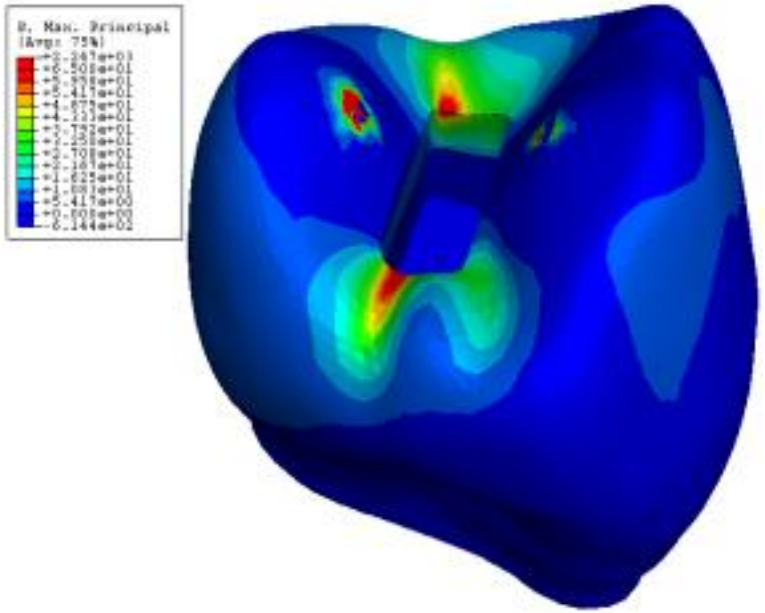
Is this the year 2026 or 1890?



Stress/Strain Concentration

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



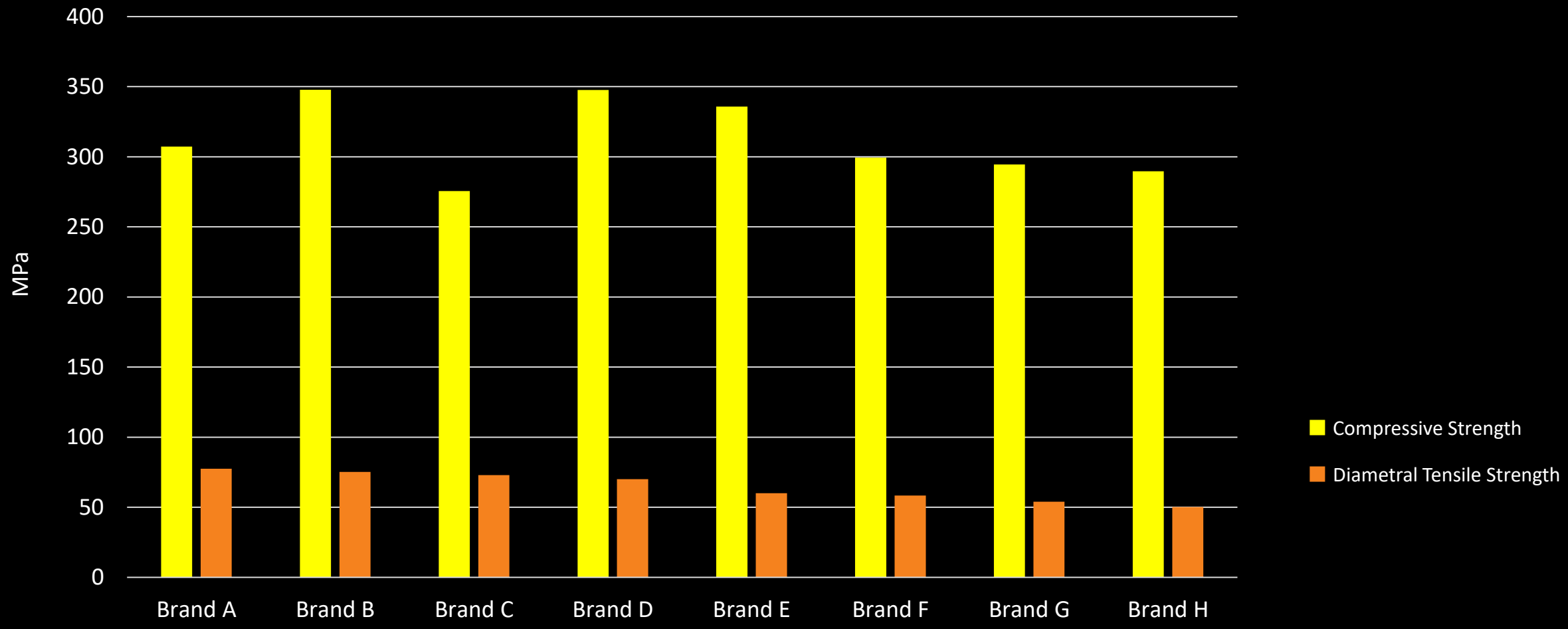


Epidemic of Cracked Teeth…Why?

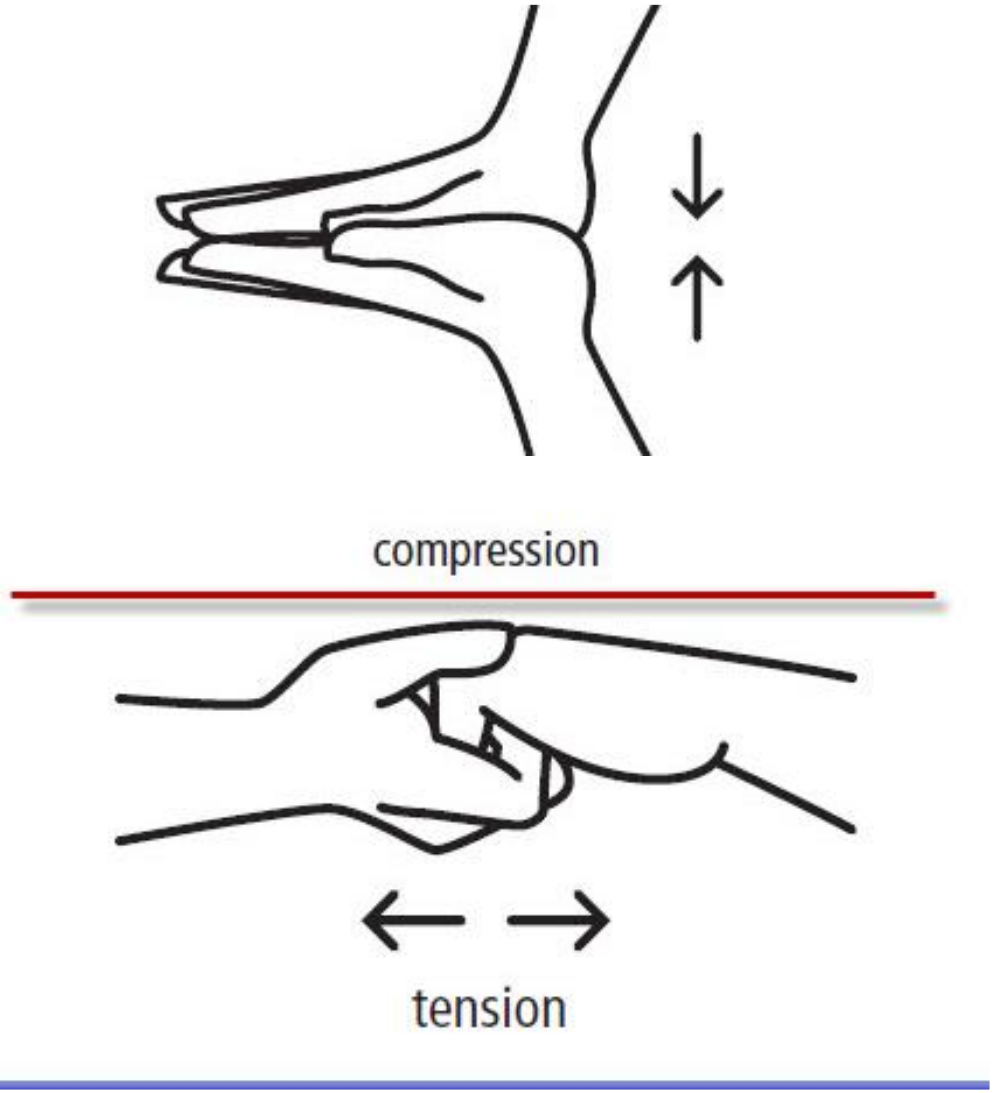
Brittle Materials with Tension joints

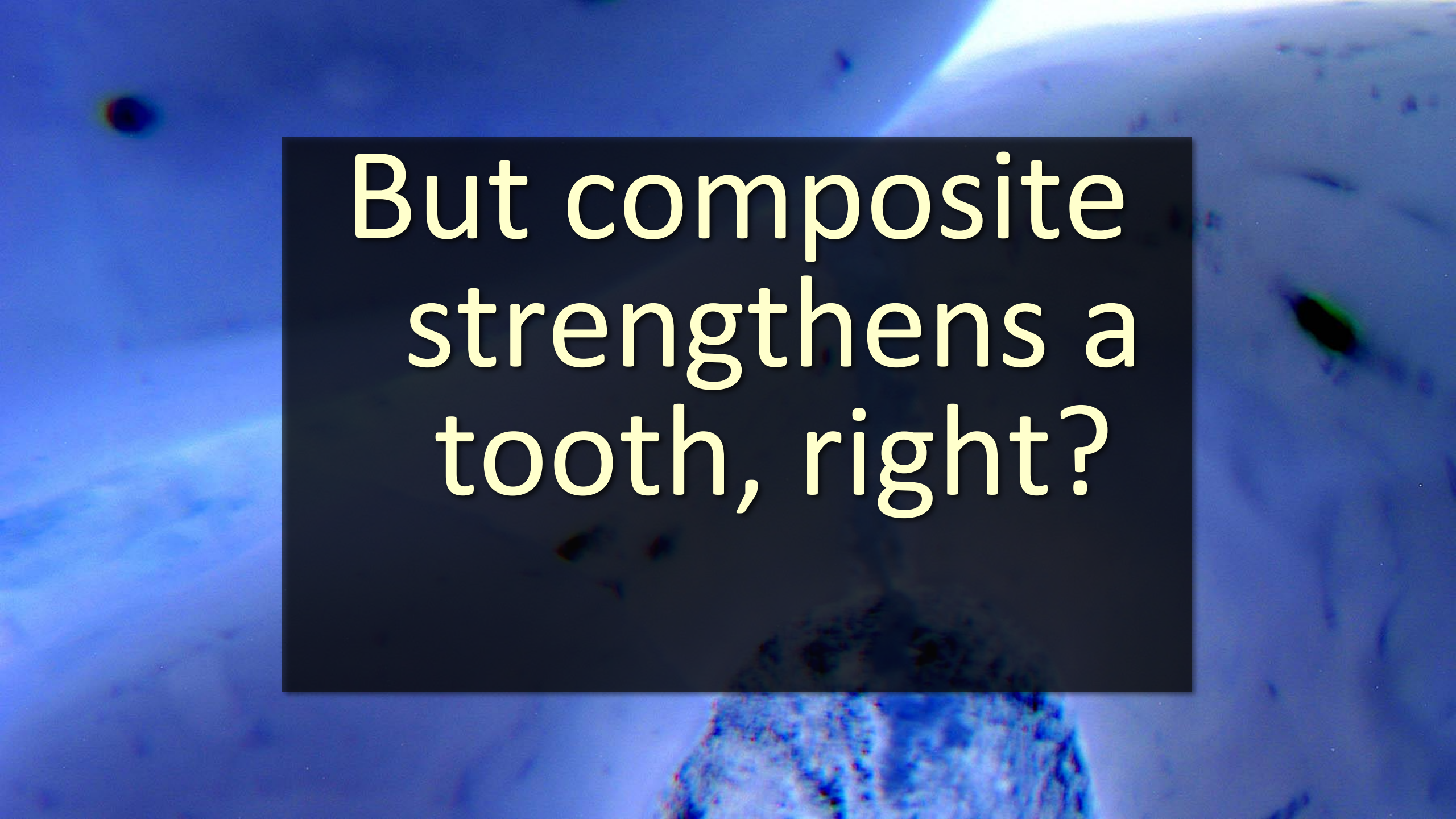
Composite Resin Material Properties

Compressive vs Diametral Tensile Strength



Compression vs. Tension is “Engineering 101”

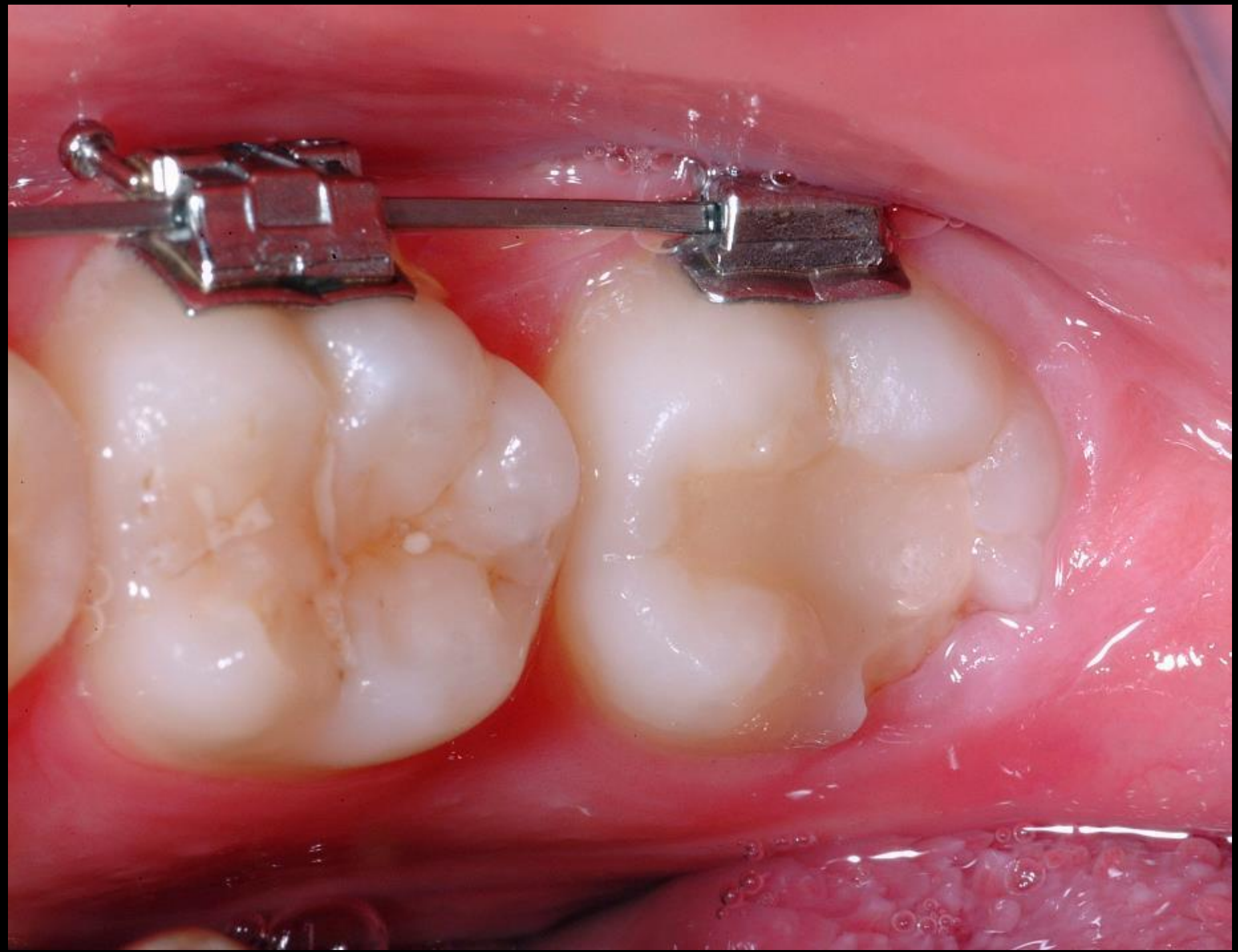


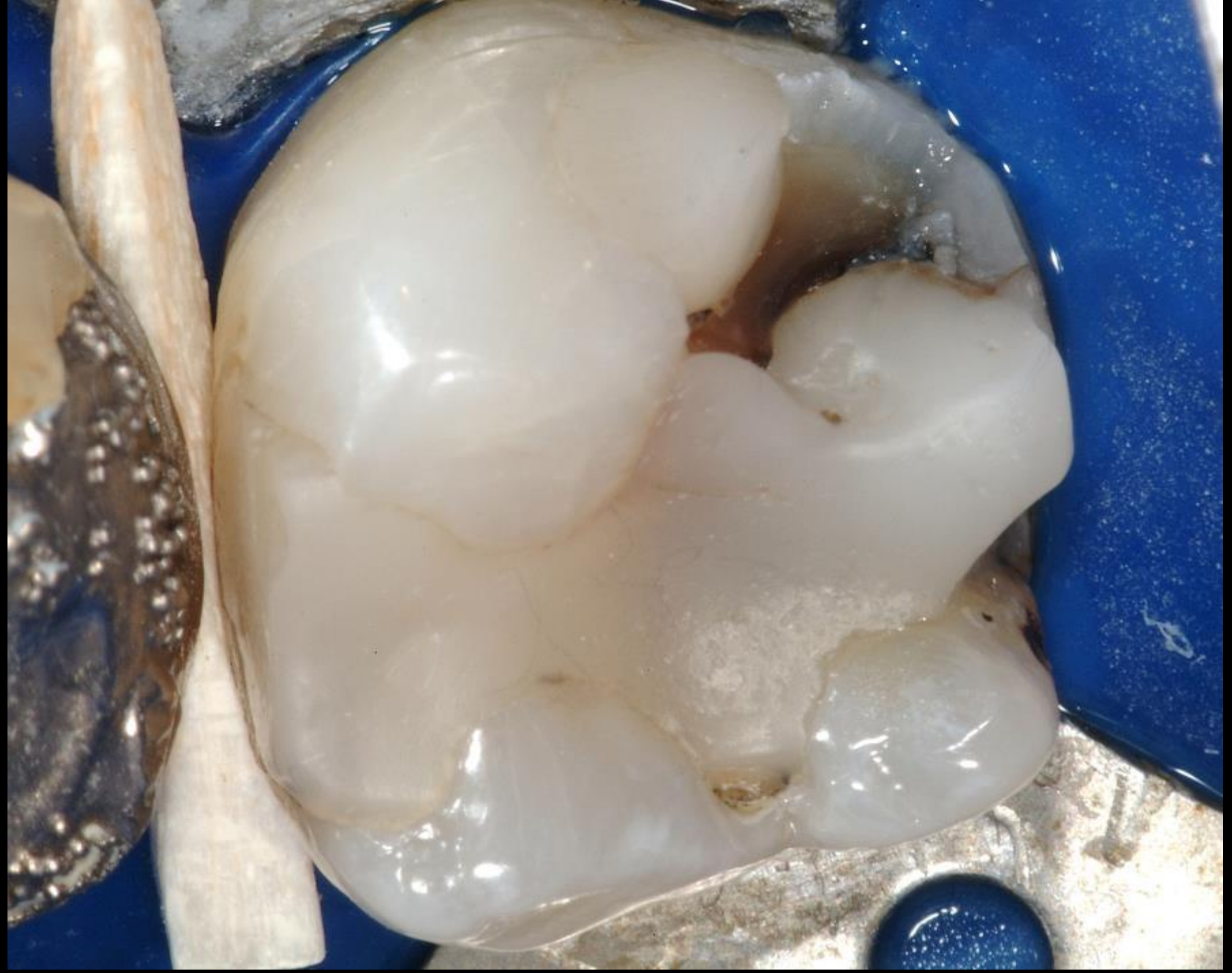

But composite strengthens a tooth, right?

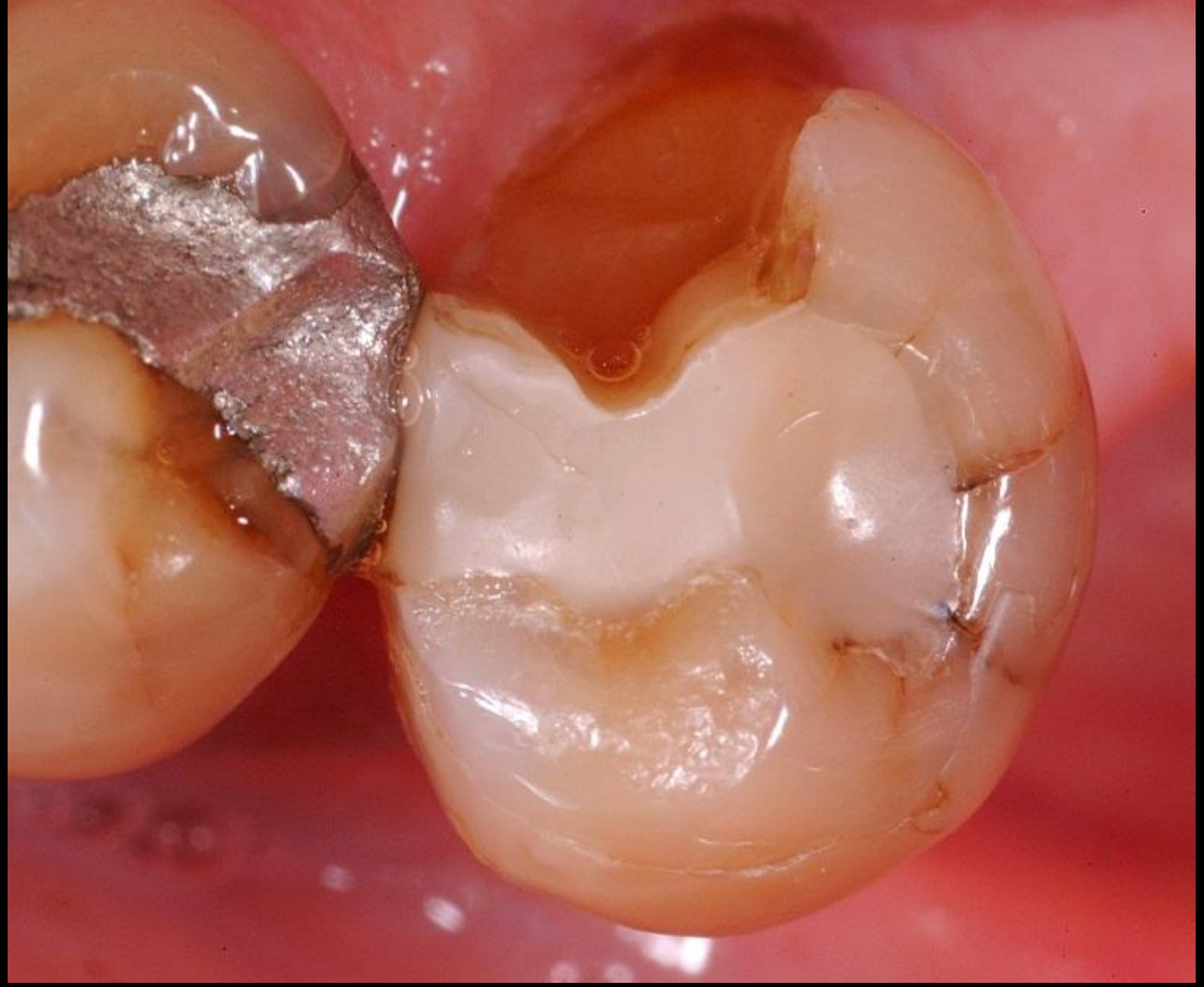
Does composite strengthen the tooth?

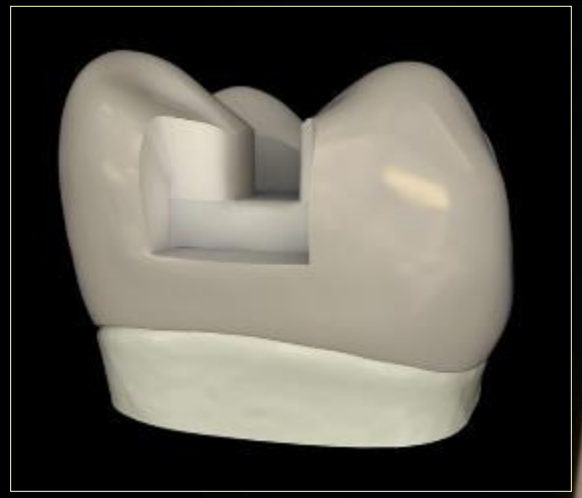
No more than does amalgam

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)





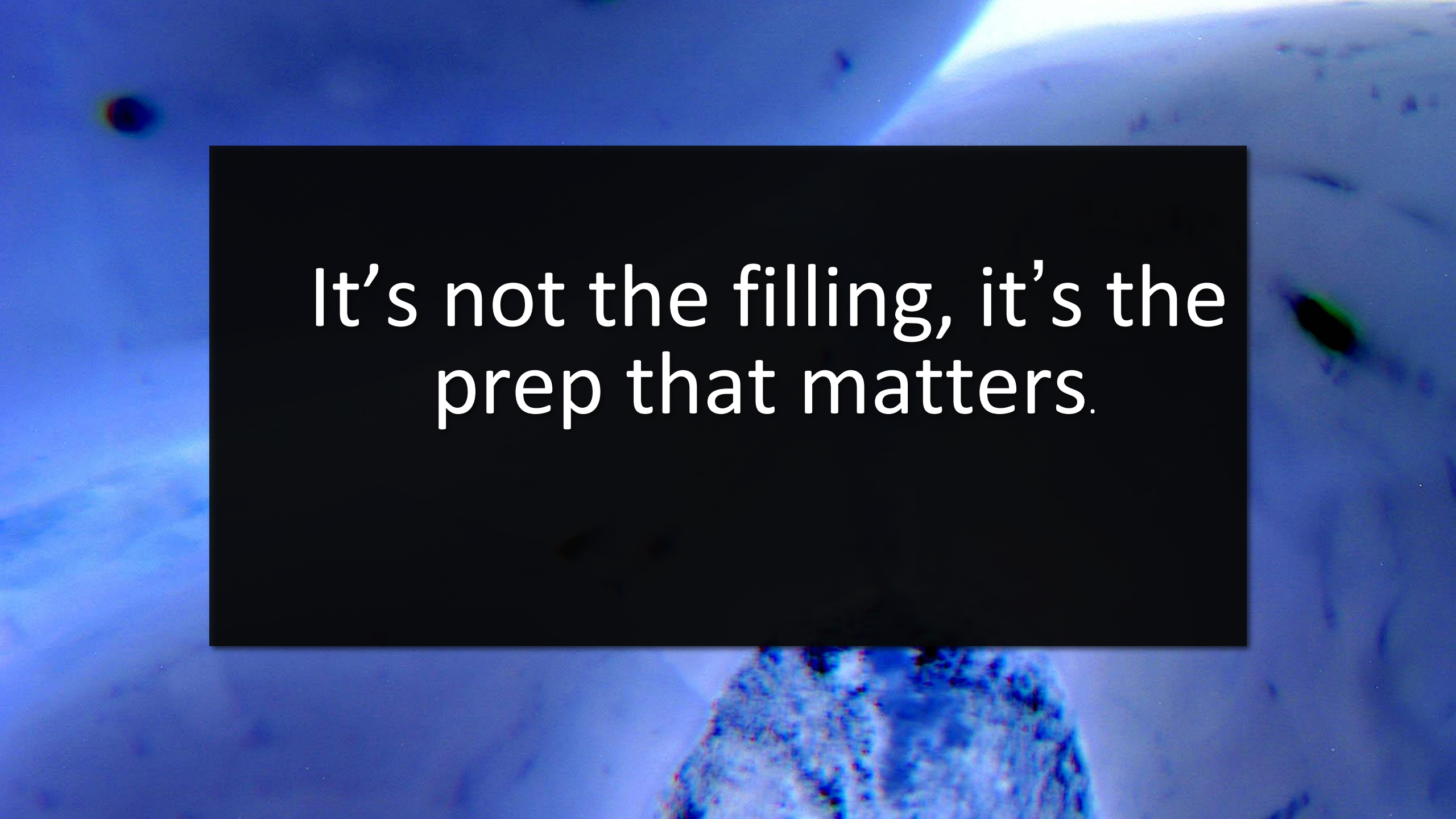




Boxes are bad.

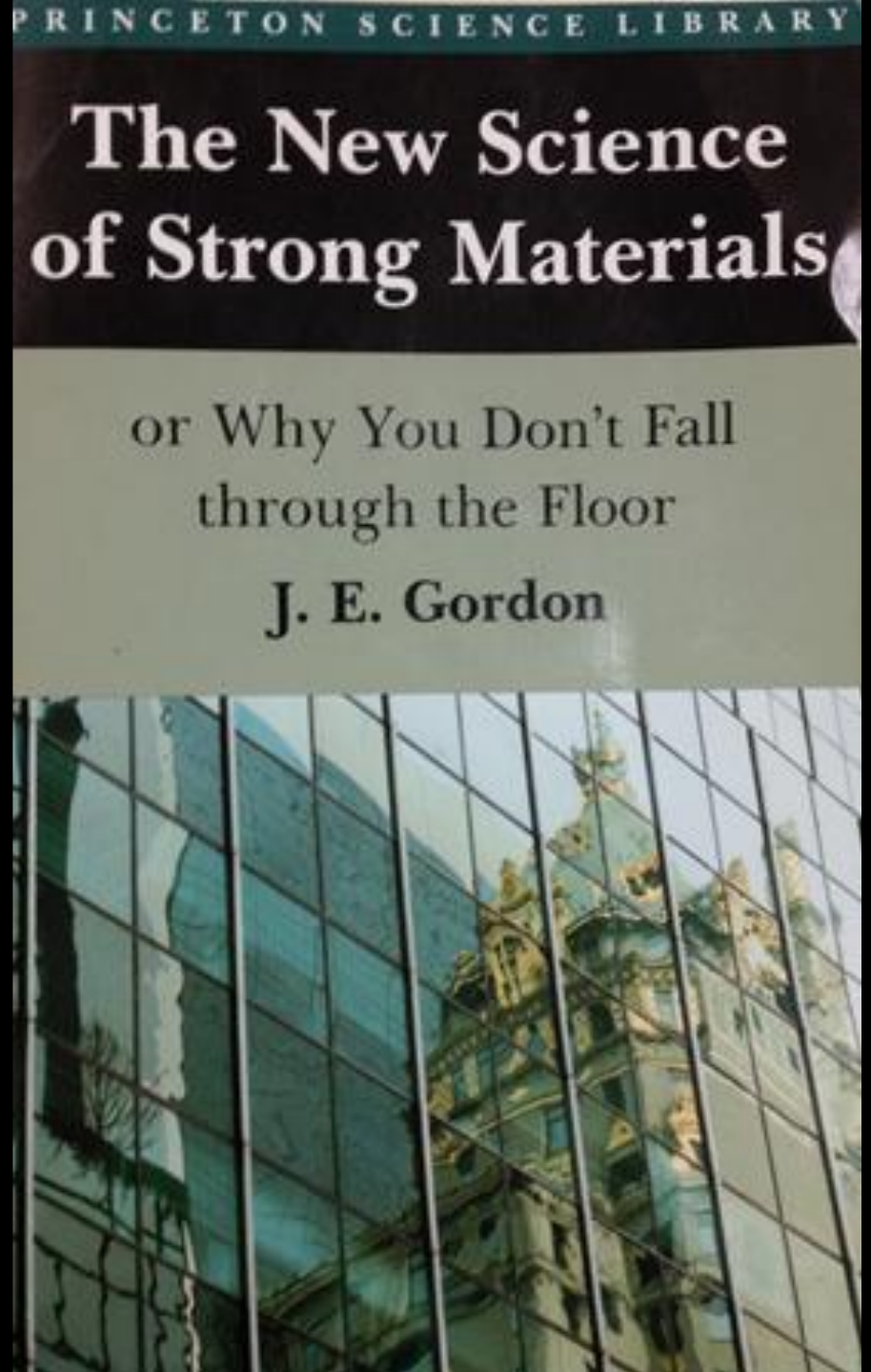
Bevels make them less bad.

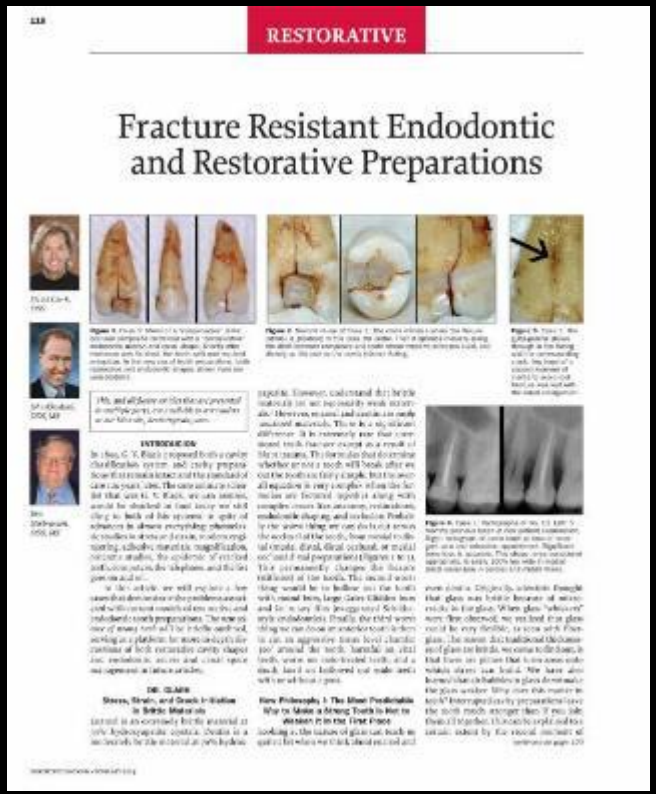
The Clark Class II replaces beveling with radius walls.


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


MAGNIFICATION

The Epidemic of Cracked and Fracturing Teeth




RESTORATIVE

Fracture Resistant Endodontic and Restorative Preparations

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

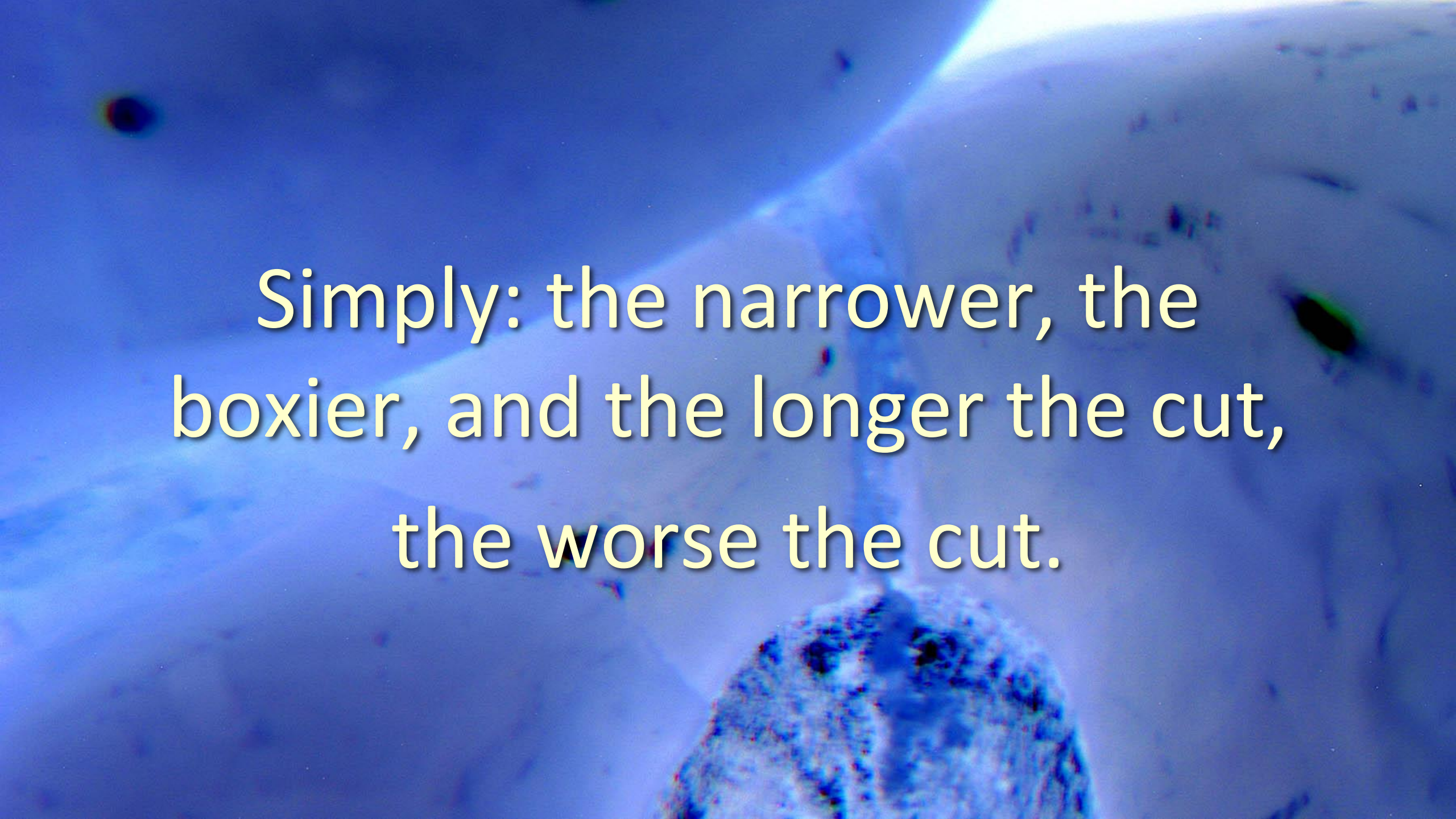
The formula for determining stress concentration due to a cavity preparation is $(1+2\sqrt{\frac{L}{R}})$ where L is length of the cut and R is the radius of the cut. In simple terms, the longer the cut, the worse the cut. A long narrow cut, interestingly, is worse than a wide, round-bottomed cut. One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

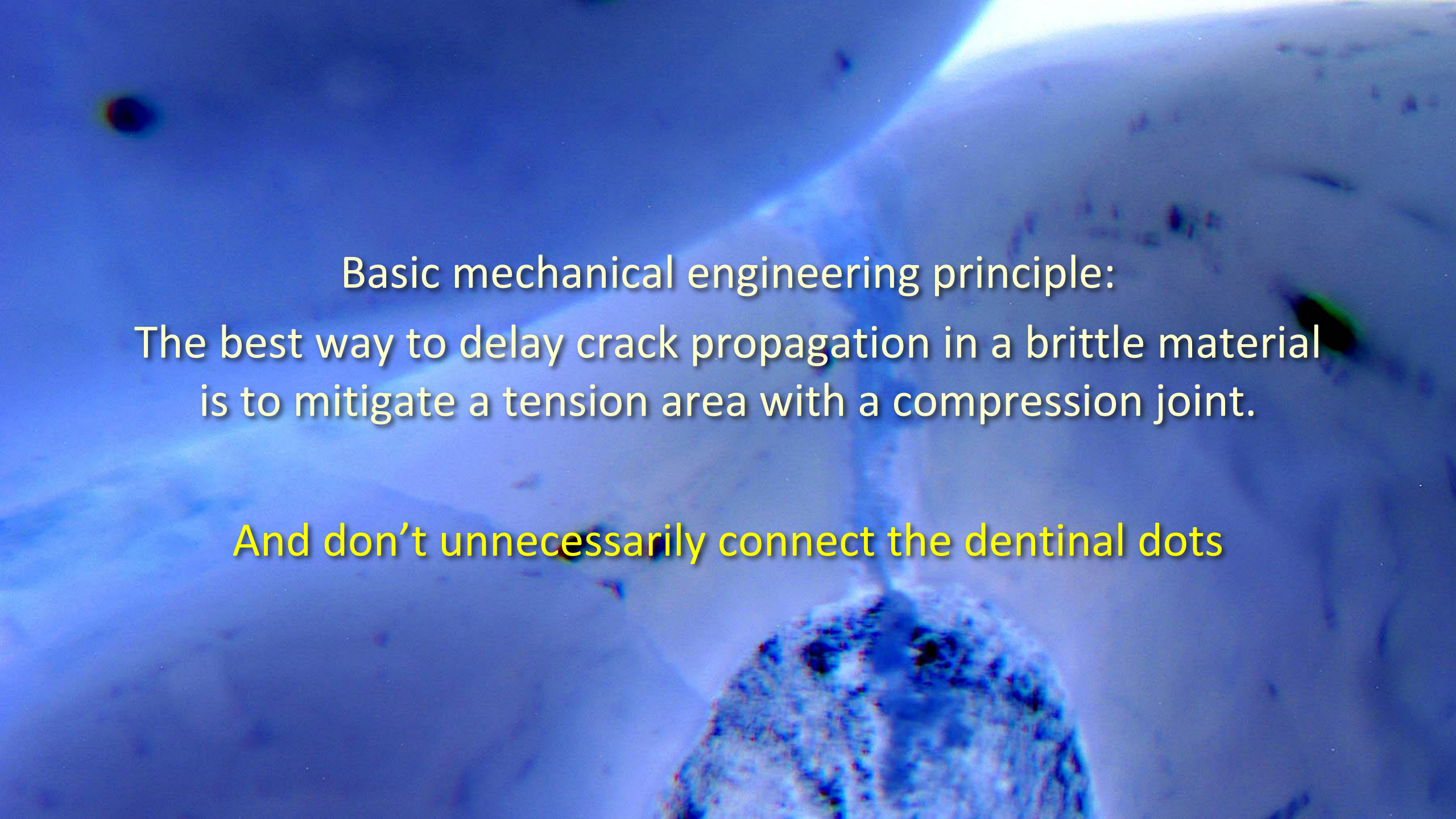
The formula for stress concentration in a cavity is

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

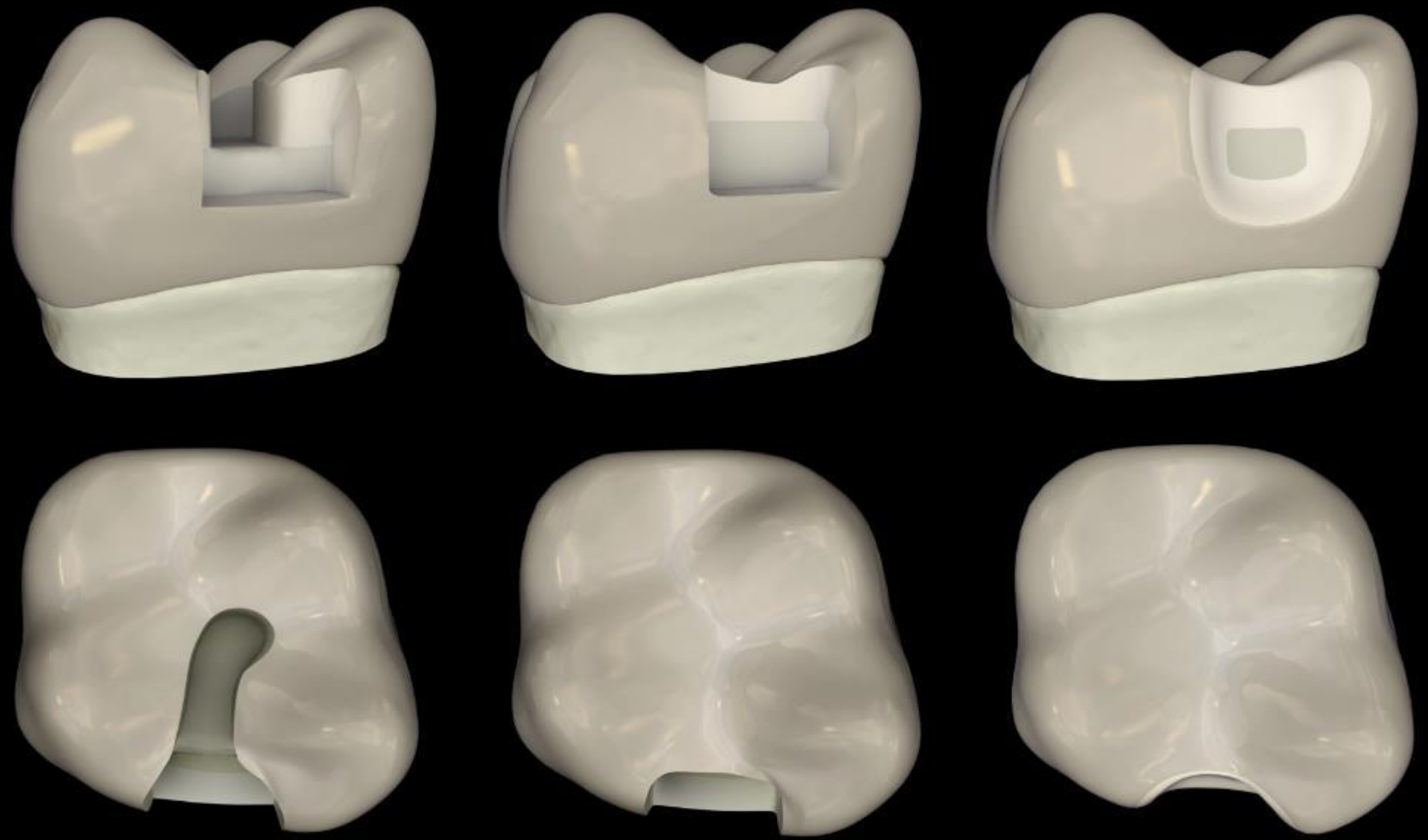
L is the depth of the cut.

R is the radius of the cut.

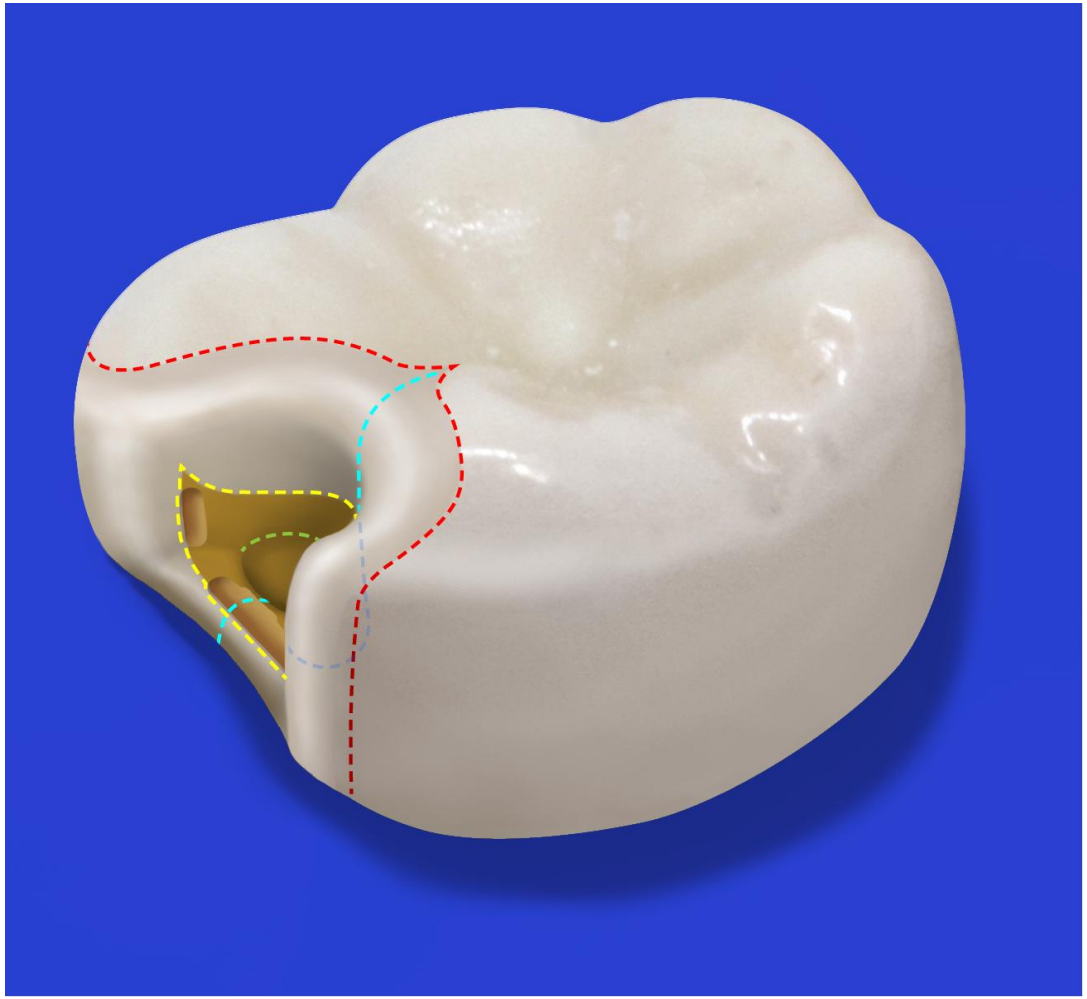

Simply: the narrower, the
boxier, and the longer the cut,
the worse the cut.


Basic mechanical engineering principle:
The best way to delay crack propagation in a brittle material is to mitigate a tension area with a compression joint.
And don’t unnecessarily connect the dentinal dots

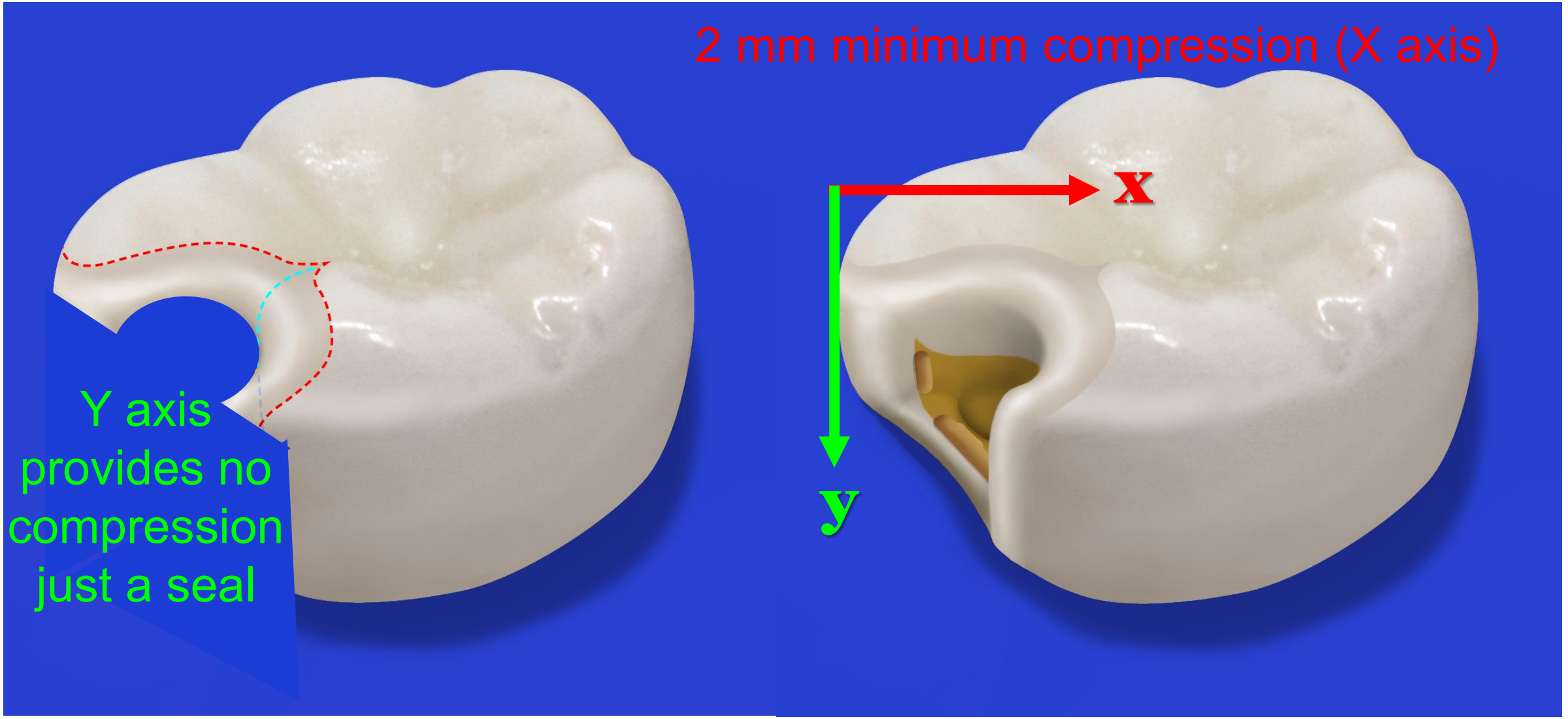
The Prep?



Final views of completed Bioclear Class II Preparation.



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



Modern Restoration Design=**I.C.E.**

Infinity edge

Compression based

Enamel driven

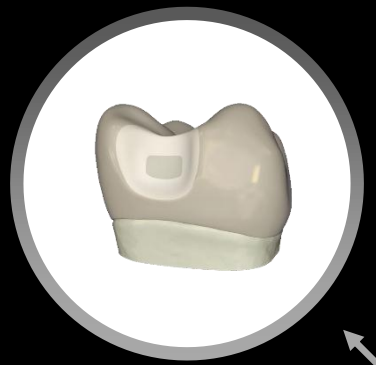
Modern Method for Composite Restorations

Clear Anatomic Matrices

- Anterior & Posterior Matrices designed to mimic nature

Preparation Design

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



Injection Mold Composite

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

Biofilm Removal

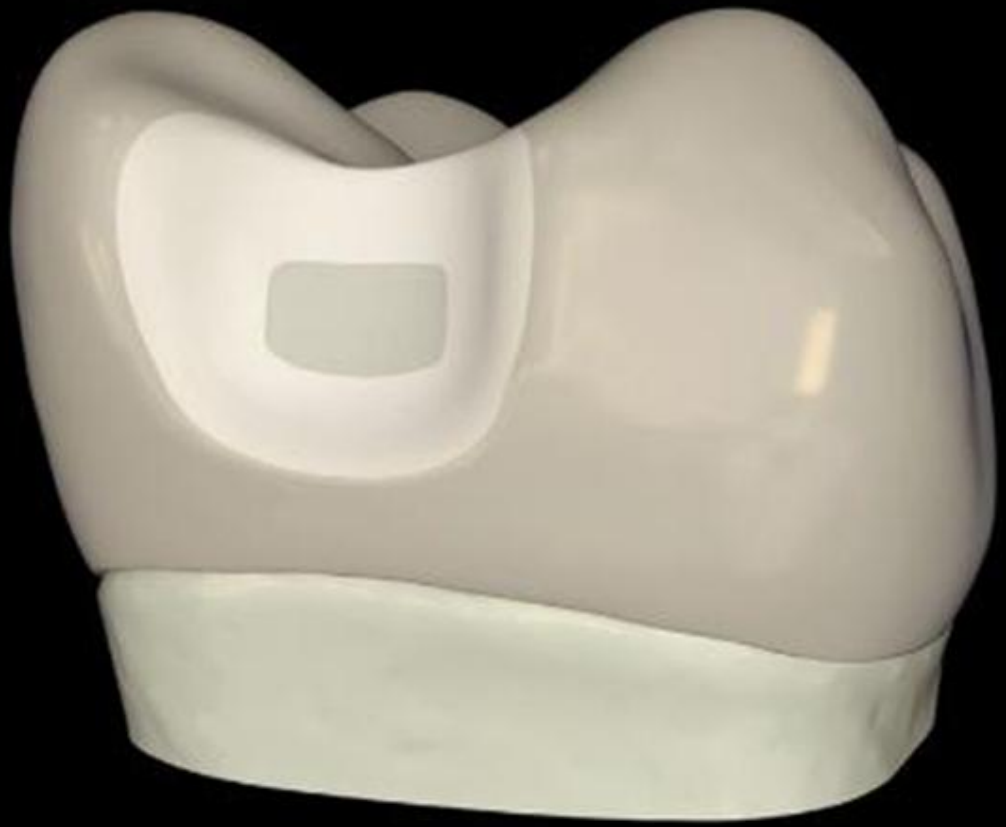
- Remove biofilm before bonding
- Allows bonding to uncut enamel
- Allows infinity edge margins

Systematic restorative protocol for esthetic long-term clinical outcomes

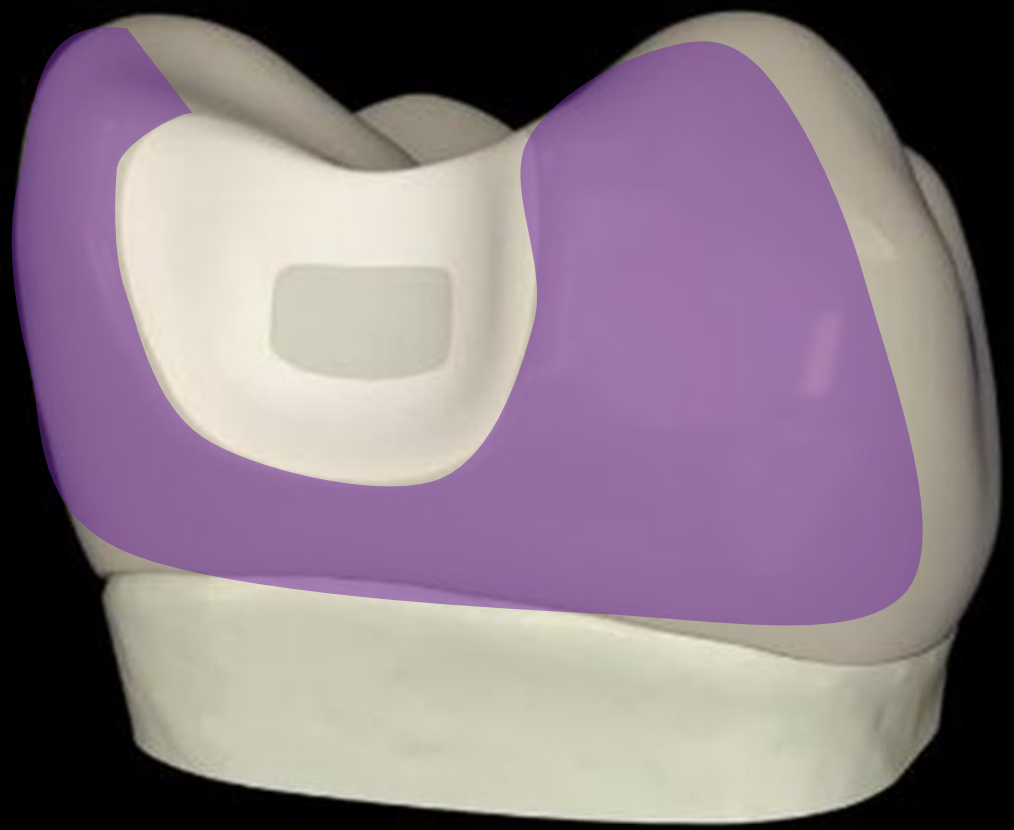
Final Polish

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

Clark Class II Prep Design

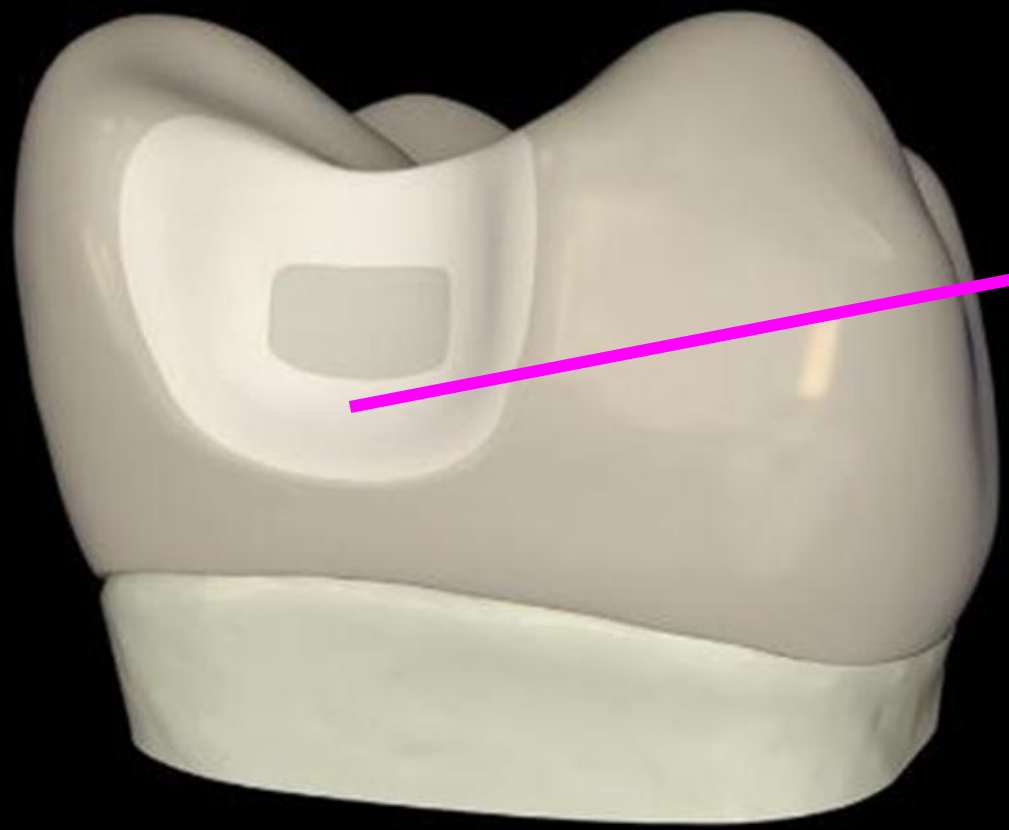


Unique Aspects of the Clark Class II Prep Design



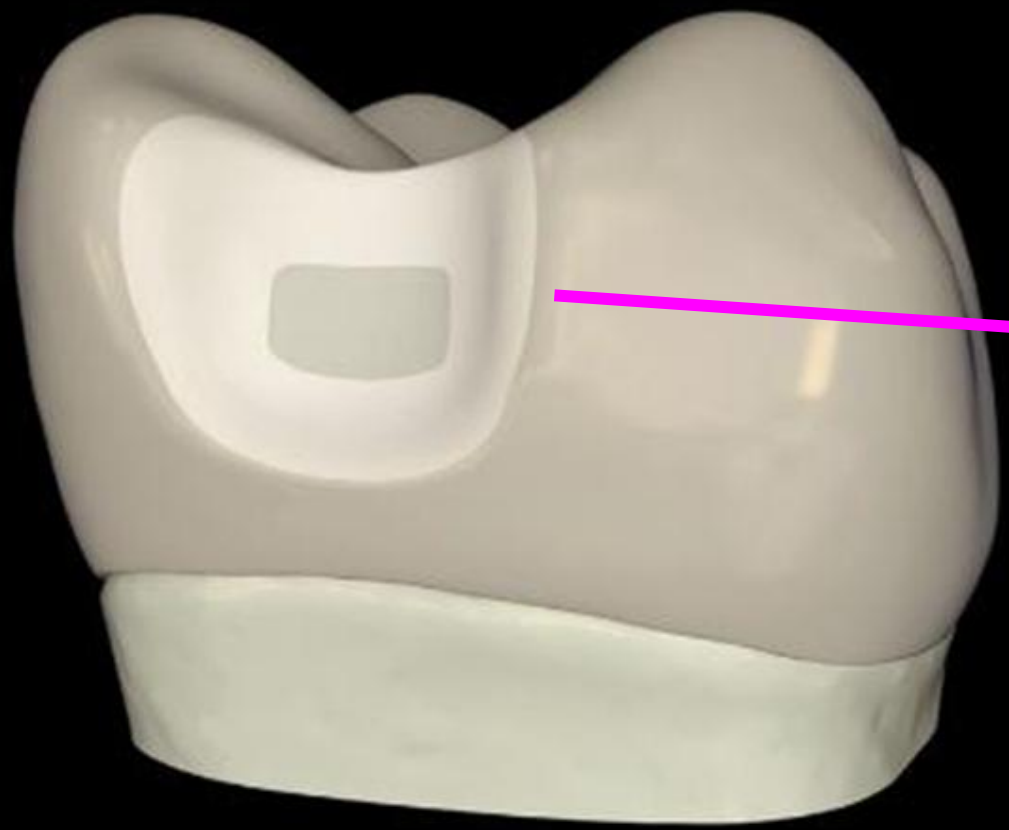
- Removal of biofilm

Unique Aspects of the Clark Class II Prep Design



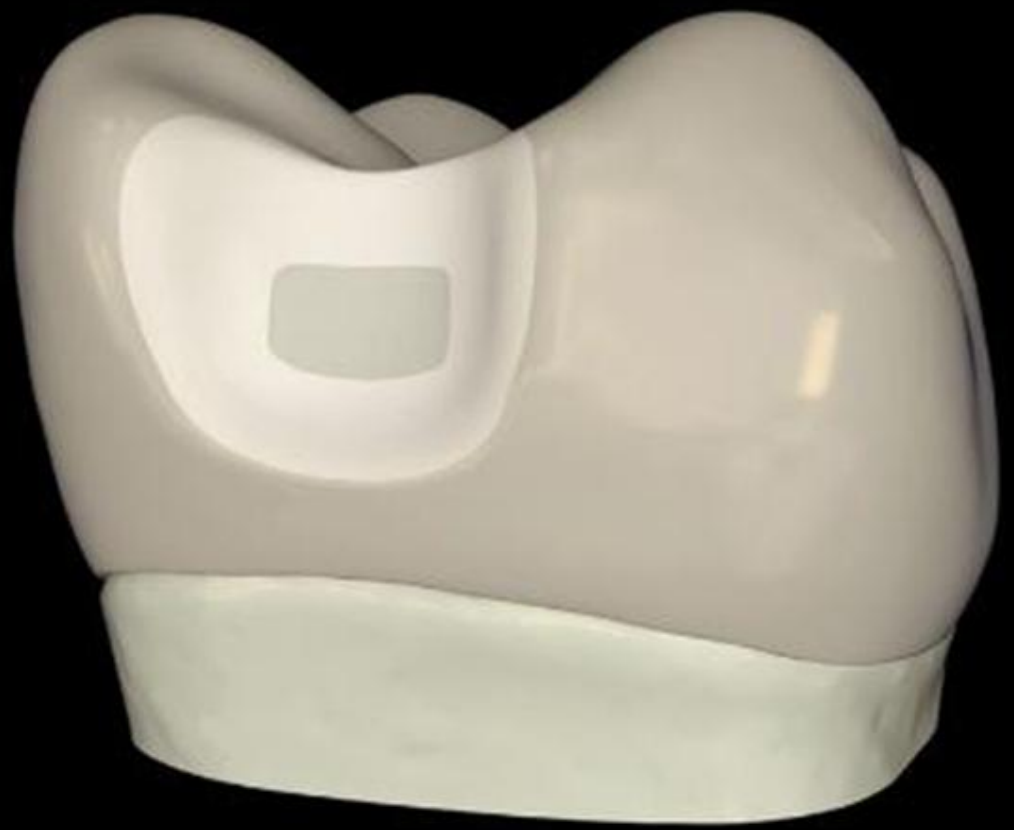
- Removal of biofilm
- Rounded internal line angles

Unique Aspects of the Clark Class II Prep Design



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

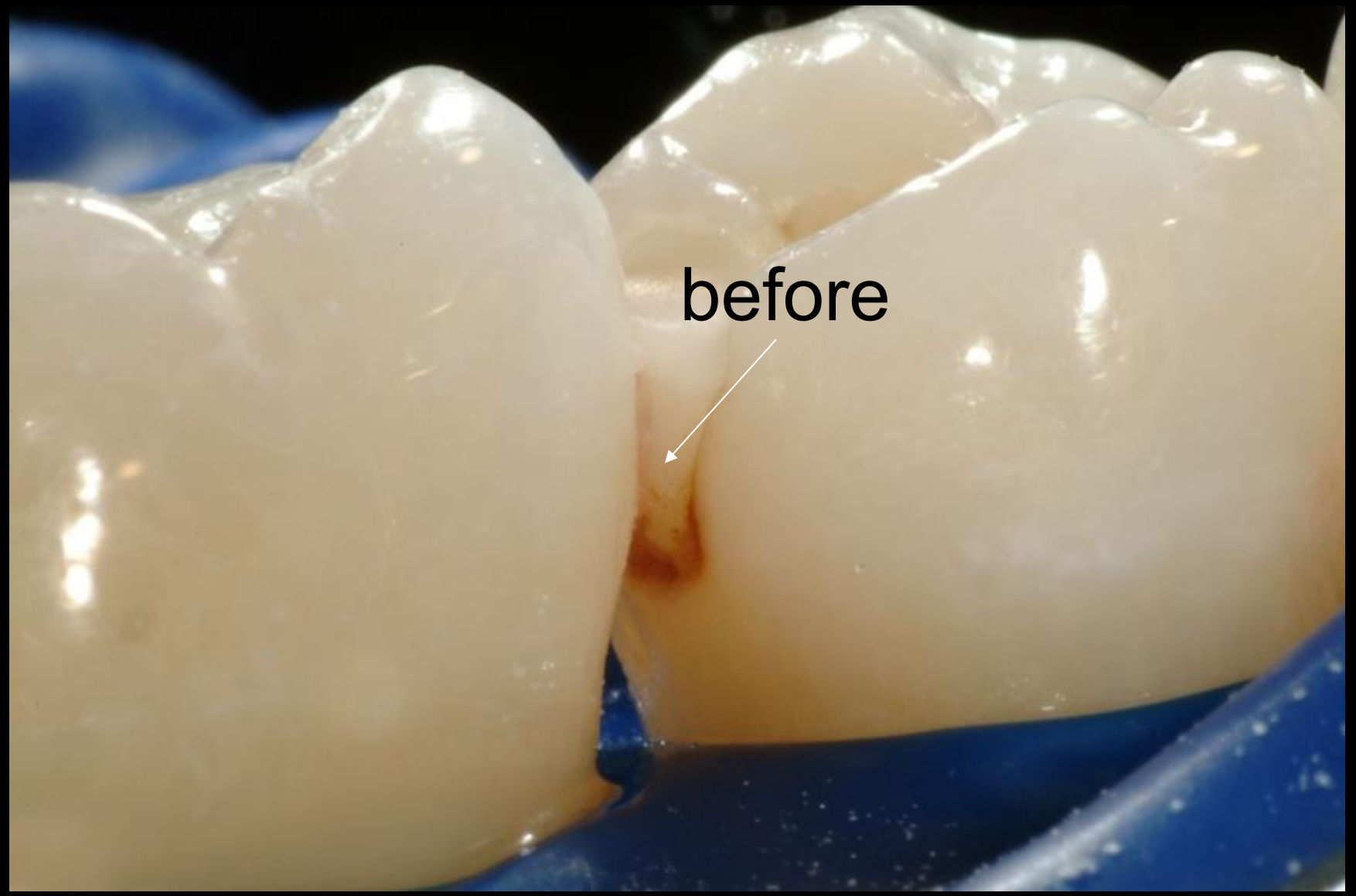
Unique Aspects of the Bioclear Prep Design



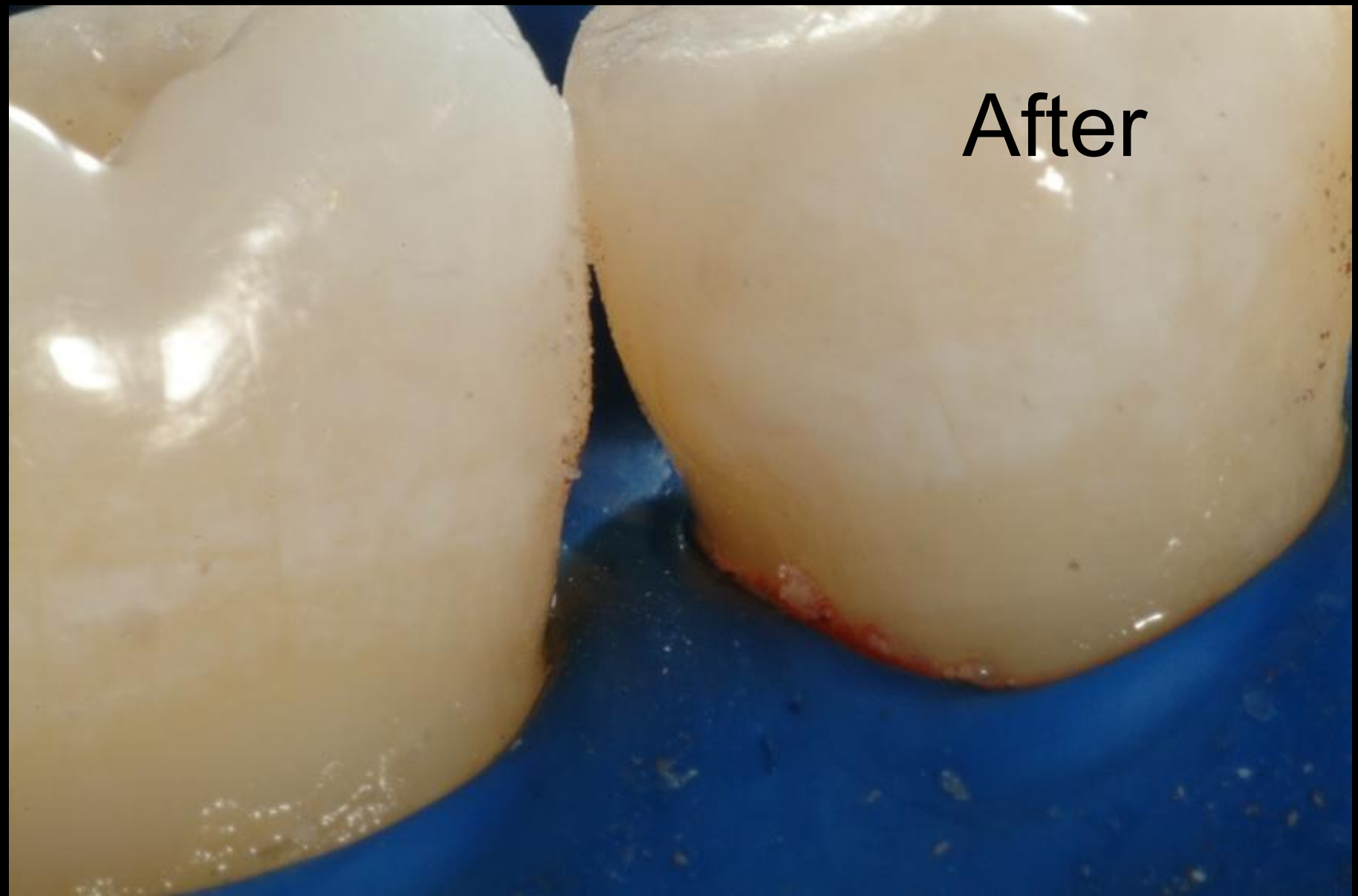
- Removal of biofilm
- Rounded line angles
- Injection mold rather than place incrementally

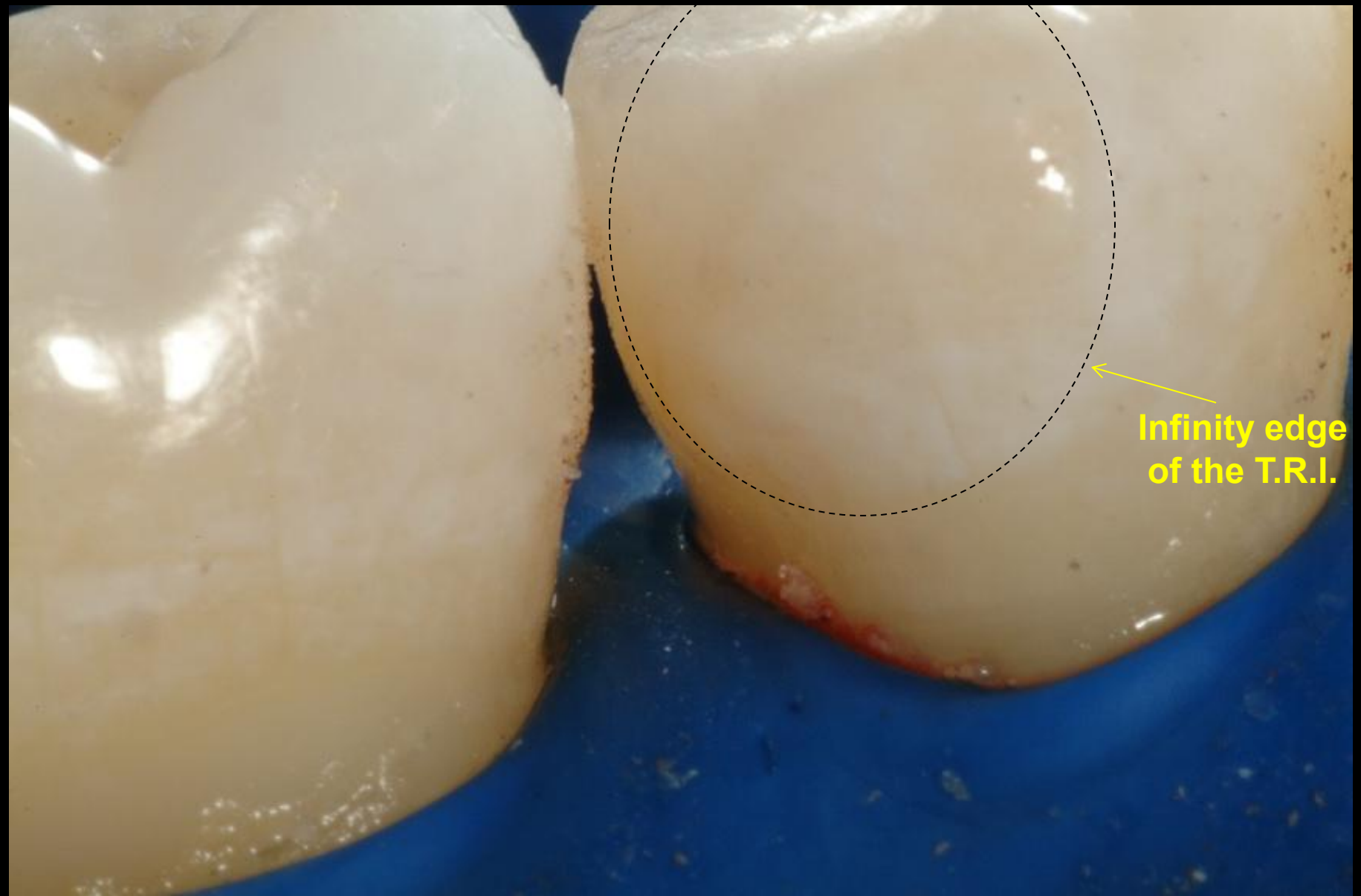
Unique Aspects of the Clark Class Prep Design

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

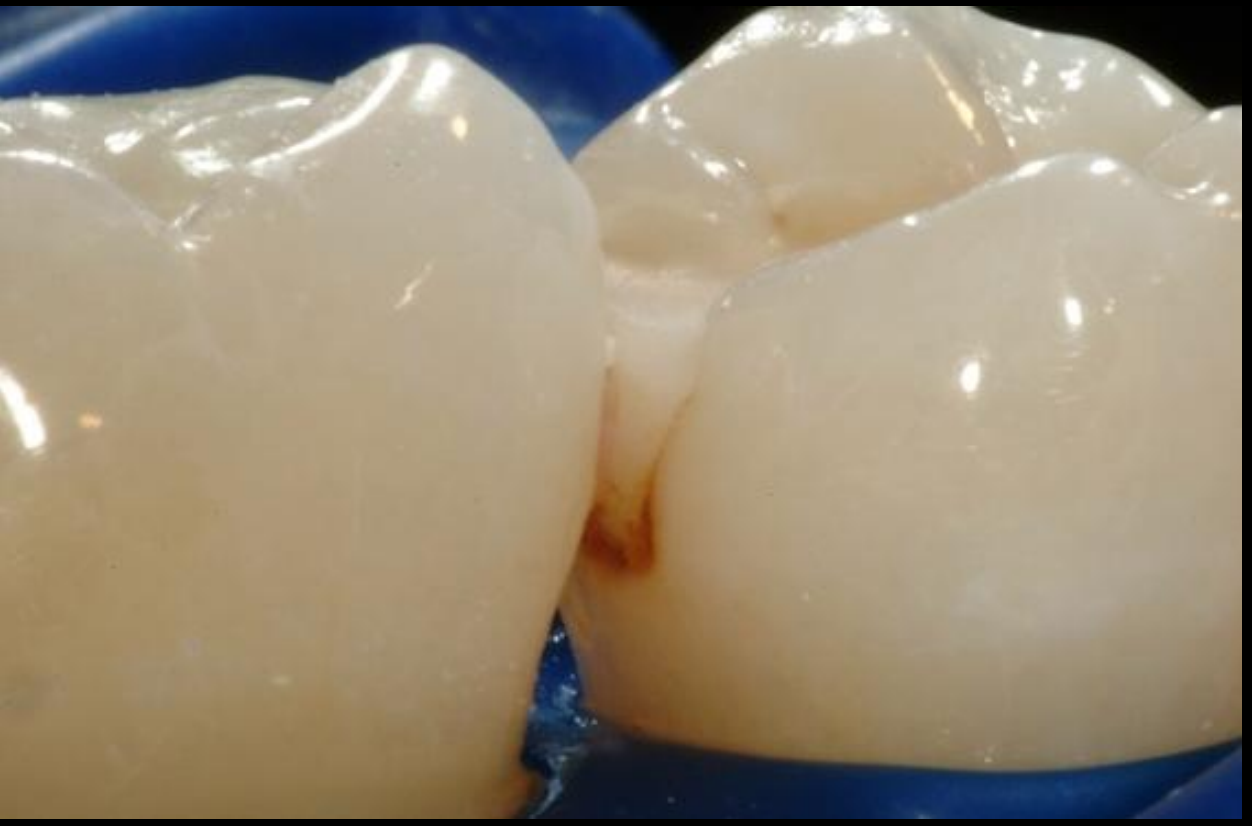

before

The Bioclear method

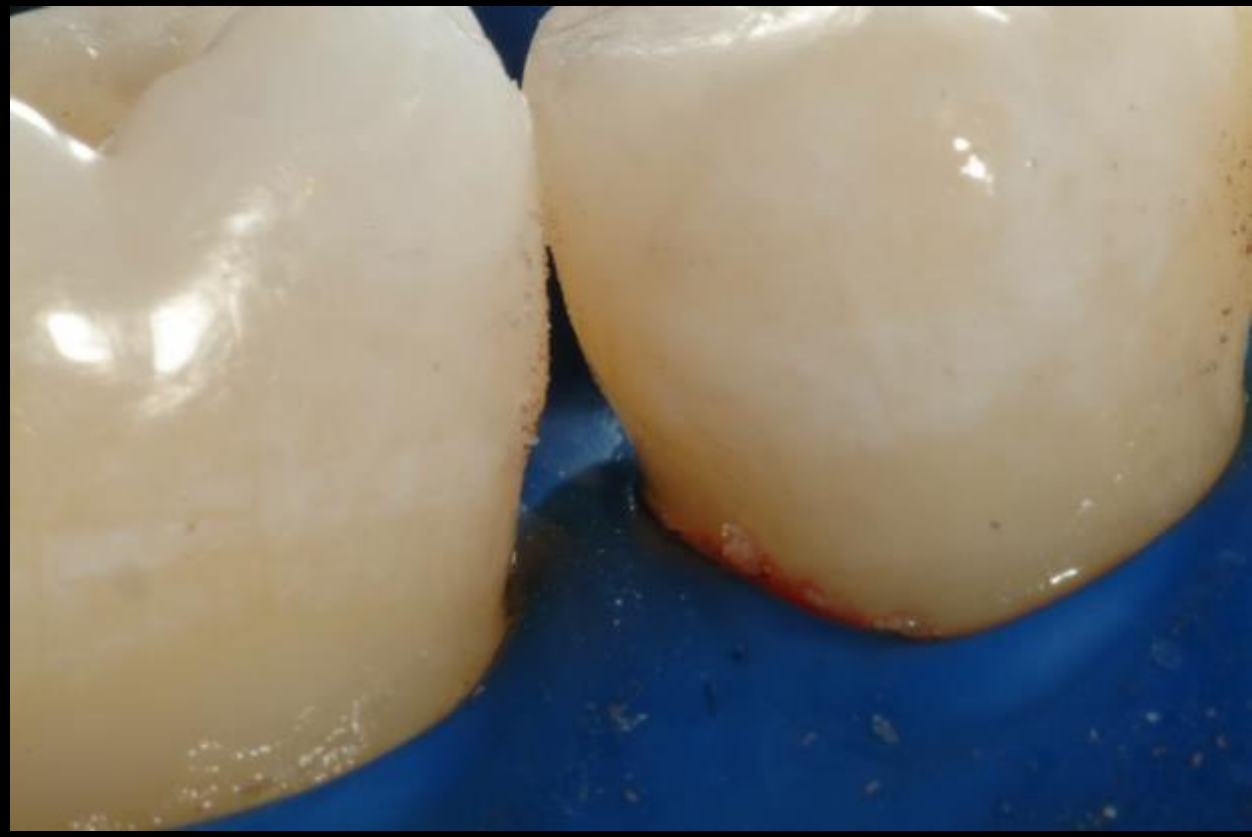



Infinity edge
of the T.R.I.

The Bioclear Injection Molding Approach



Failing composite;
traditional preparation



Re-restored using the
Bioclear approach

BIOCLEAR

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

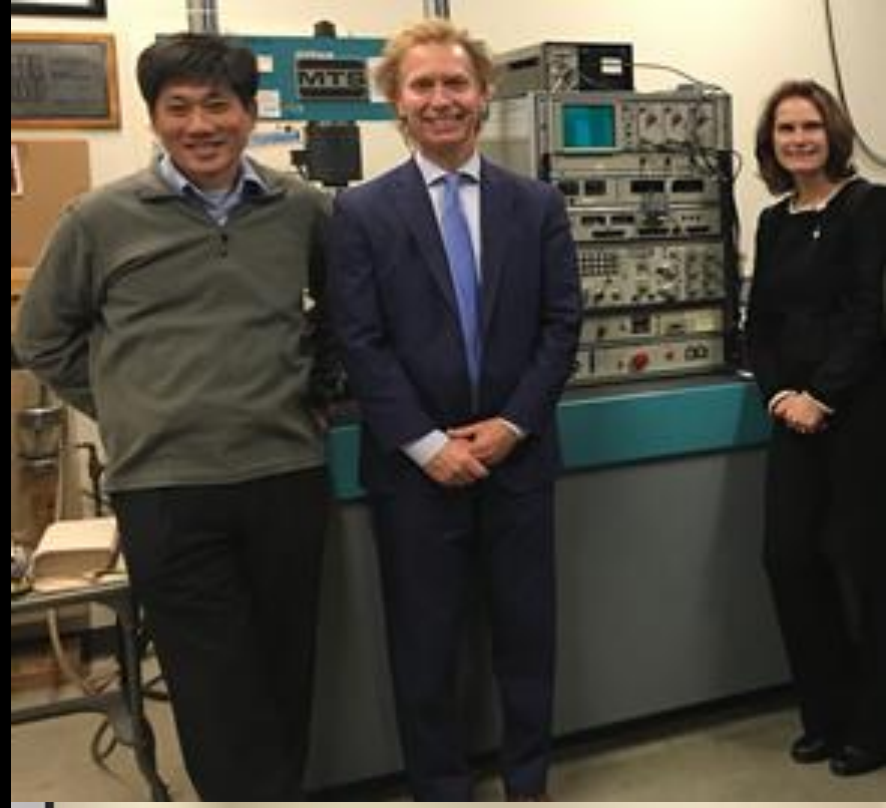
- 3M Material Property Testing Including Injection Molding

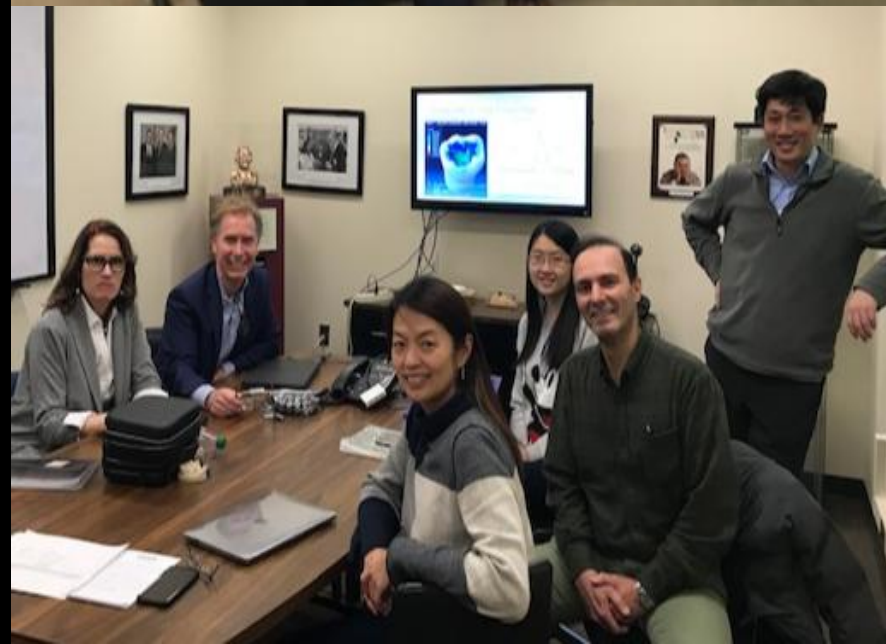
  Timothy D. Dunbar, Ph.D. Advanced Product Development Specialist

In Process

- Biofilm Adhesion Study

  Sabrina F. Sochacki, DDS, MS, PhD
  Indiana University School of Dentistry



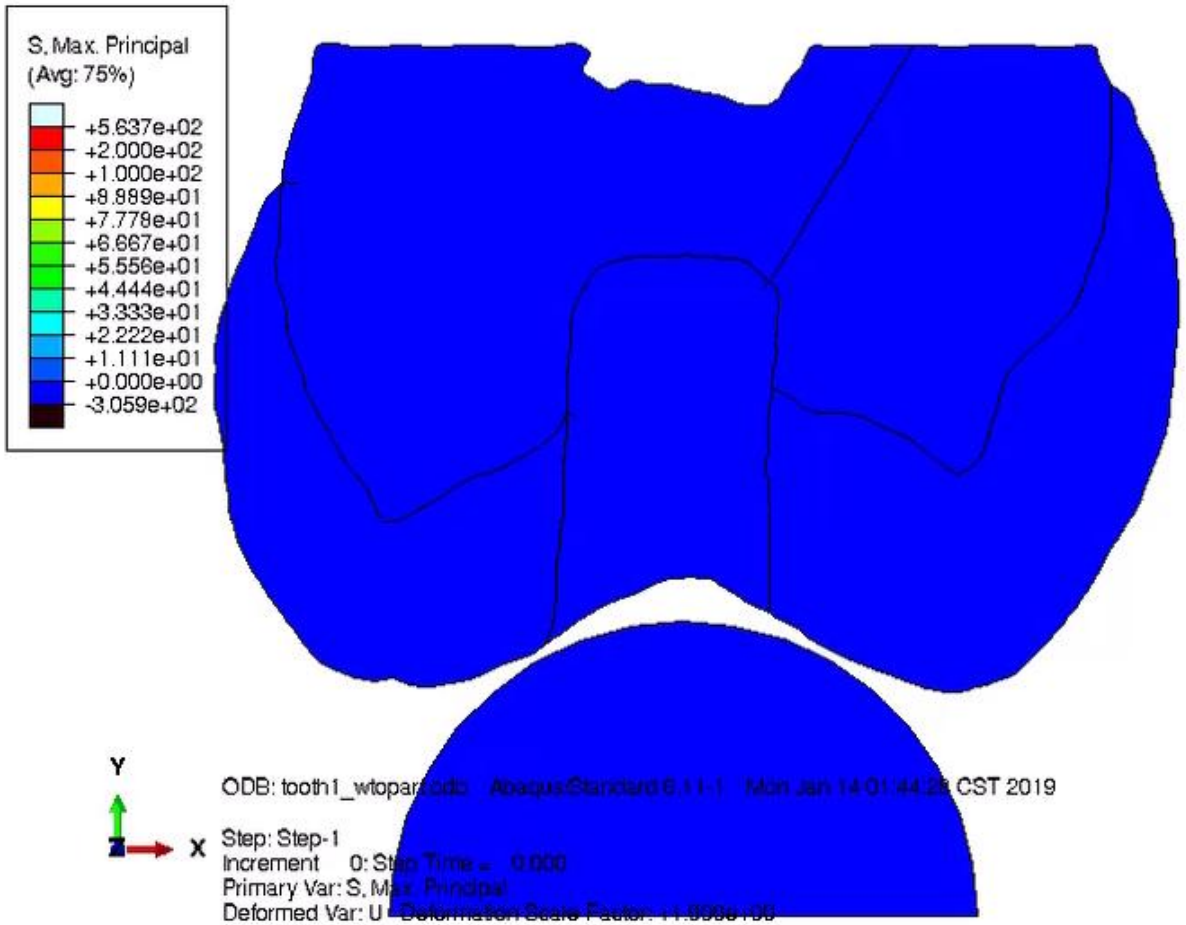


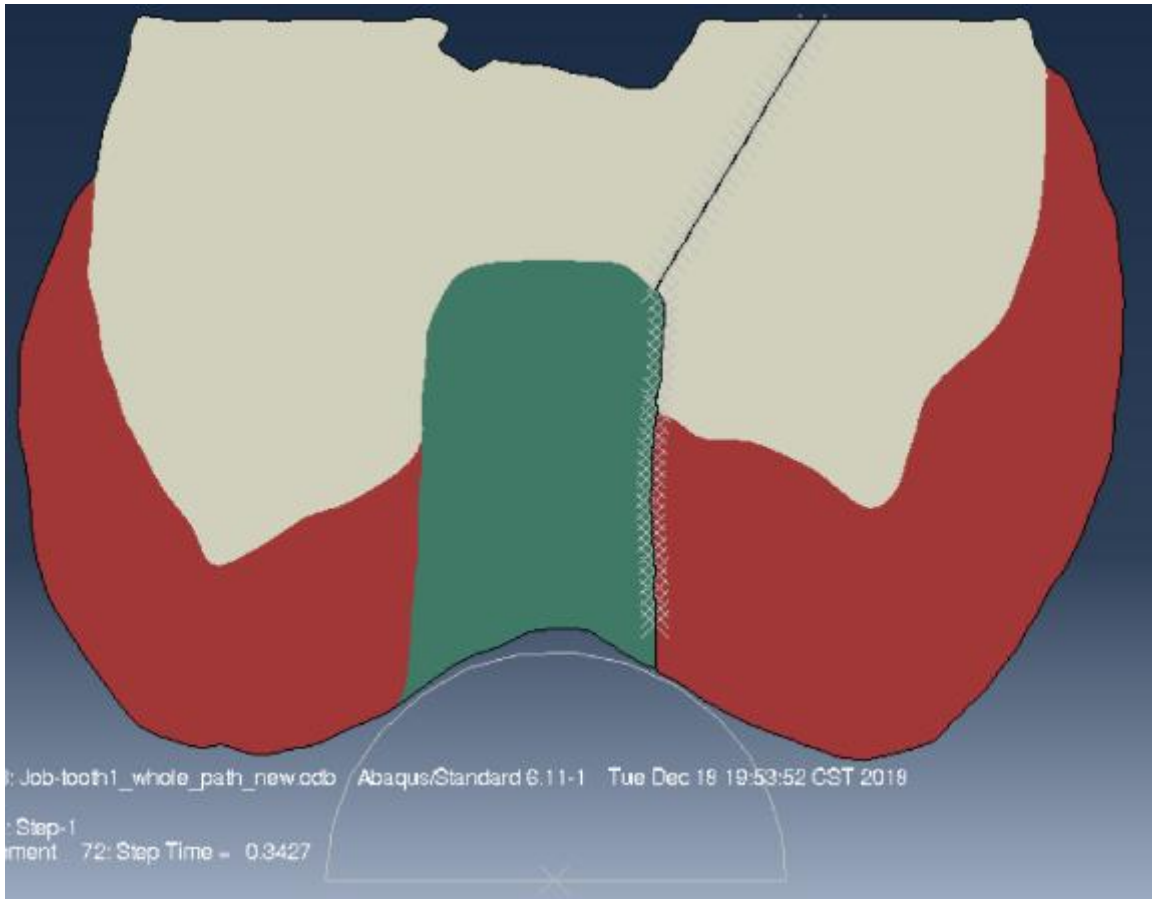
Fracture Simulation of Class-I Restorations

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

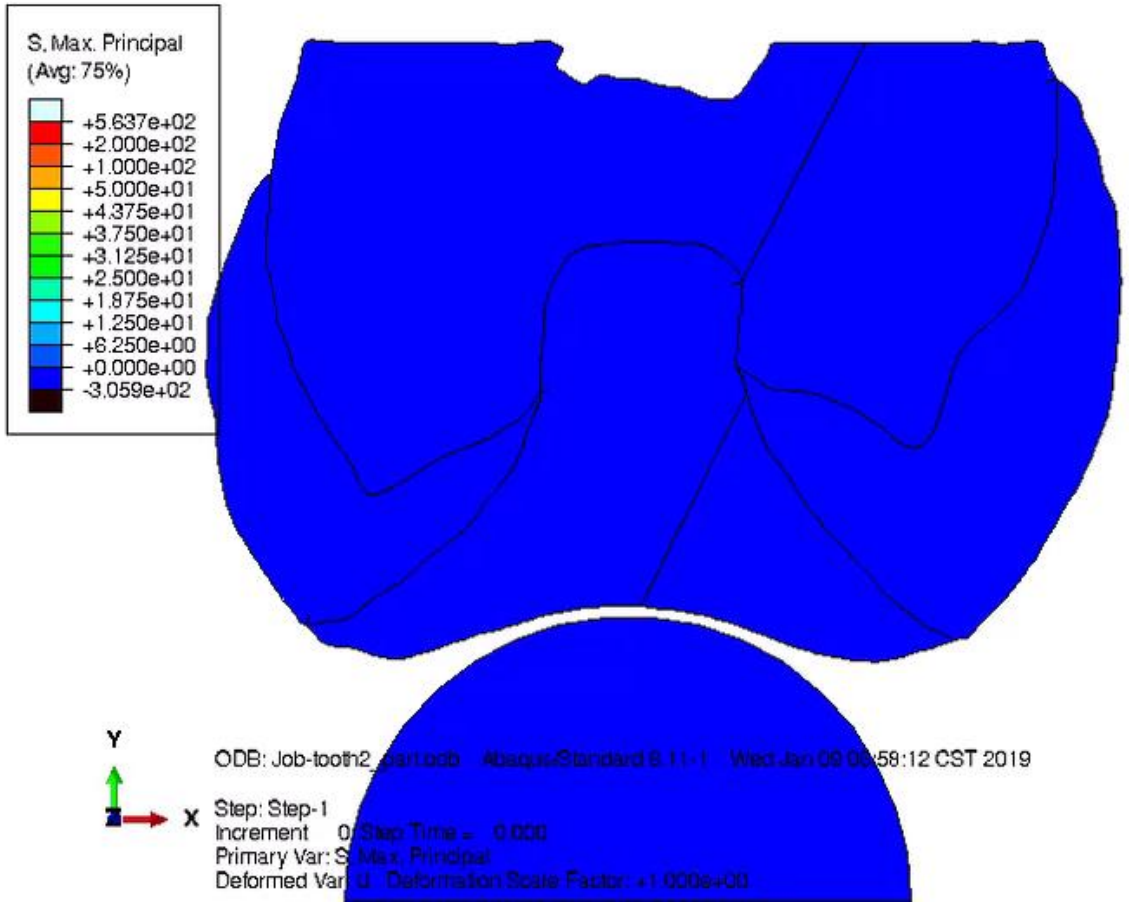
Reference no. MDRCBB-NY-JAN11-2019

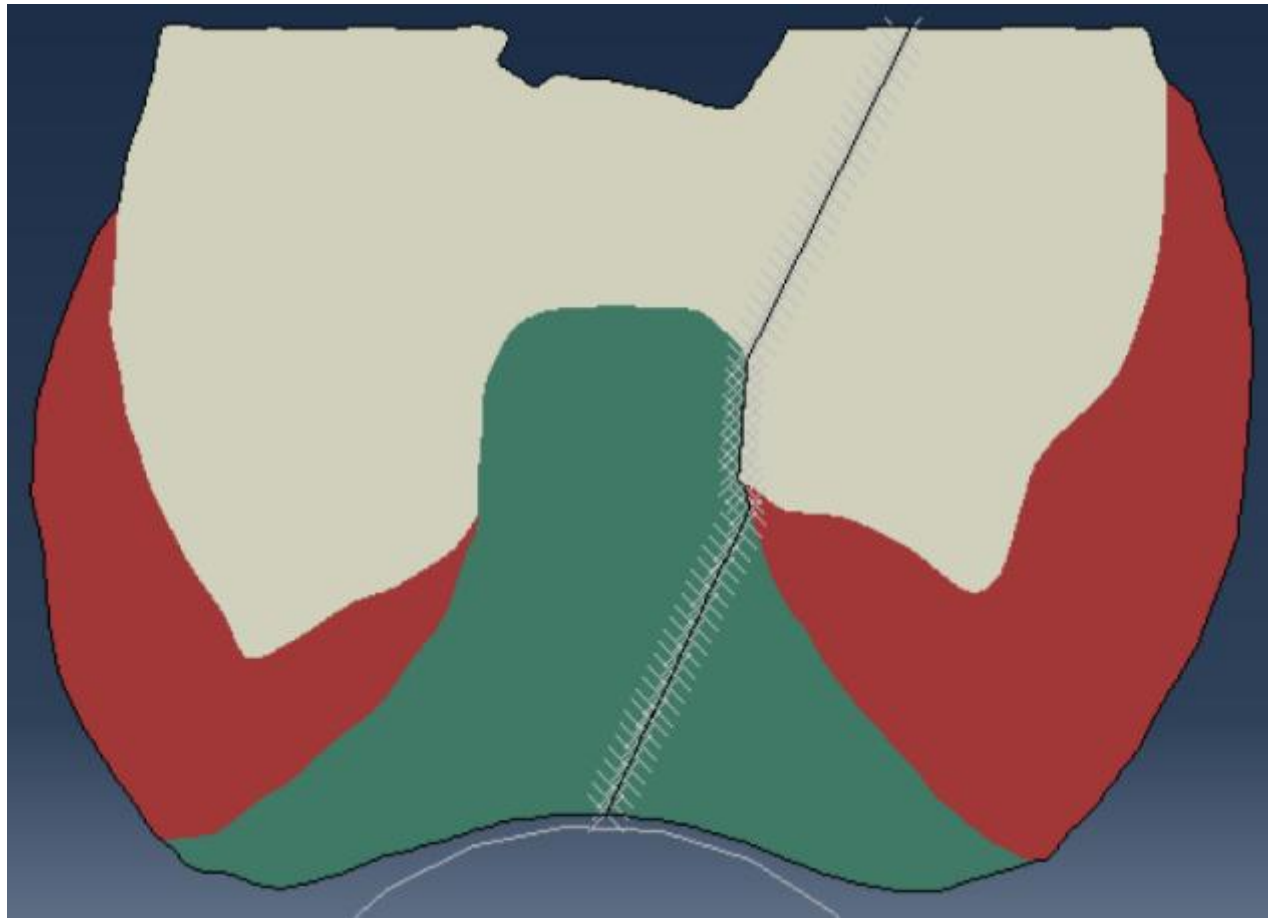
Traditional Class I Prep





Calla Lily Class I Prep





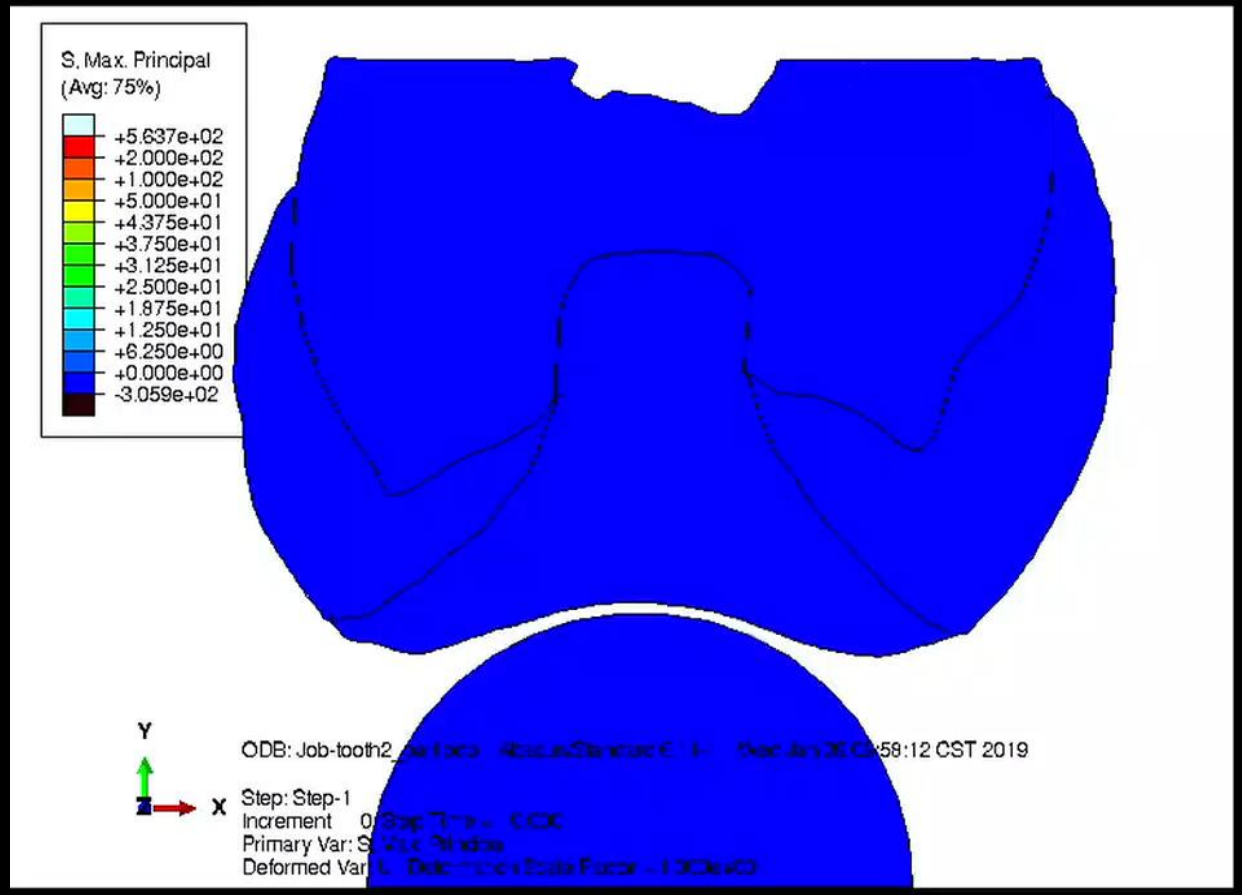
$$A_1 N_1^B = A_2 N_2^B \quad \frac{N_1}{N_2} = \left(\frac{A_2}{A_1}\right)^{1/B}$$

…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.

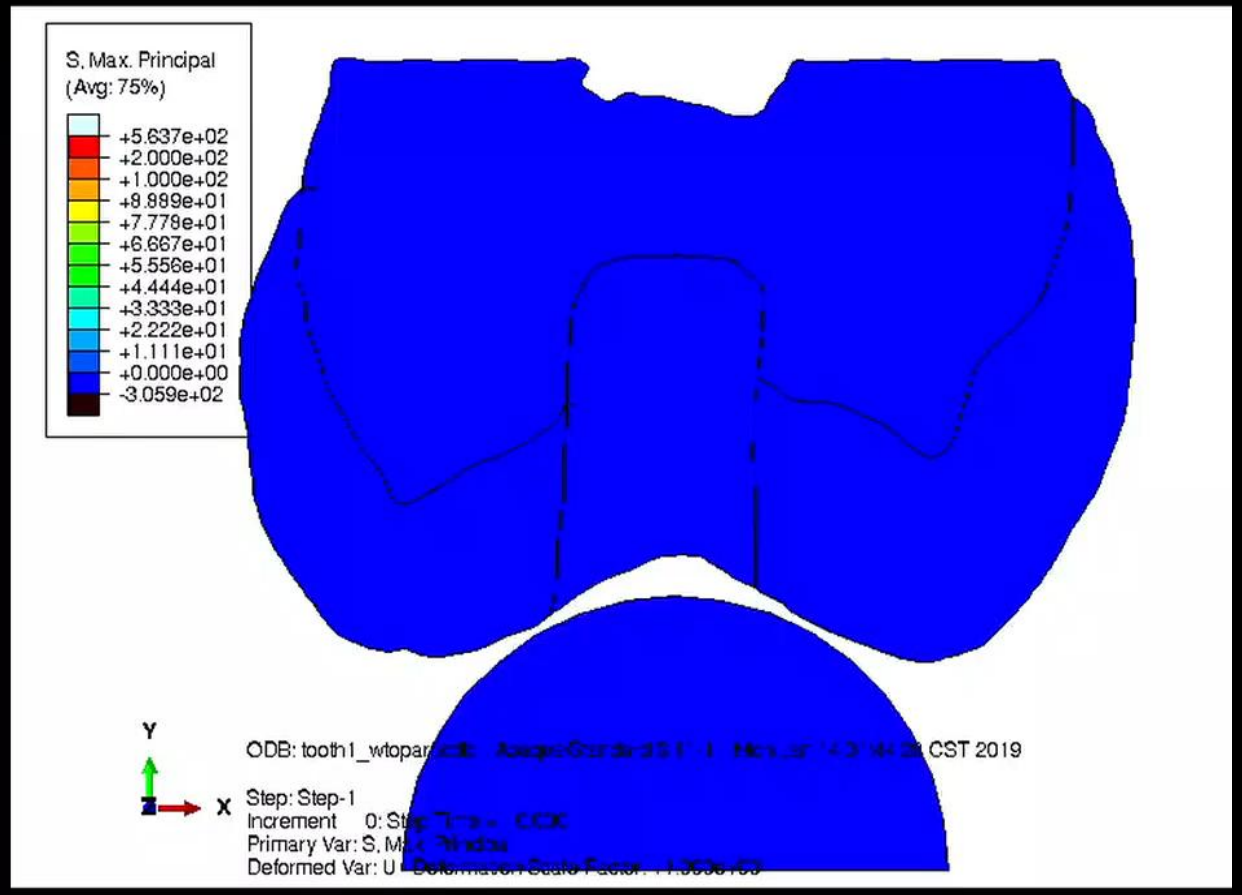
If the difference in fast fracture strength is 20%, then Restoration 1 will last roughly 8 times as long, etc.

Alex Fok
Minnesota Dental Research Center
for Biomaterials and Biomechanics

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

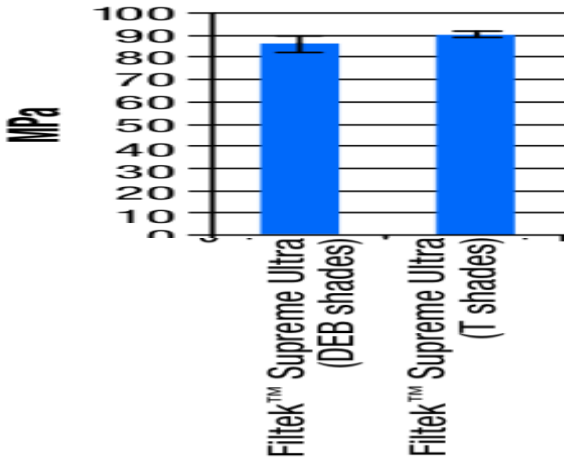


Traditional Class I filled with composite resin

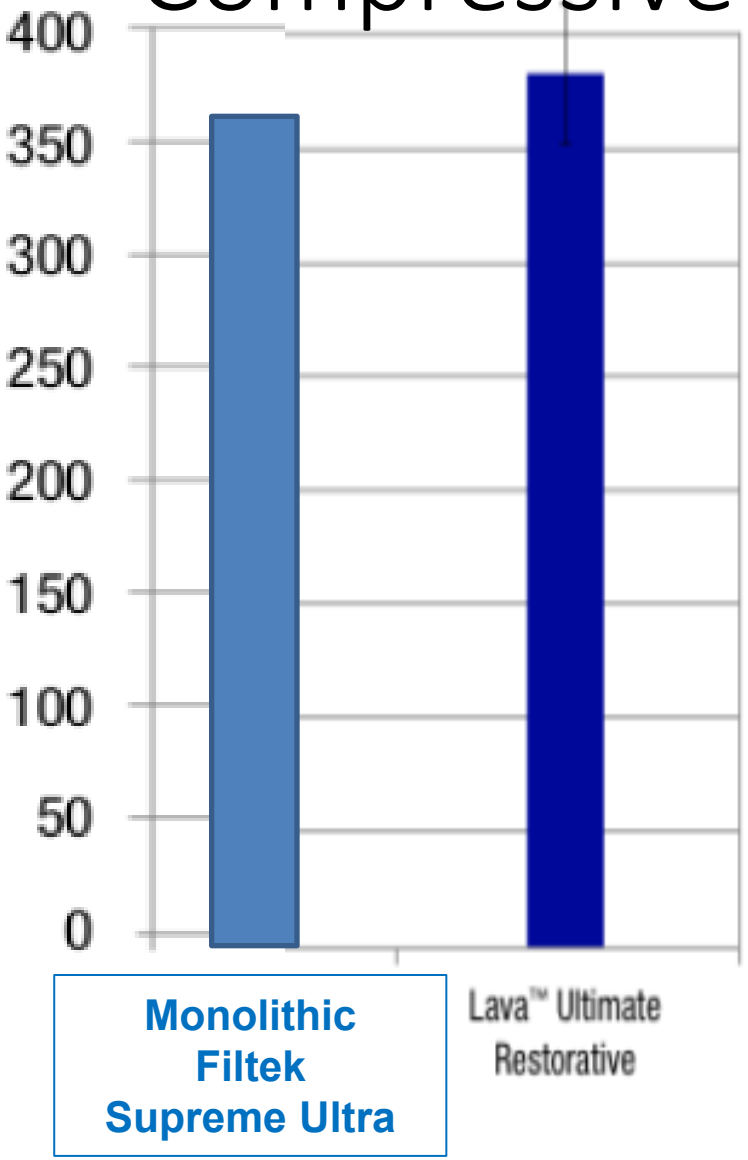


The compressive strength of composite is about 4x the diametral tensile strength.

Tensile



Compressive

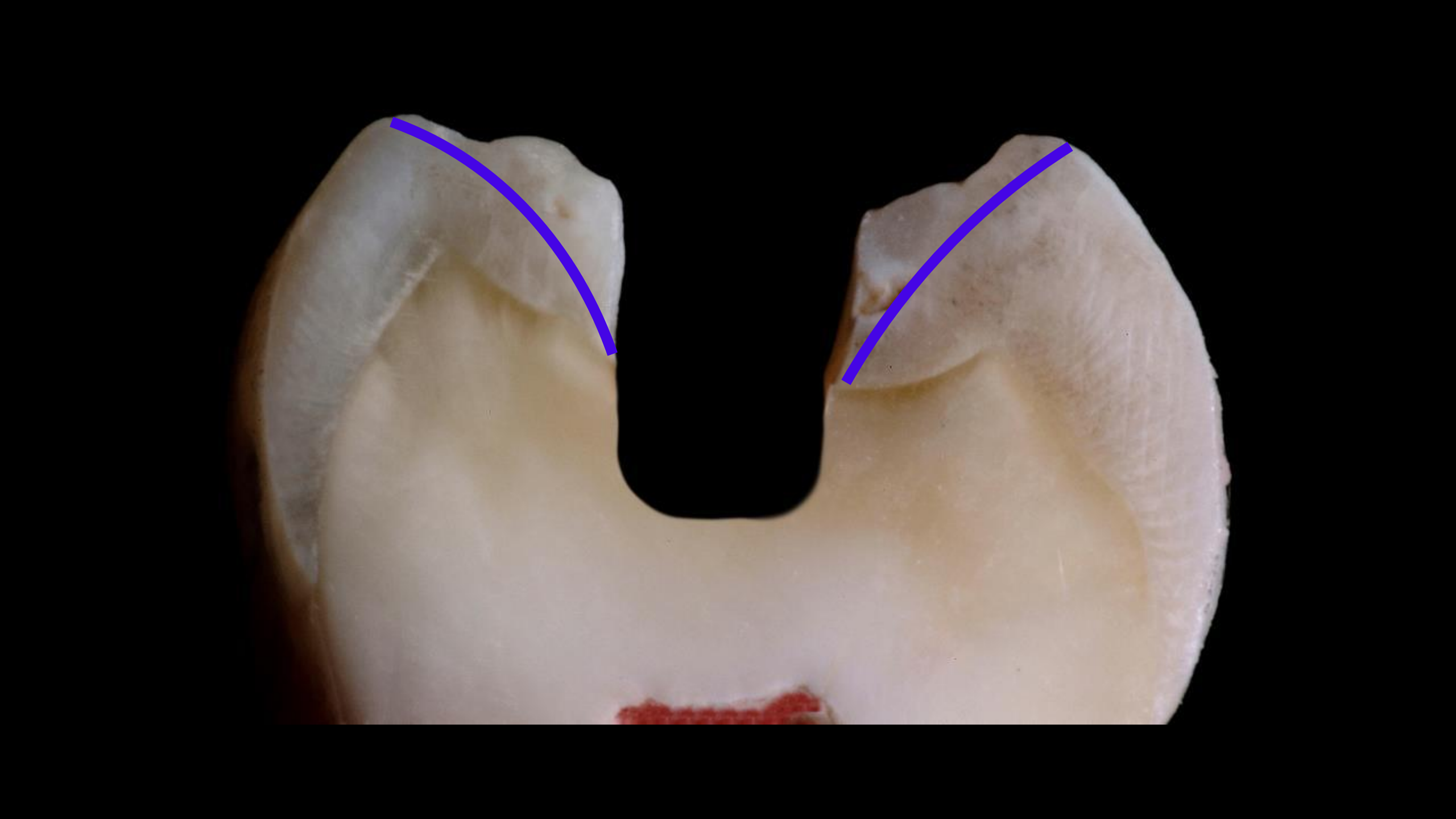


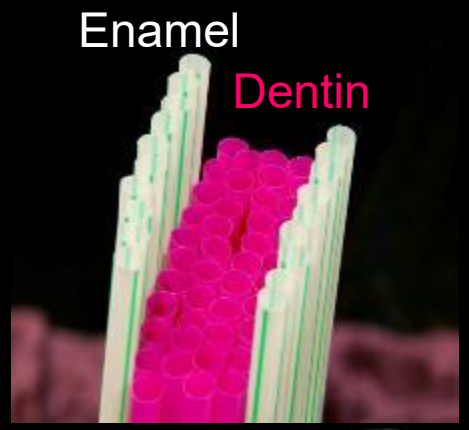
Bioclear Learning Center Guidelines:

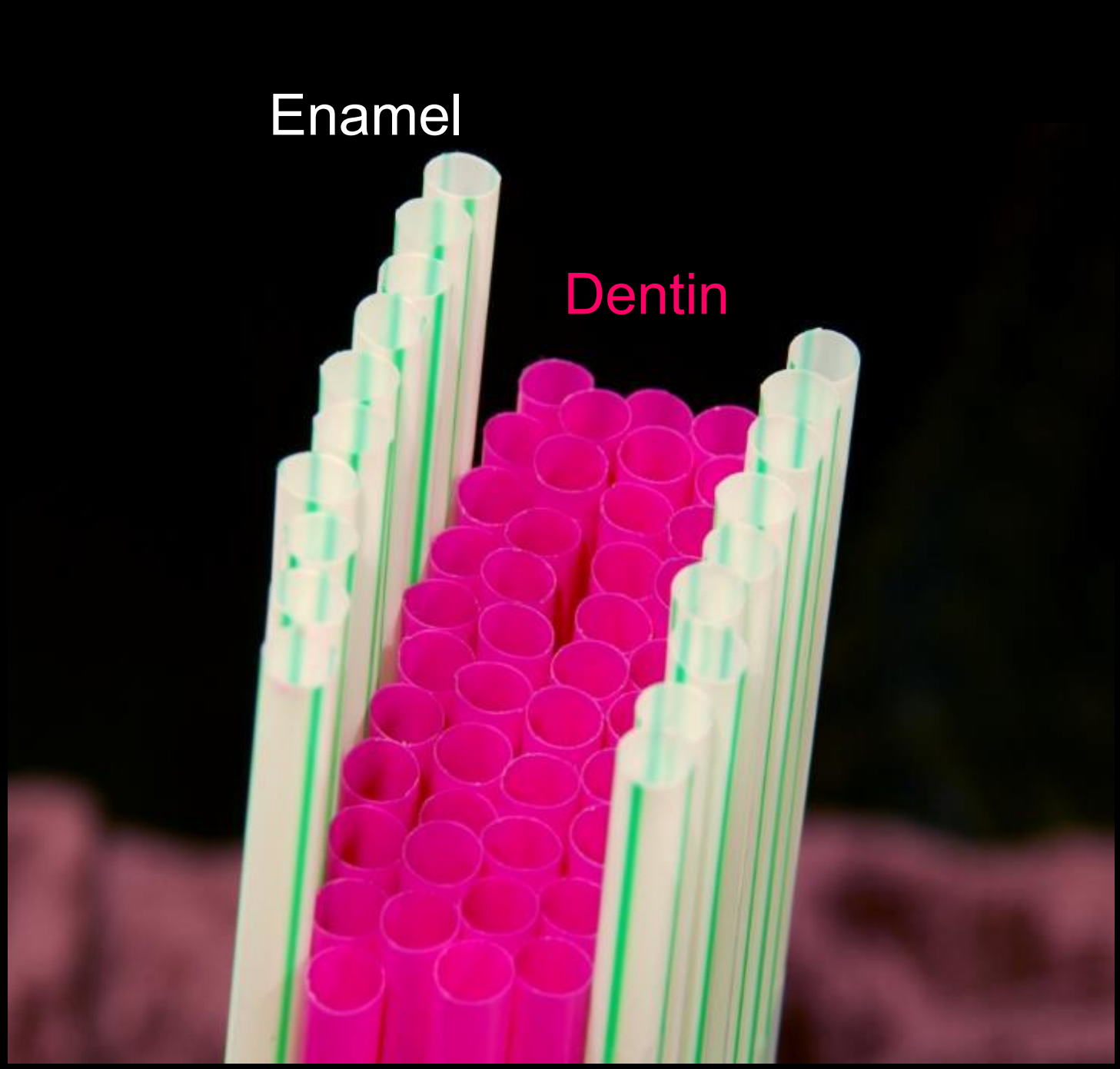
- In compression, resin over enamel has no minimum thickness requirement
- In compression, resin over dentin needs at least 2mm thickness
- For Incisal Edges and cusp tips we need 2 mm (occluso gingivally and buccal-lingual)
- All monolithic-no seams or grooves

Calla Lily Prep

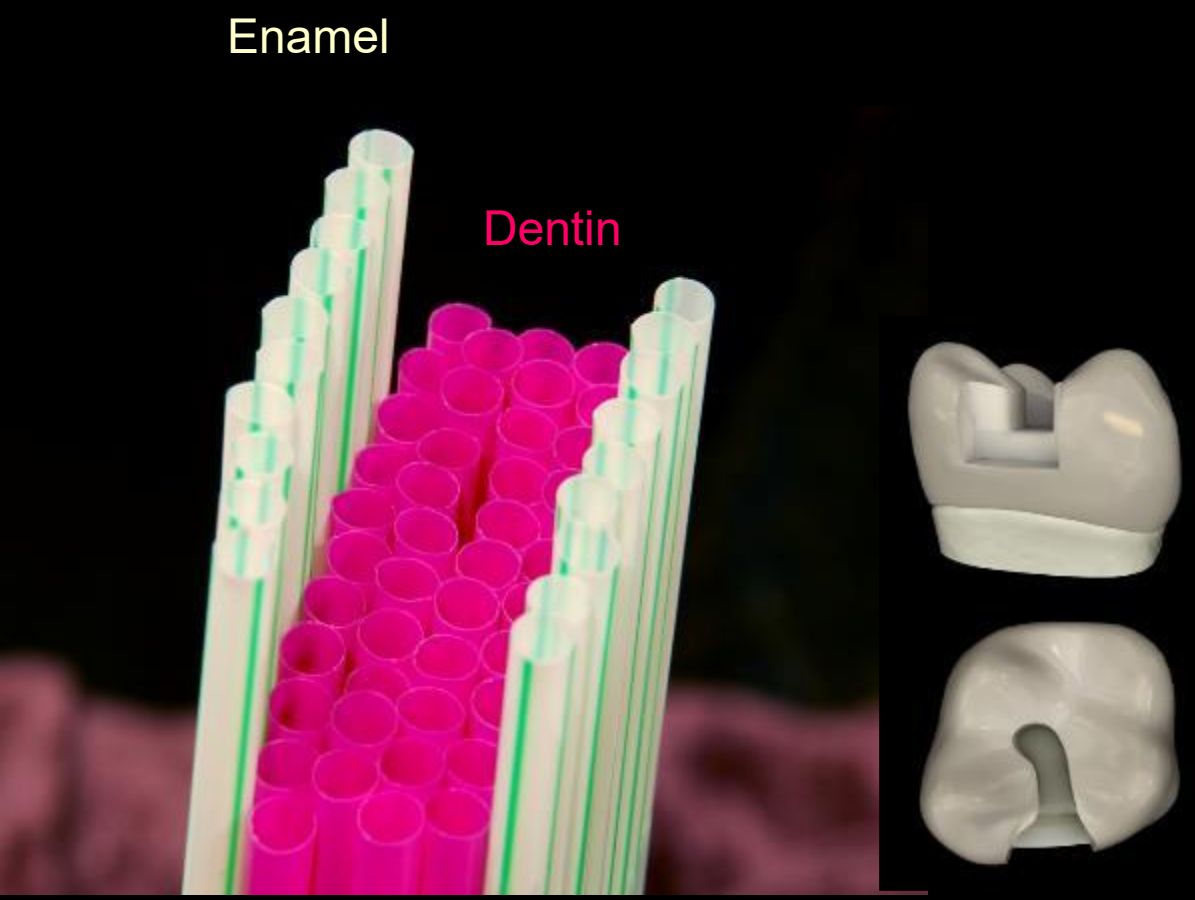
Calla Lily Prep

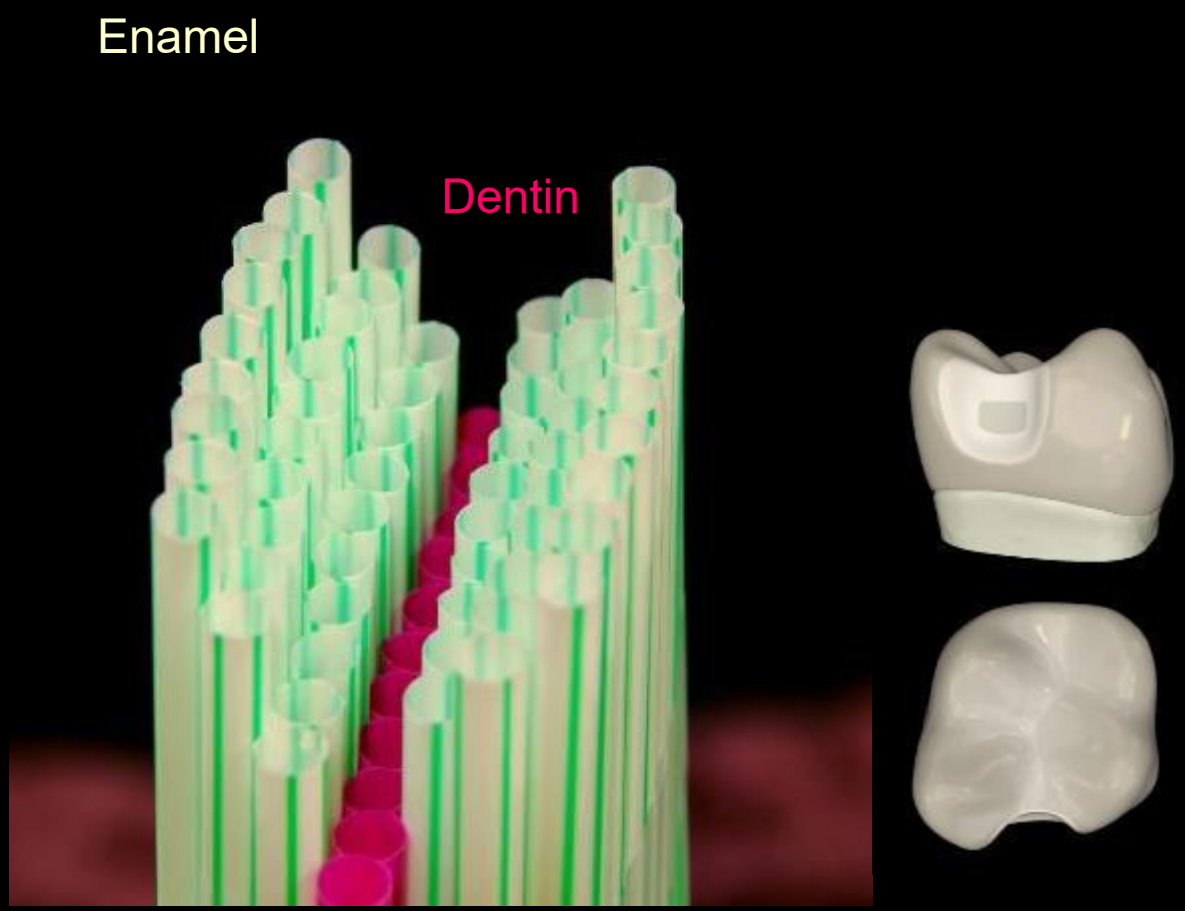


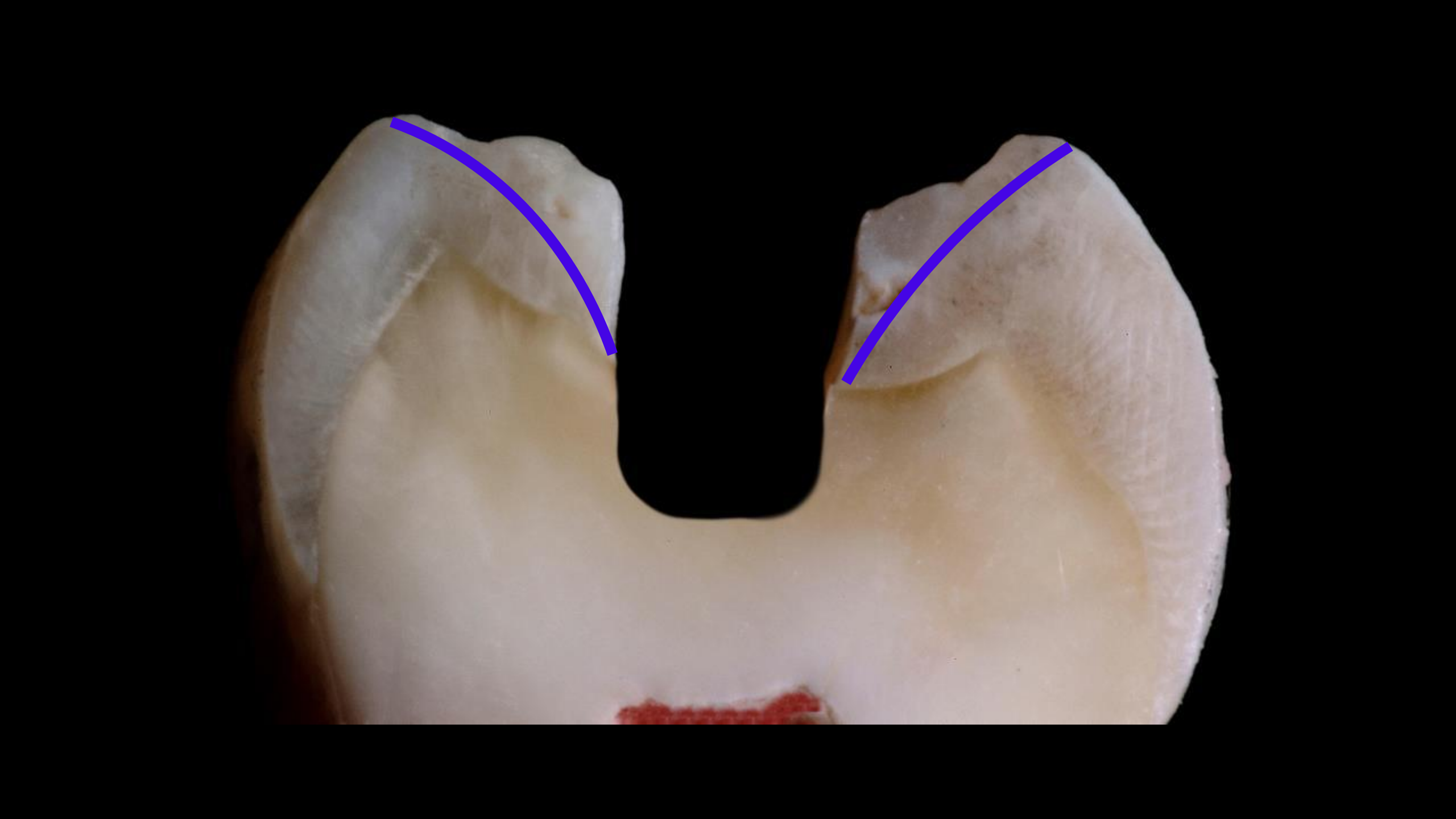

Enamel
Dentin

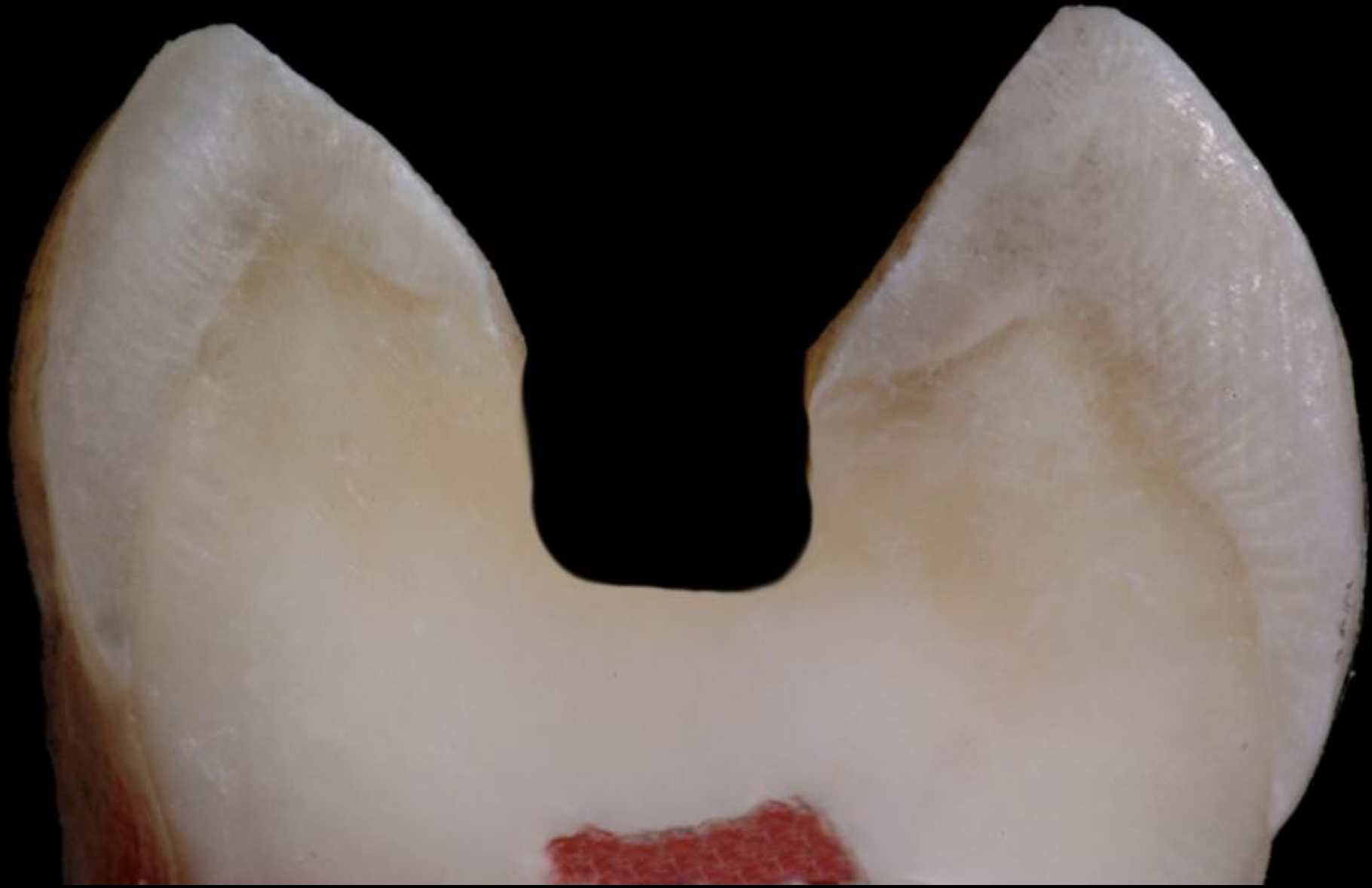

Enamel
Dentin

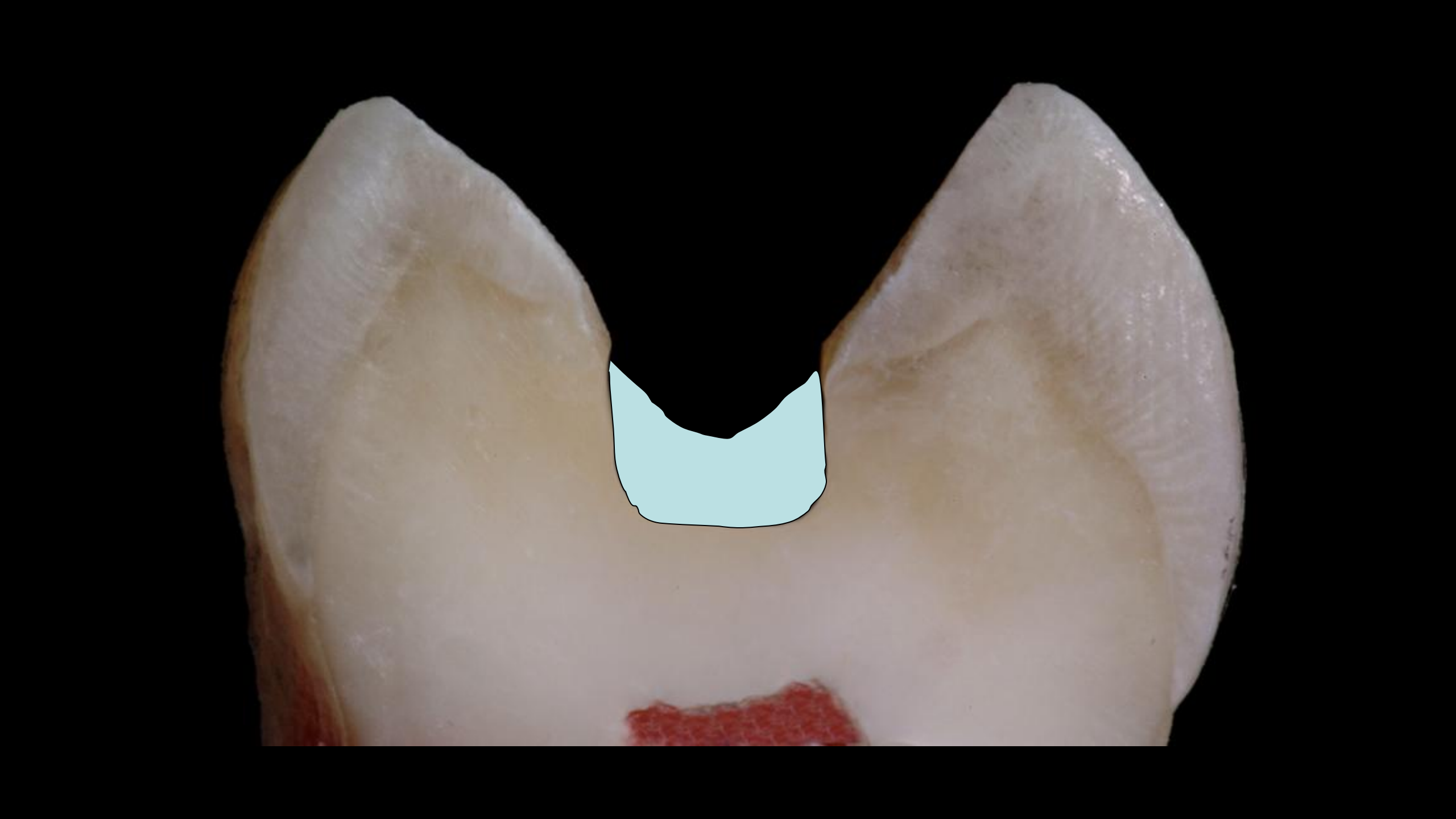
Do you trust enamel bonding or dentin bonding?

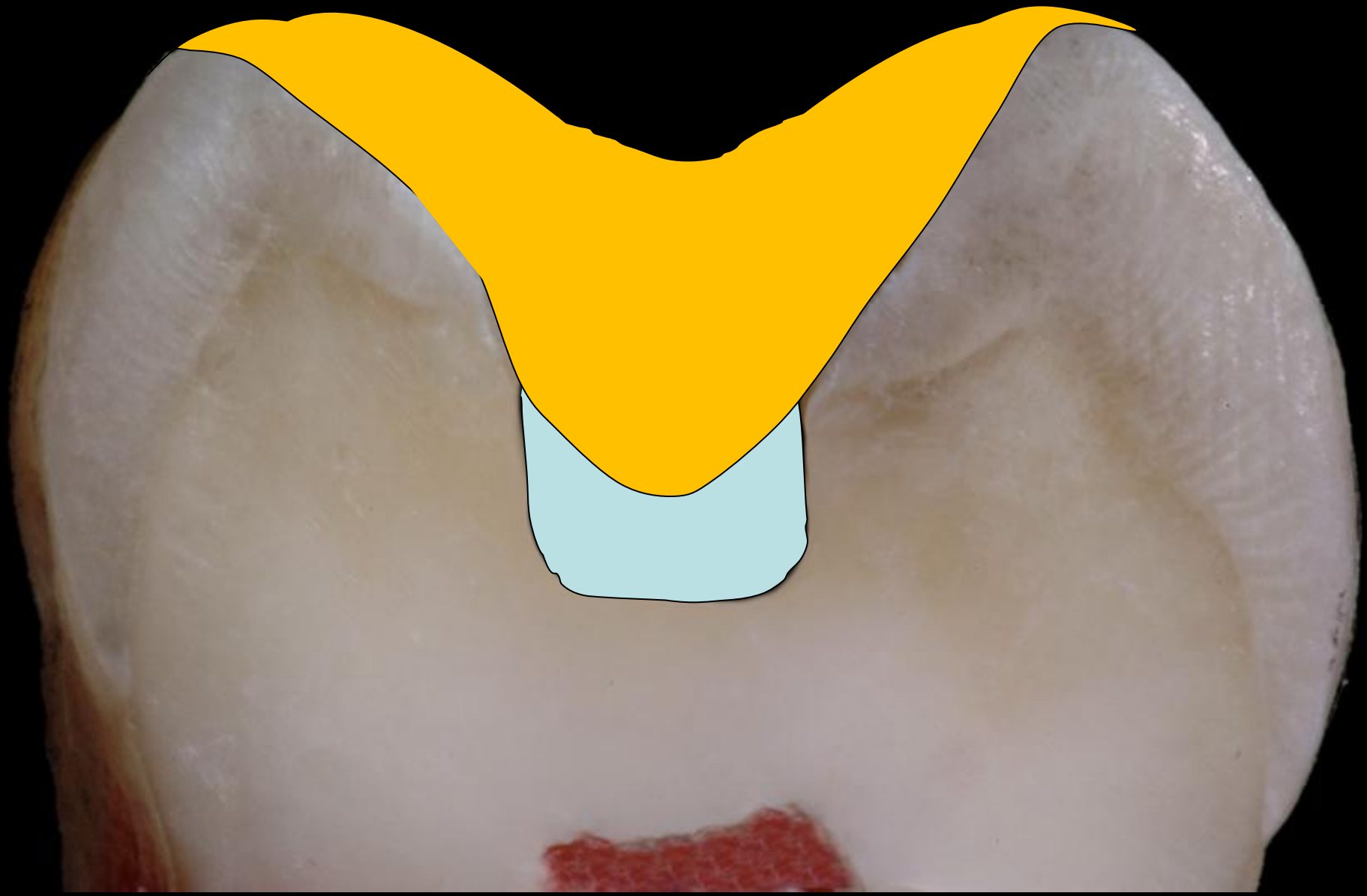


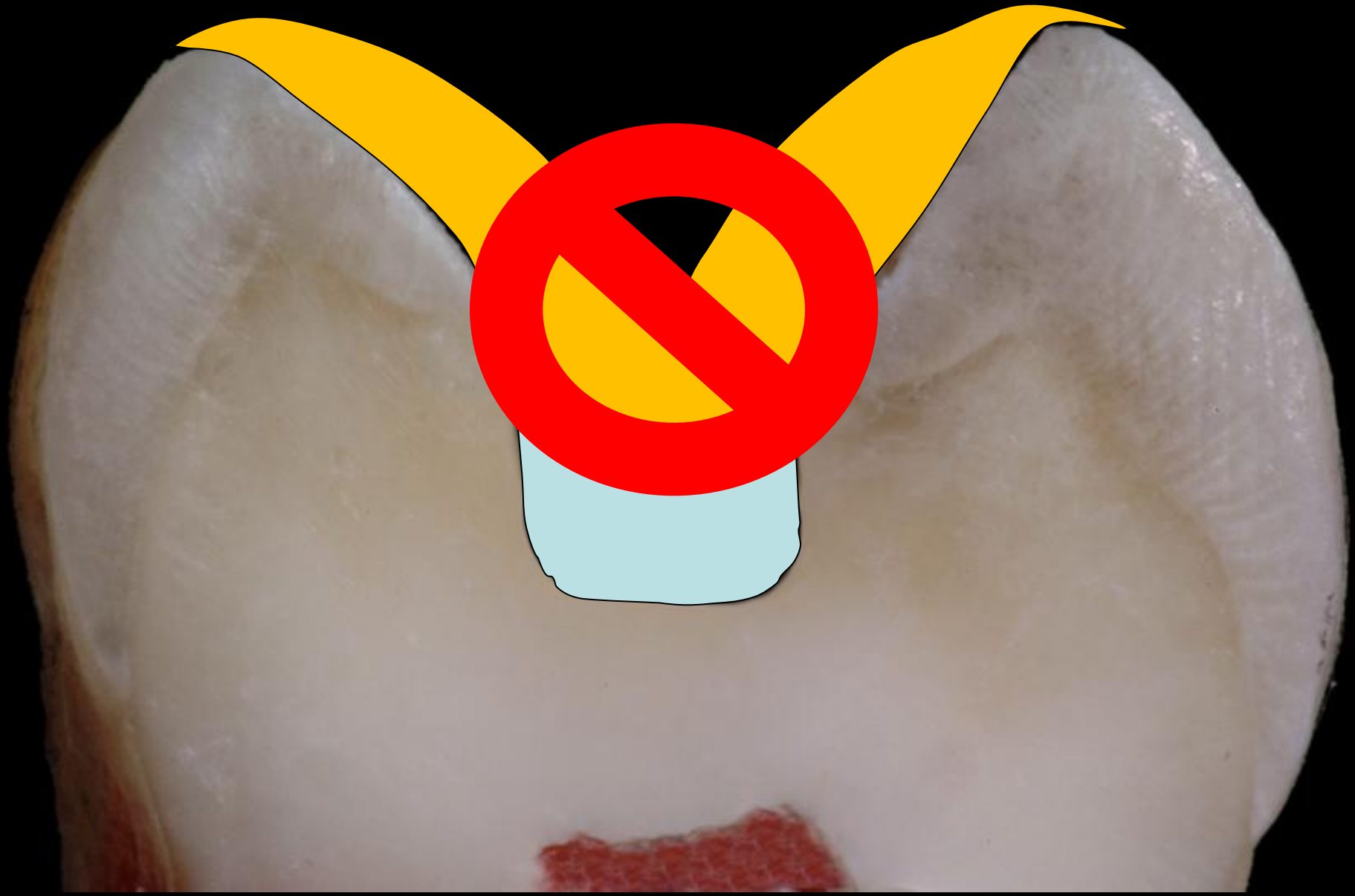




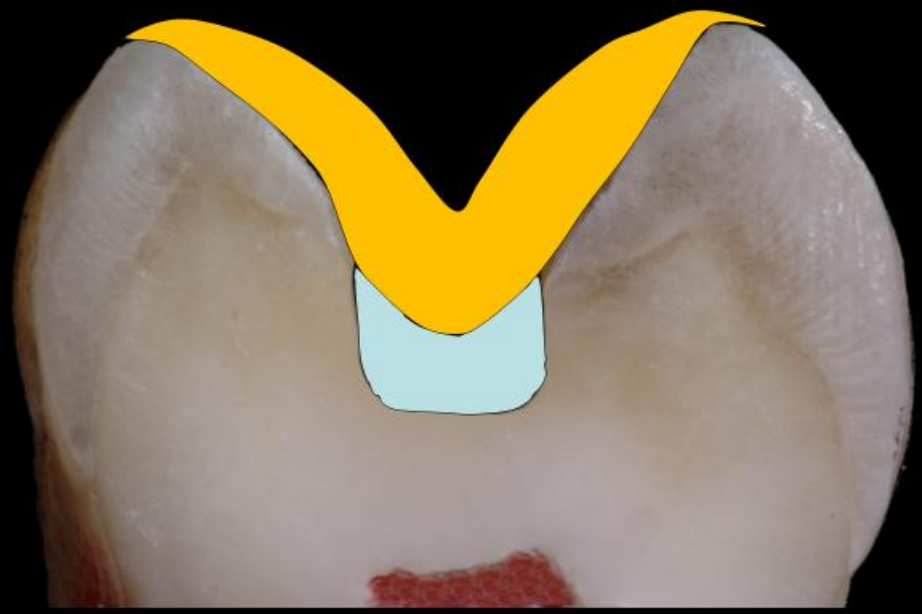




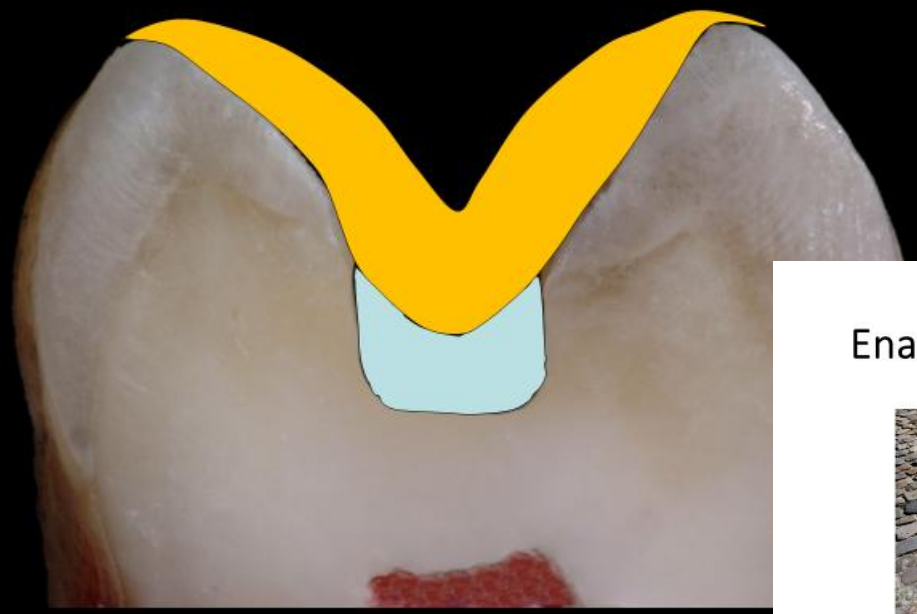




At what point will this tooth go from compression into tension, and vice versa?



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

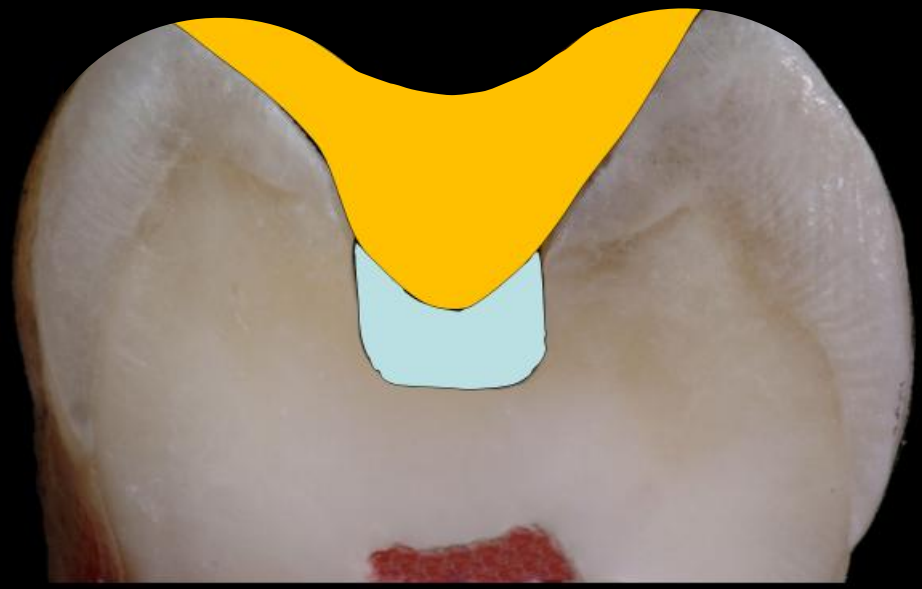


Enamel vs. resin composite

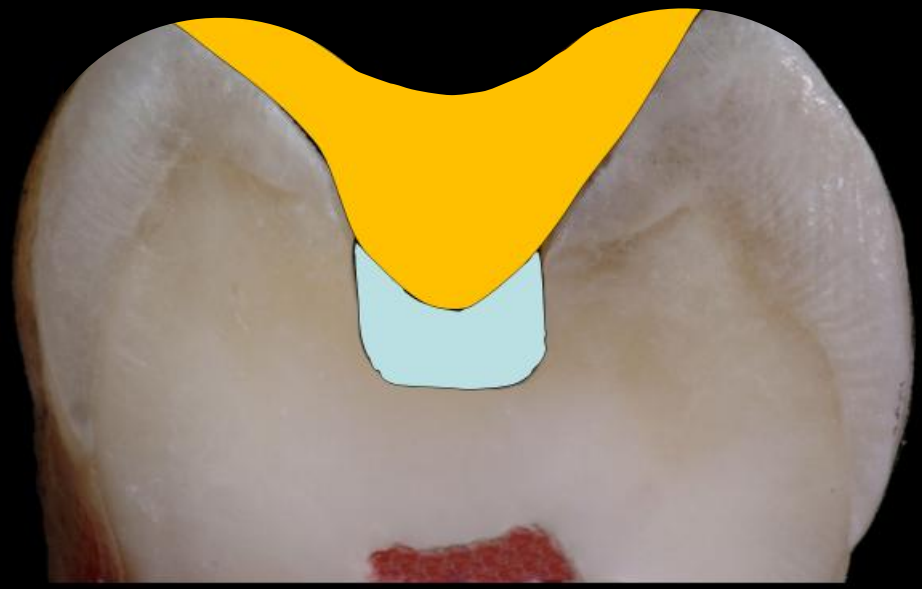
Enamel rods?

Resin composite

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

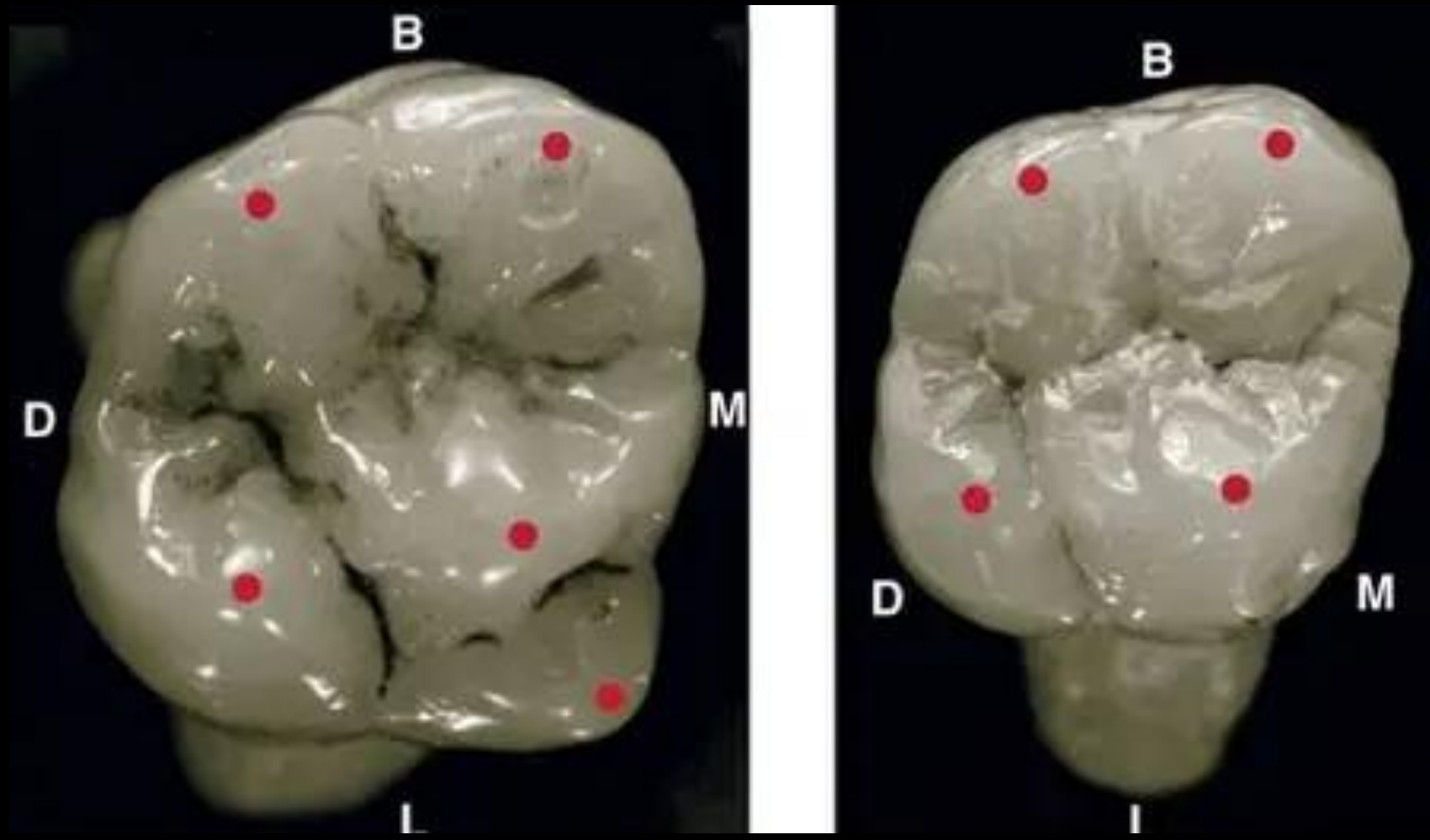


Shape Optimization:
Build a bridge from buccal to lingual

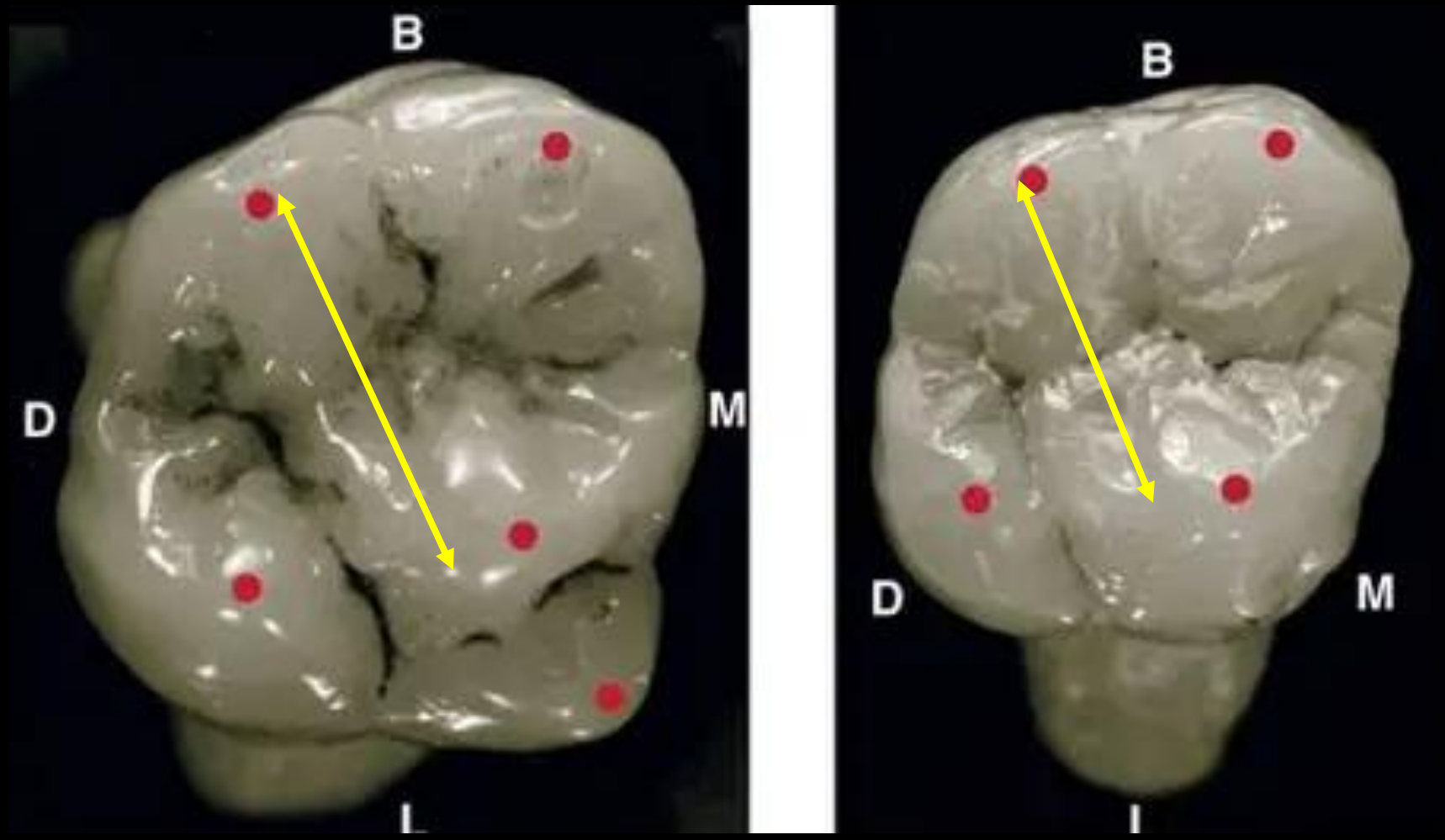


Is there anything illegal or immoral about the anatomy of a maxillary first molar?

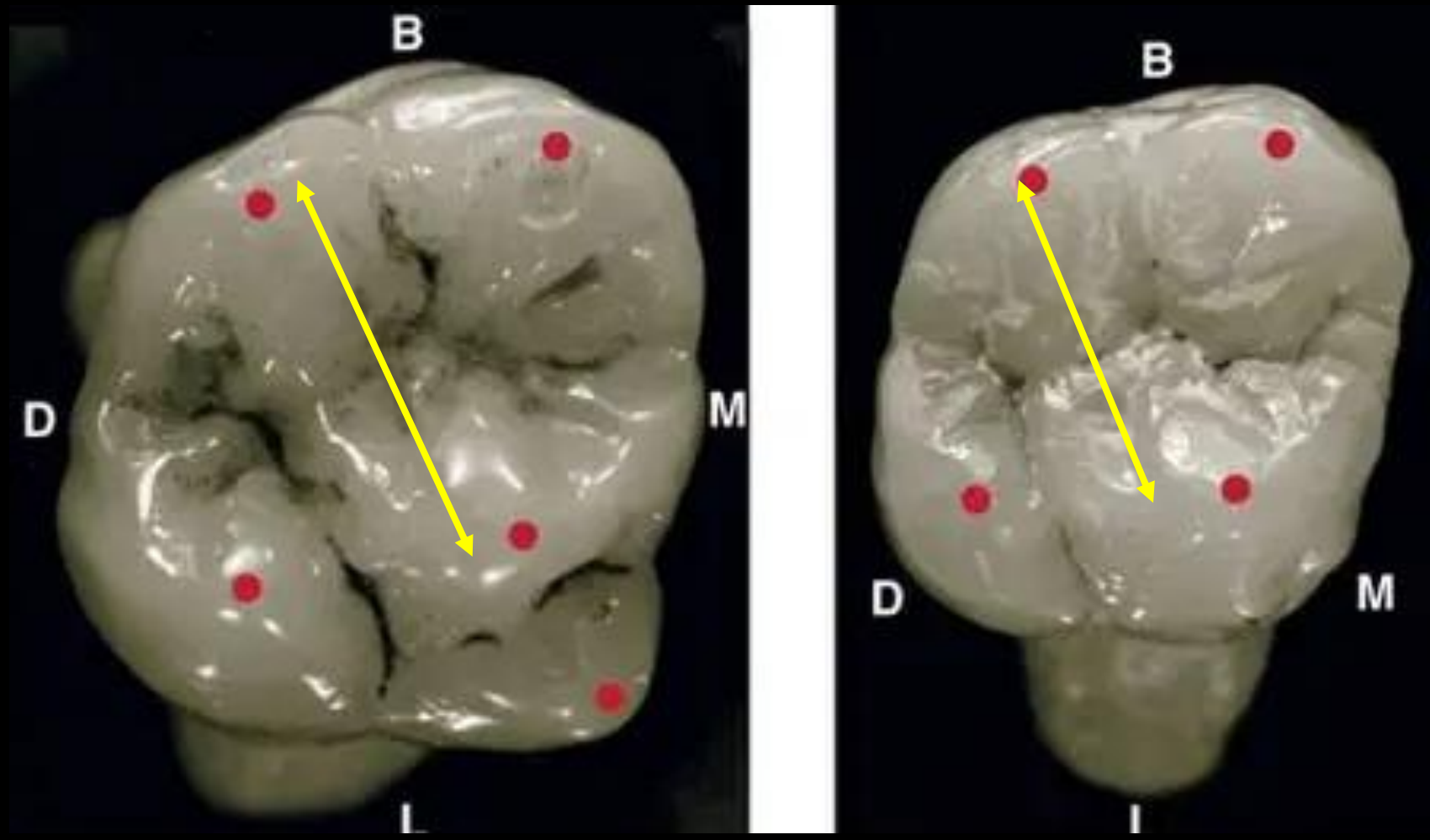
What unique trait does a maxillary first molar possess that protects it from cracking?

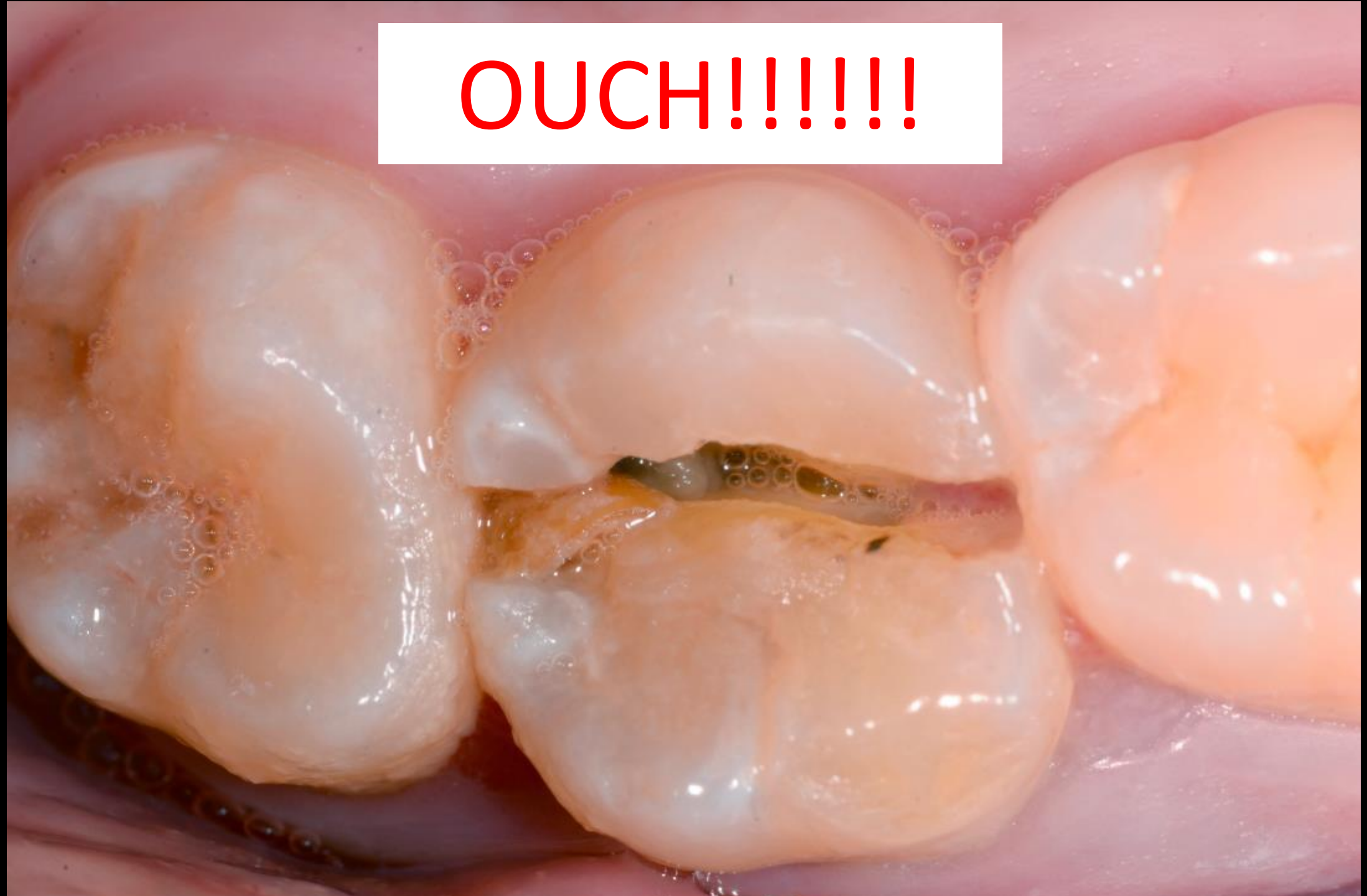


The oblique ridge

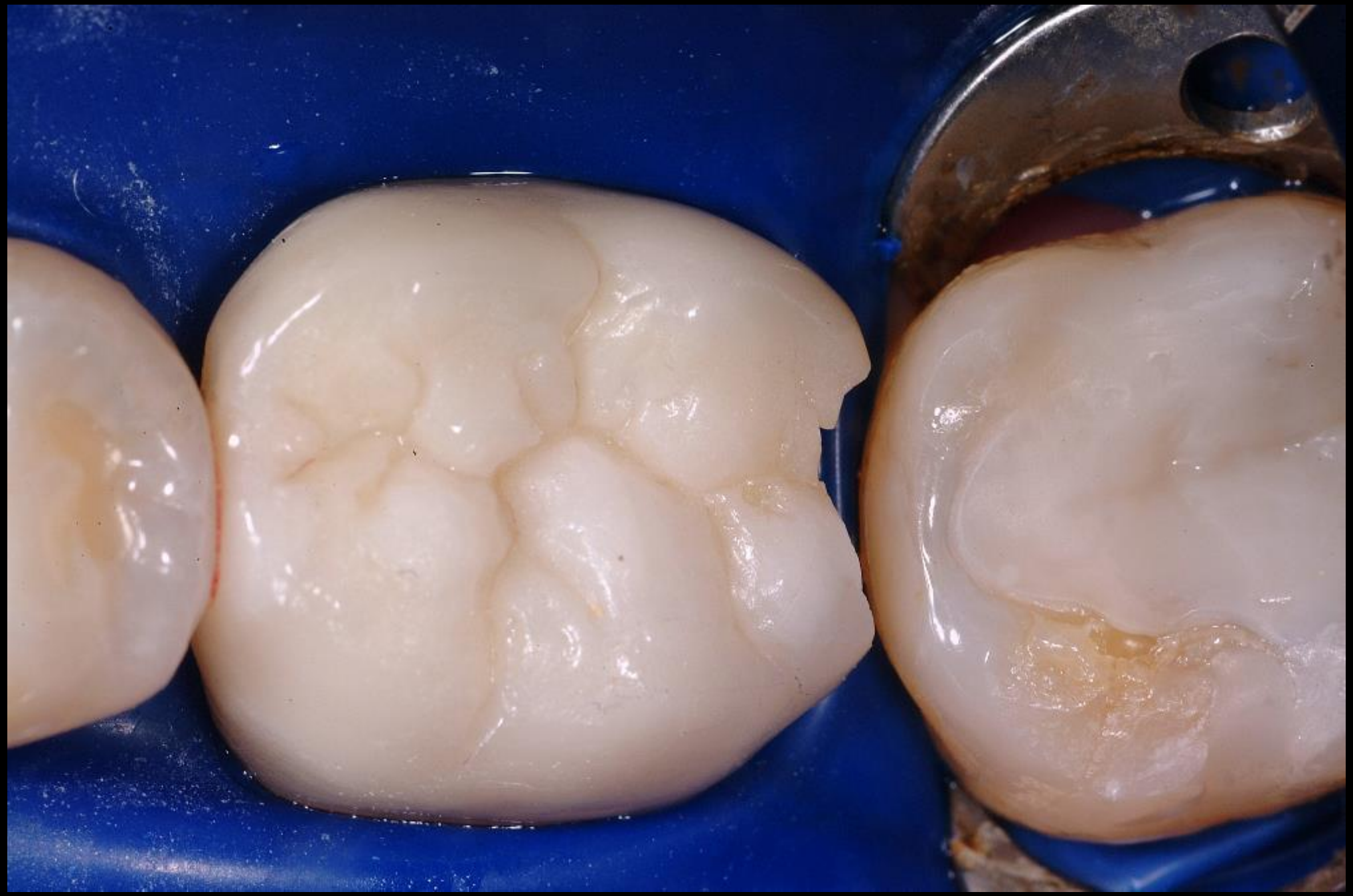


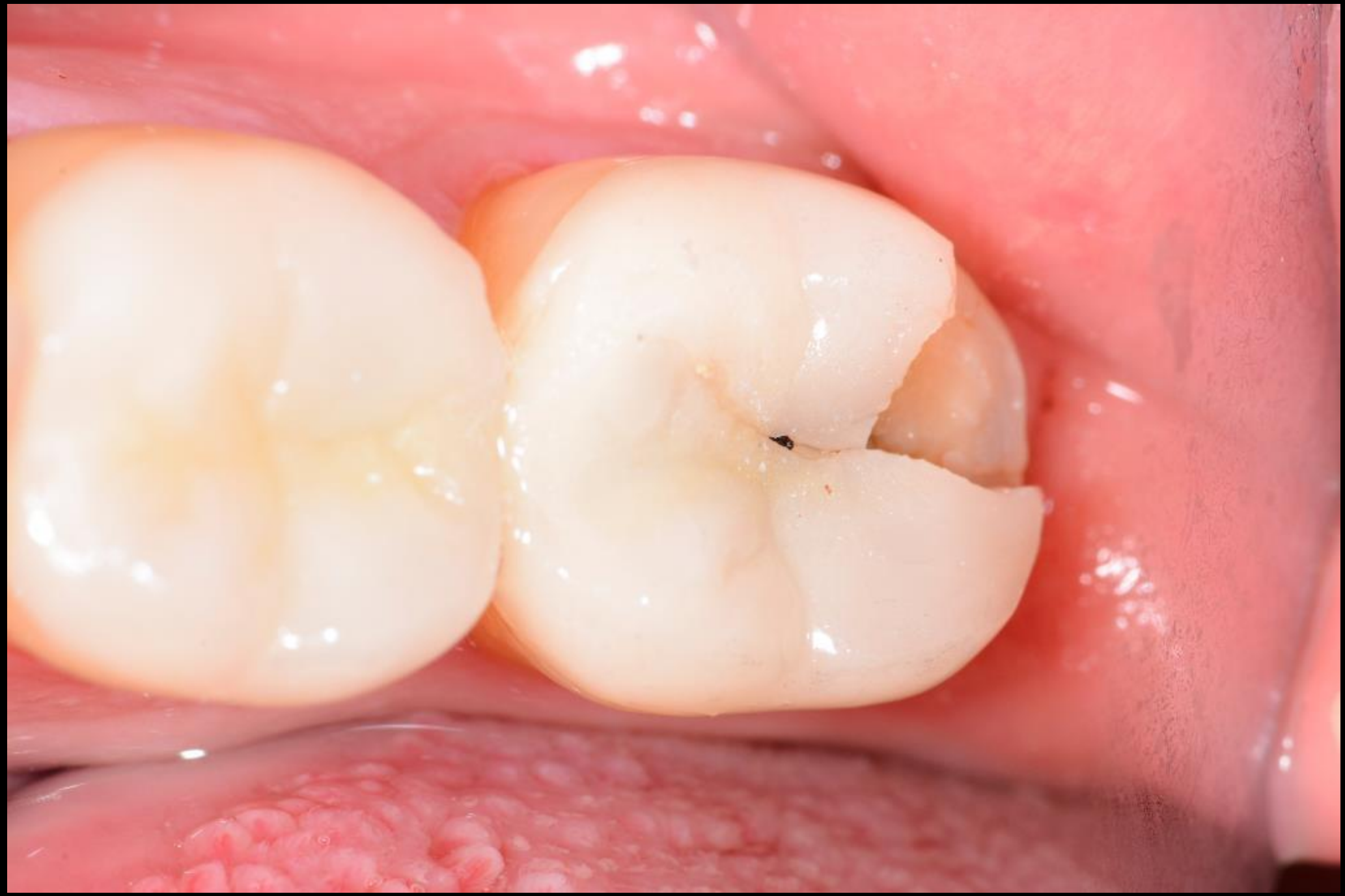
The oblique bridge

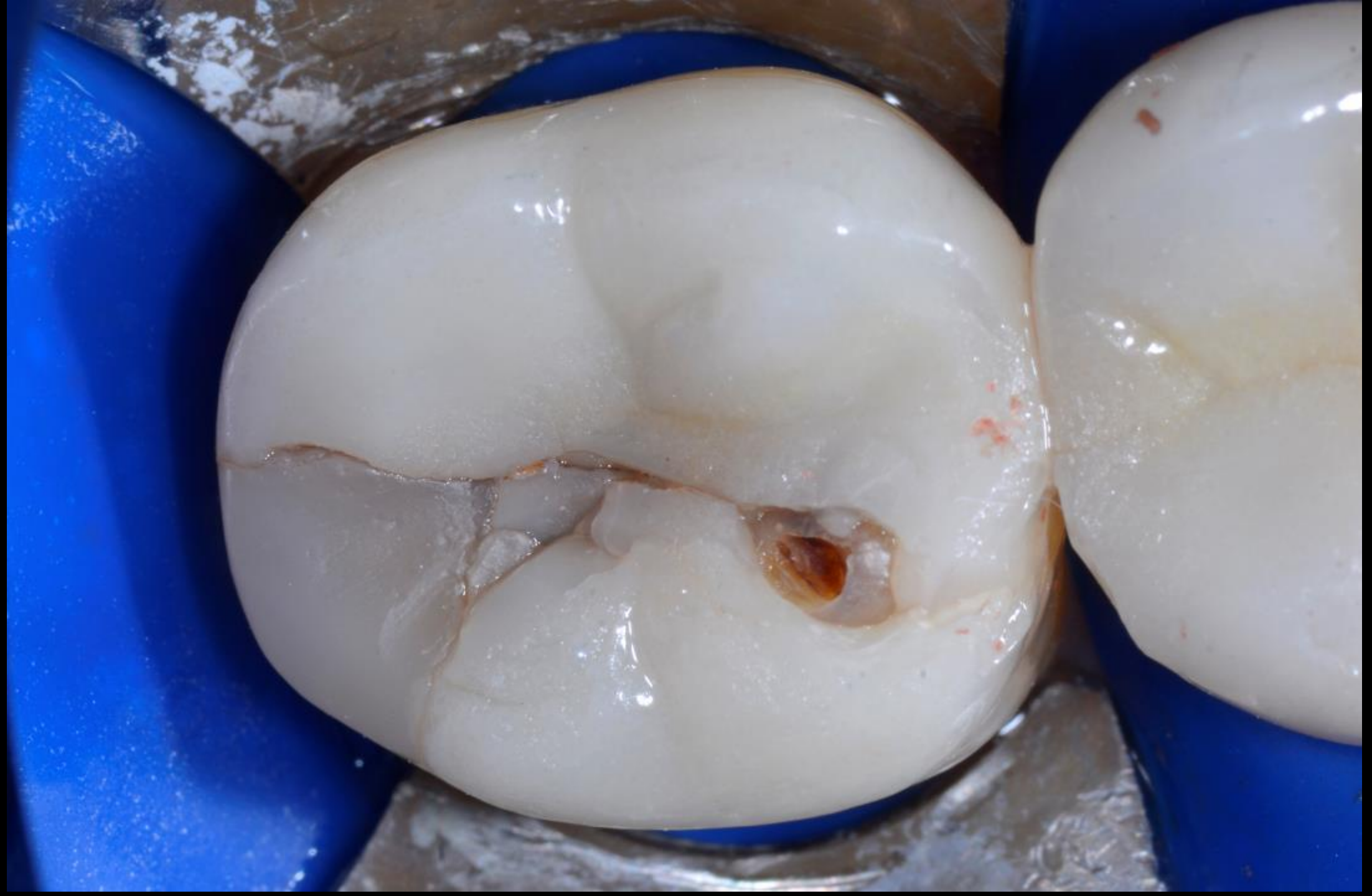


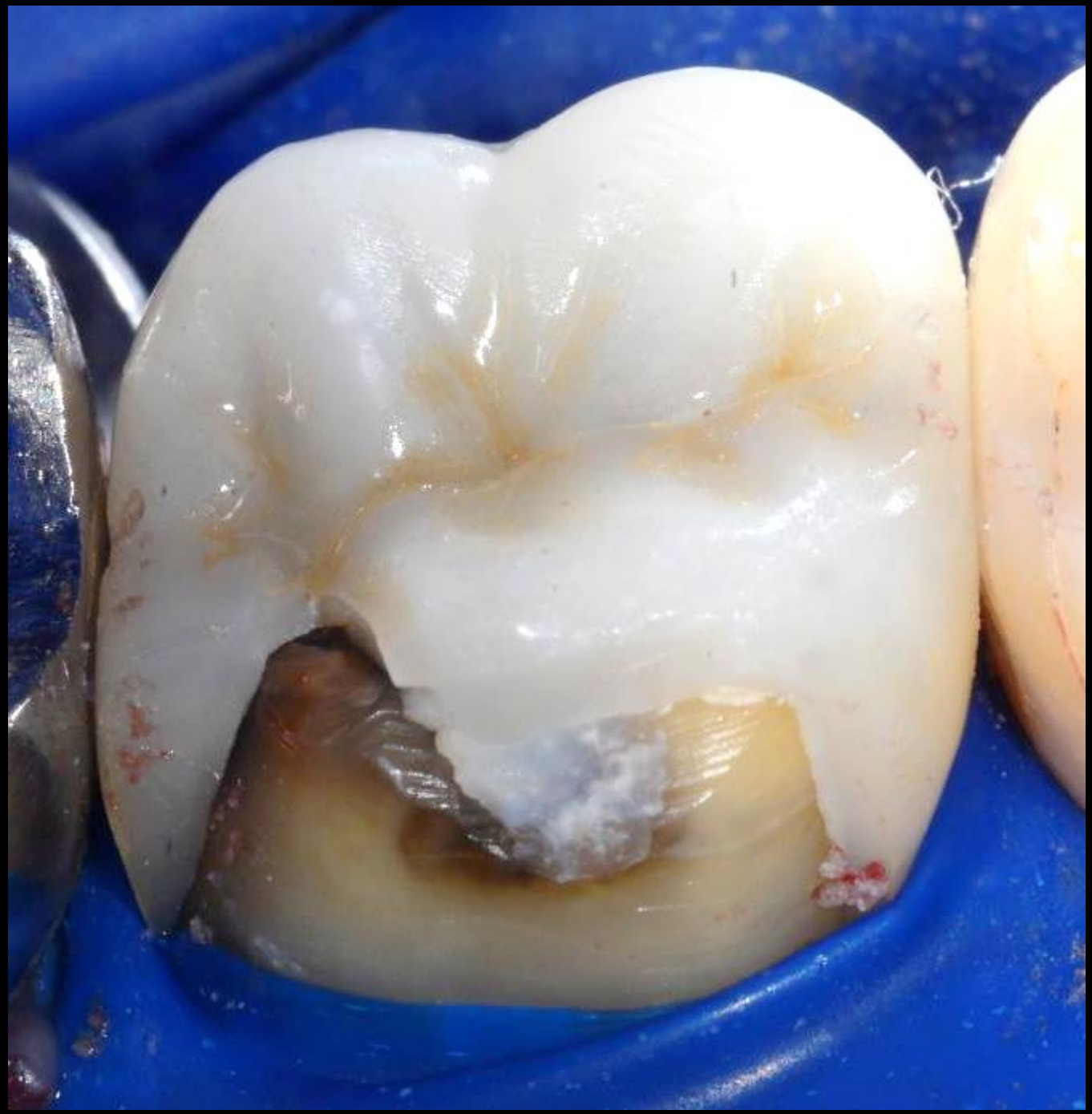

OUCH!!!!!!

Man Copies Nature's Mistake:
Vertical Layering and Deep Continuous Grooves in a Brittle Material (Composite or Ceramic)





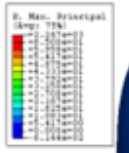




5 year post-op fracture of monolithic zirconia

Stress/Strain Concentration

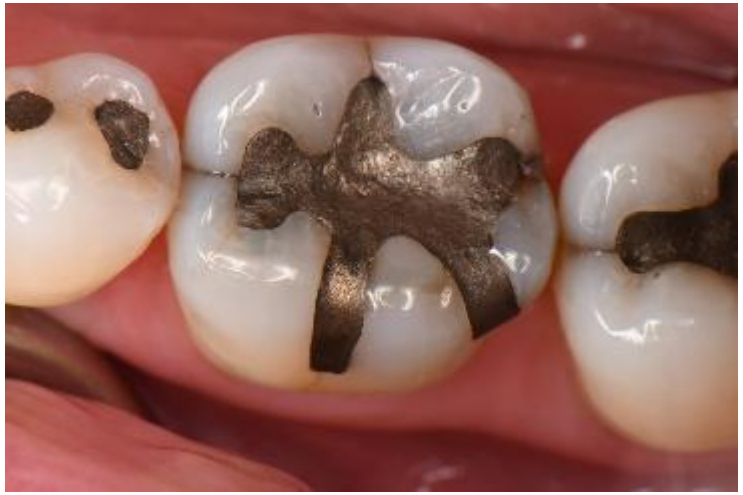
- Abrupt changes in geometry
- Mismatches in mechanical properties
- Concentrated loads

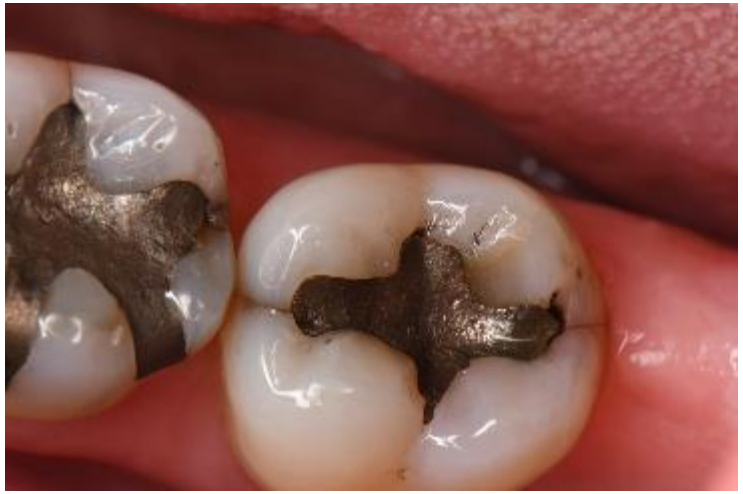


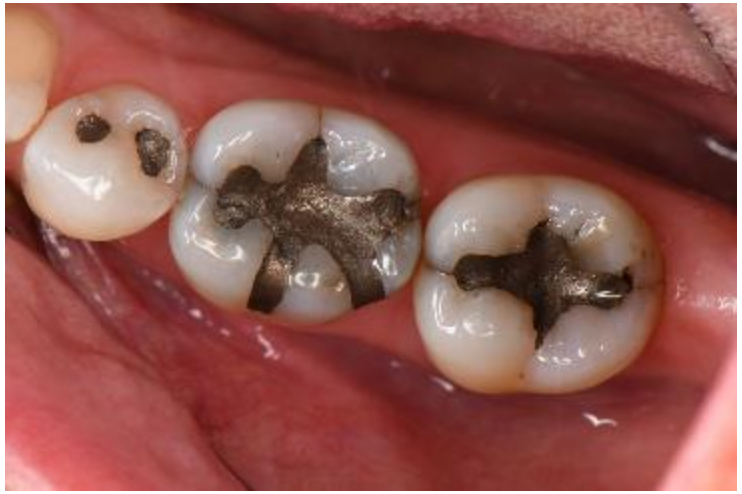
Symptomatic Cracked Lower Molars: Bioclear Consult (2nd Opinion)

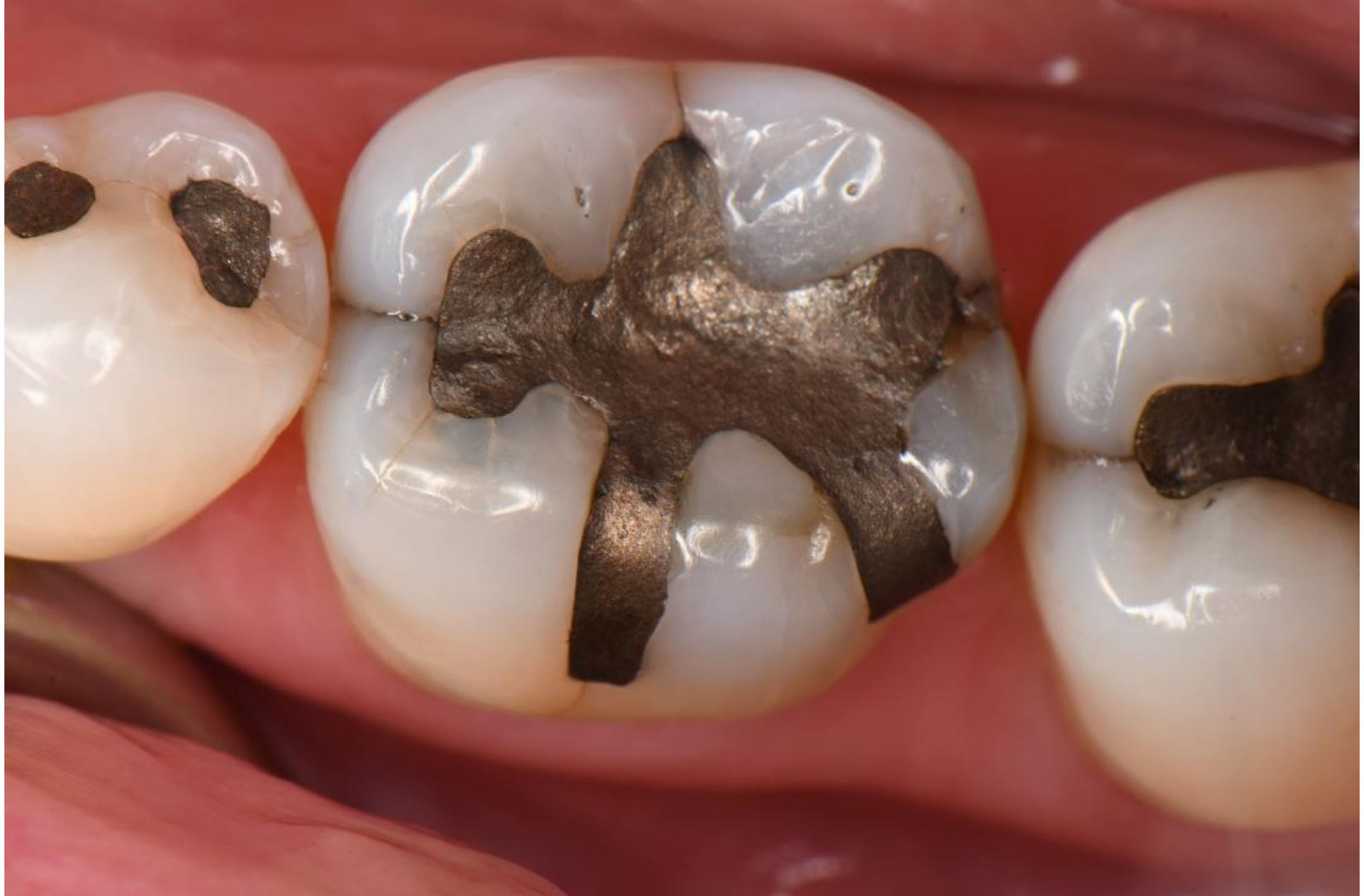
Julia's Seattle dentist has treatment planned her for at least one root canal and crown **#30 and #31**

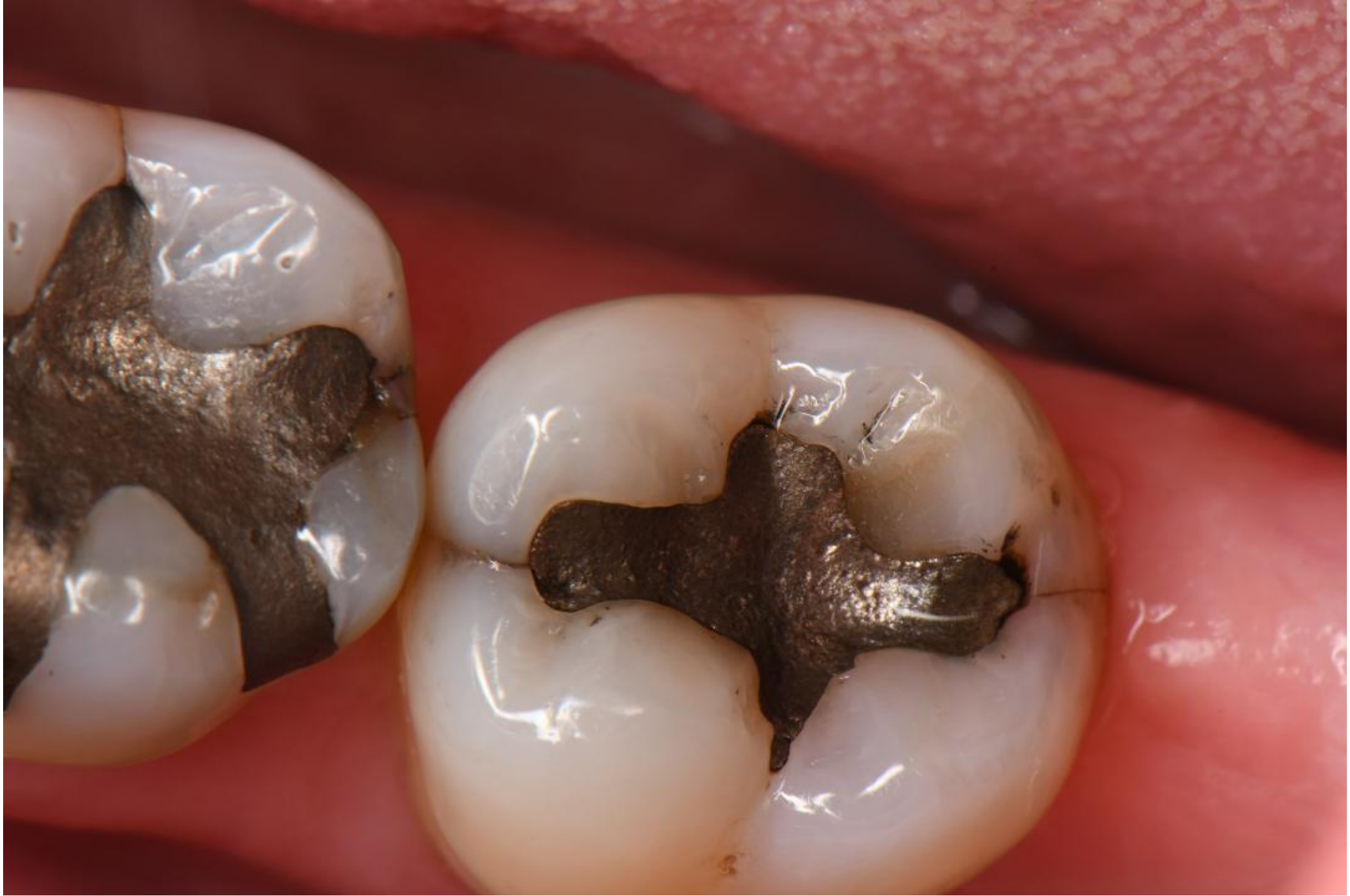

Meet Julia

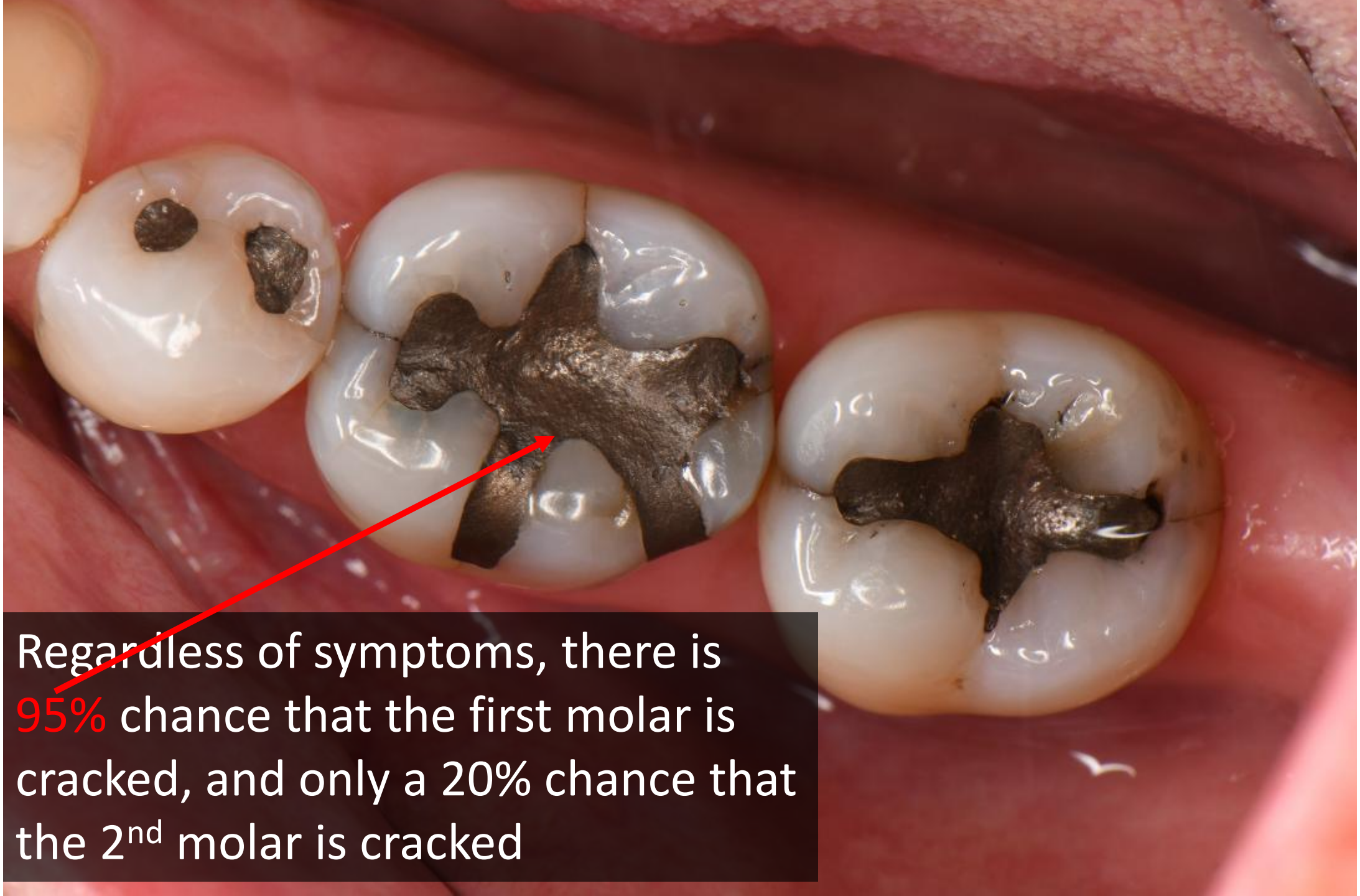


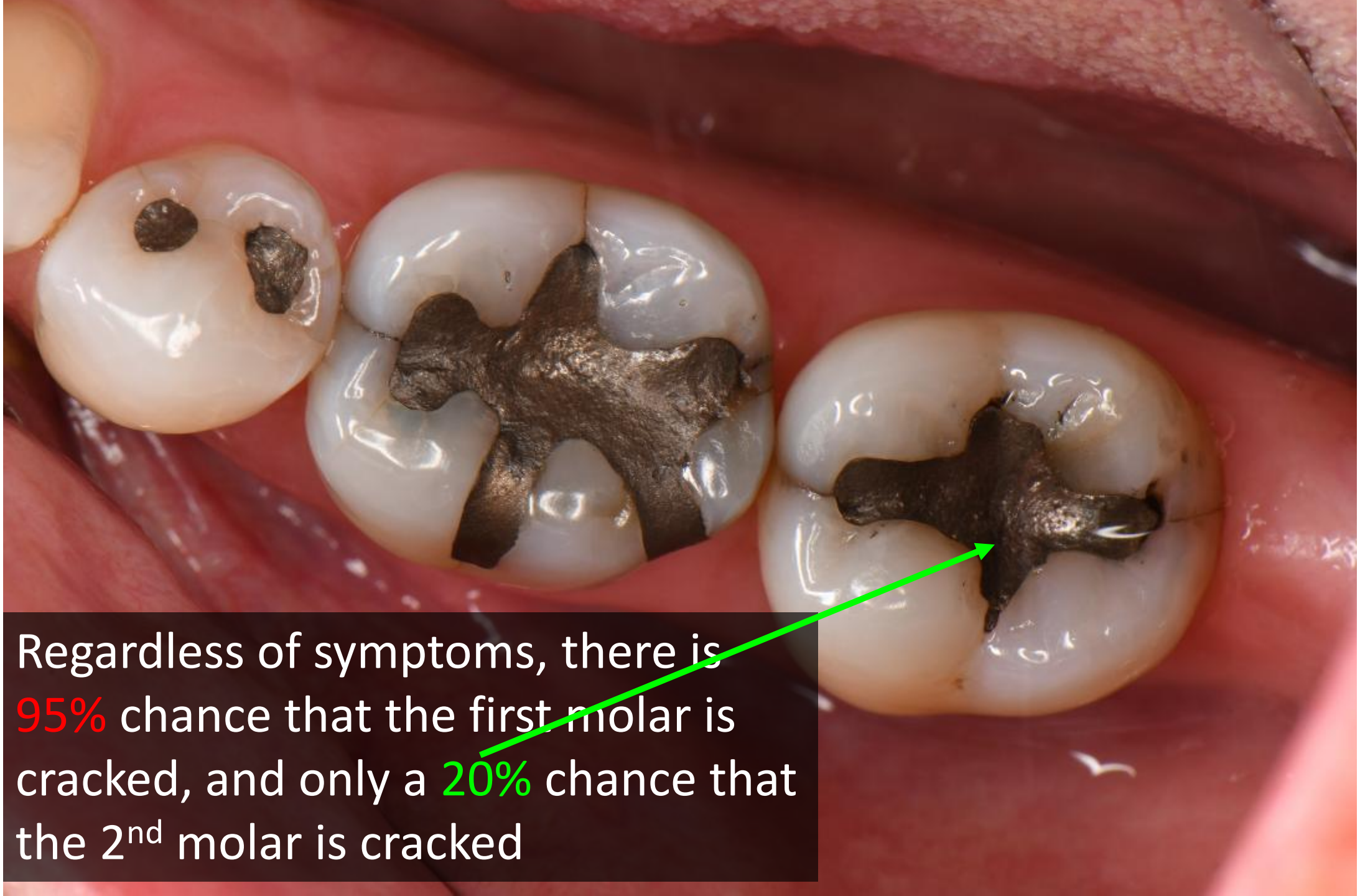


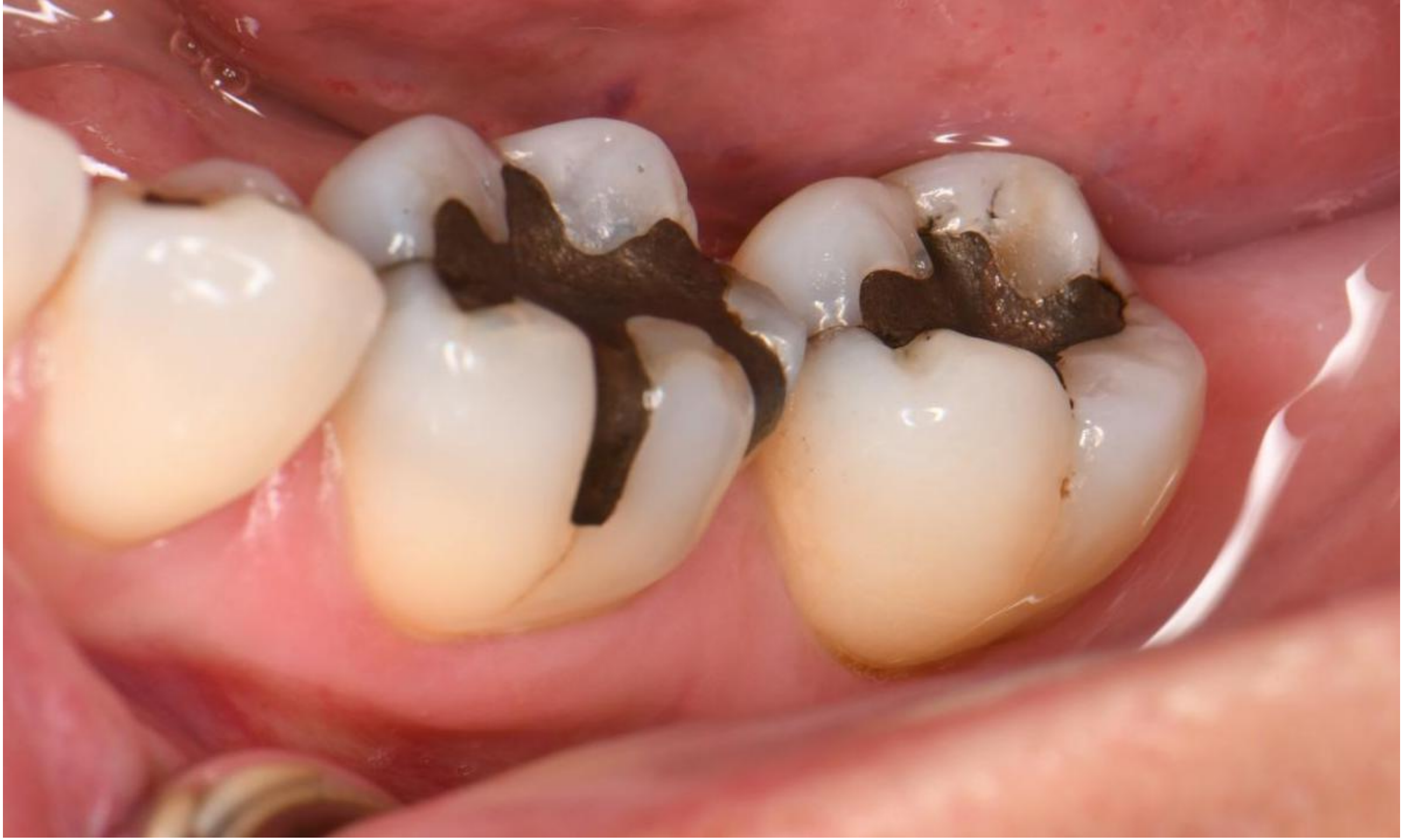







Regardless of symptoms, there is
95% chance that the first molar is
cracked, and only a 20% chance that
the 2nd molar is cracked


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



Julia:The wet cotton roll test benefits:

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

Julia:The wet cotton roll test:

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


Julia: The patient driven wet cotton roll test

Julia: The wet cotton roll test:

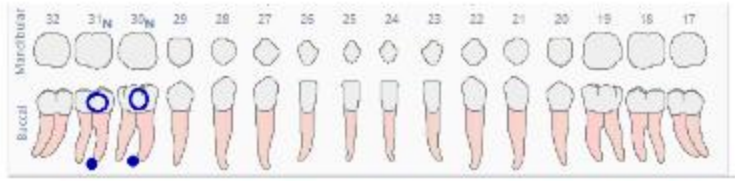
- For reversible pulpitis (RP)cases (irreversible pulpitis (IP)gets the percussion test)
- Get one end of the cotton roll wet
- Patient holds on to the dry end
- Start at the canine (a negative control)
- Repeat the full test at least once

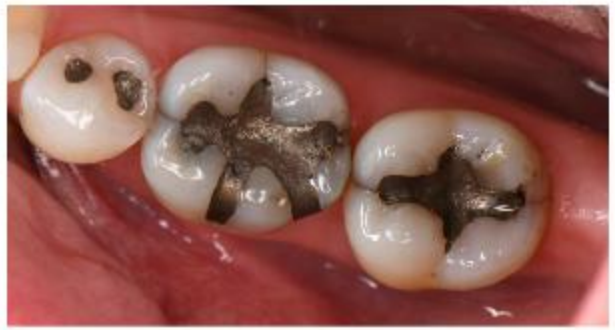
BIOCLEAR
CLINIC

3402 South 38th Street, Tacoma, WA 98409
O: 253-474-7635 E: Patient@BioclearClinic.com

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.

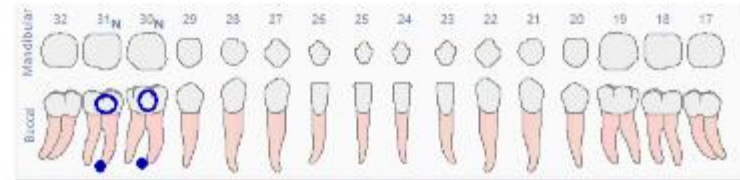
- **Bioclear Posterior Overlay**
  - Tooth # 30 $836
  - Tooth # 31 $836

BIOCLEAR
CLINIC

3402 South 38th Street, Tacoma, WA 98409
O: 253-474-7635 E: Patient@BioclearClinic.com

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

Lower Arch



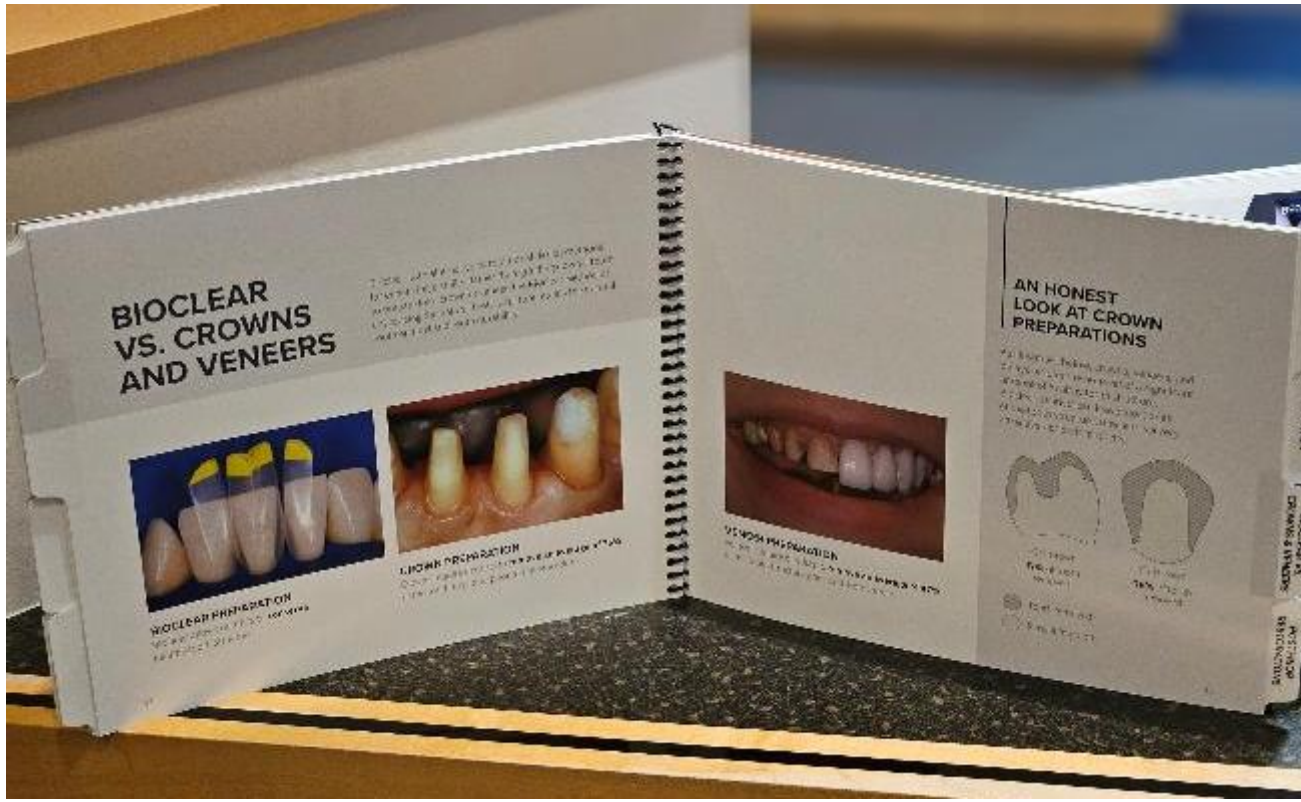
OPTION A

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

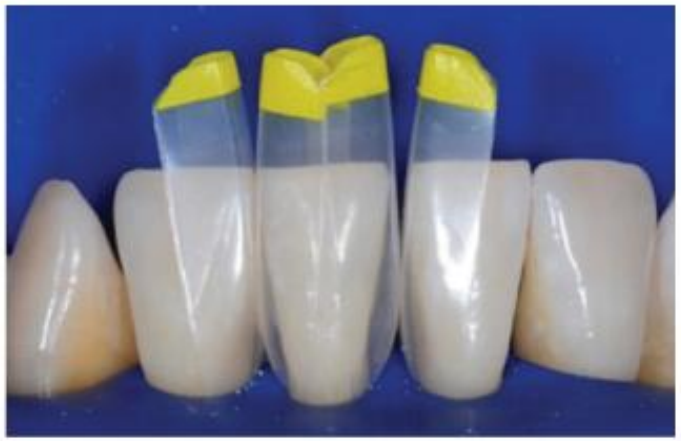


We show her the patient book and cracked teeth pamphlet. Go straight to page 42. Then she chooses a crown or Bioclear. She will get a little insurance coverage for Bioclear. (We are PPO)

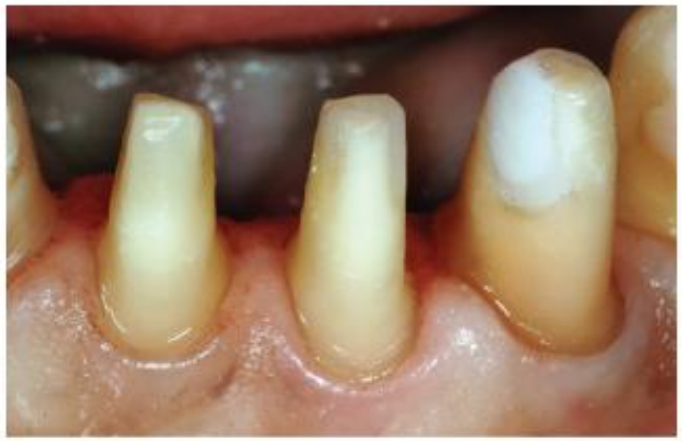
Getting paid to be conservative

BIOCLEAR VS. CROWNS AND VENEERS

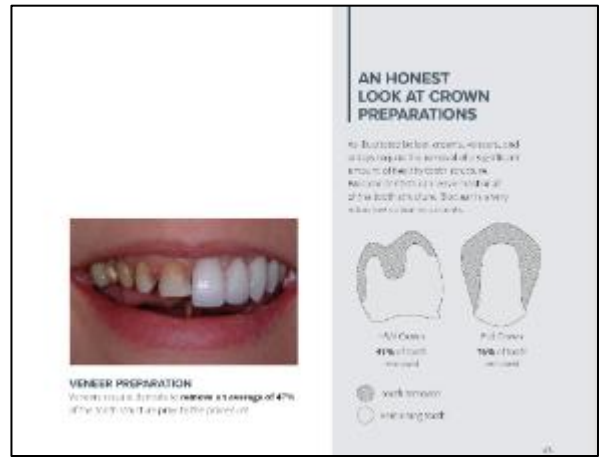
Bioclear is an alternative to traditional dental methods for enhancing a smile. Rather than grinding down a tooth to prepare for a crown or veneer, the Bioclear Method of ensconcing the natural tooth structure retains the natural tooth enamel and tooth durability.



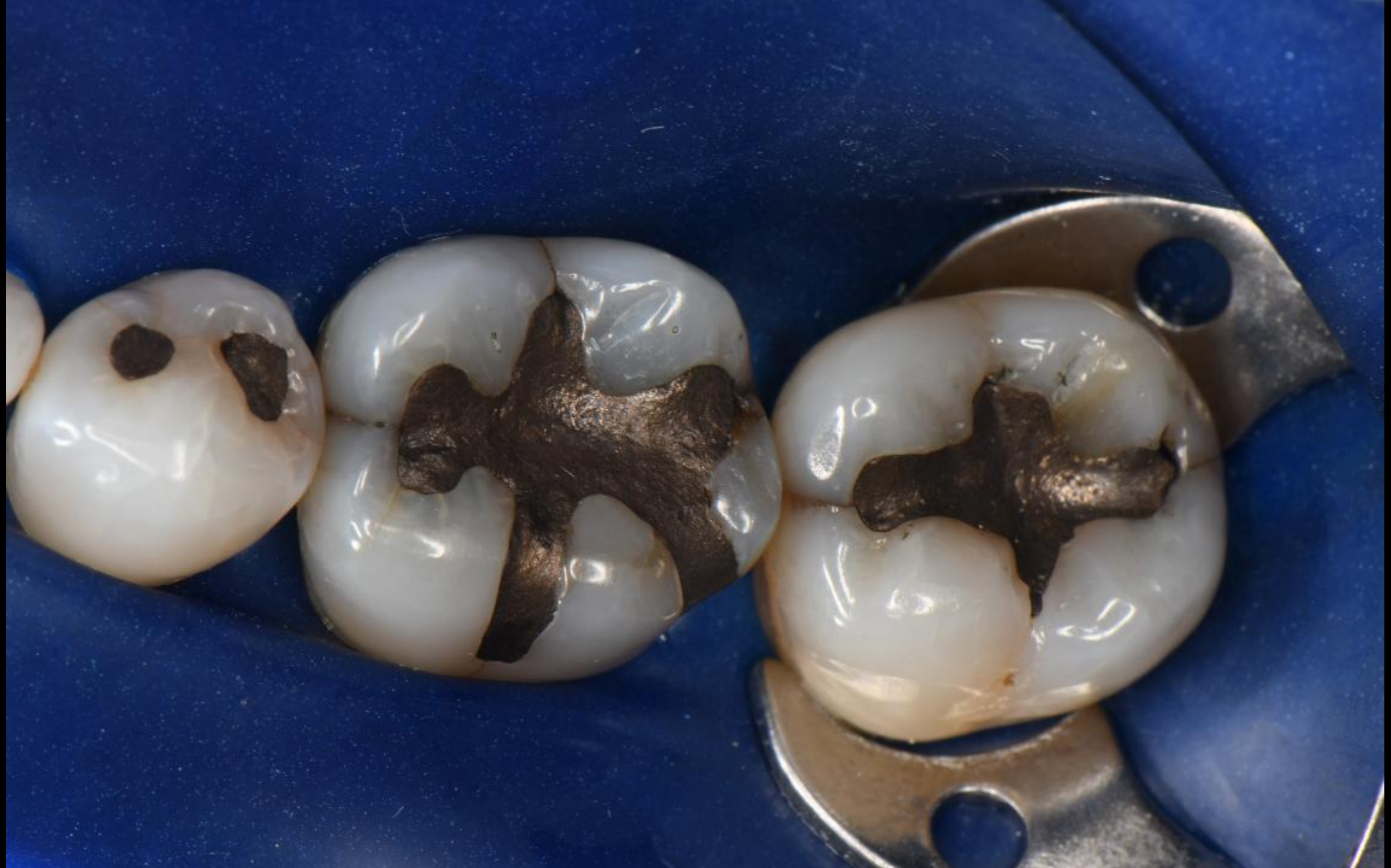
BIOCLEAR PREPARATION
Bioclear allows dentists to **conserve** healthy tooth structure

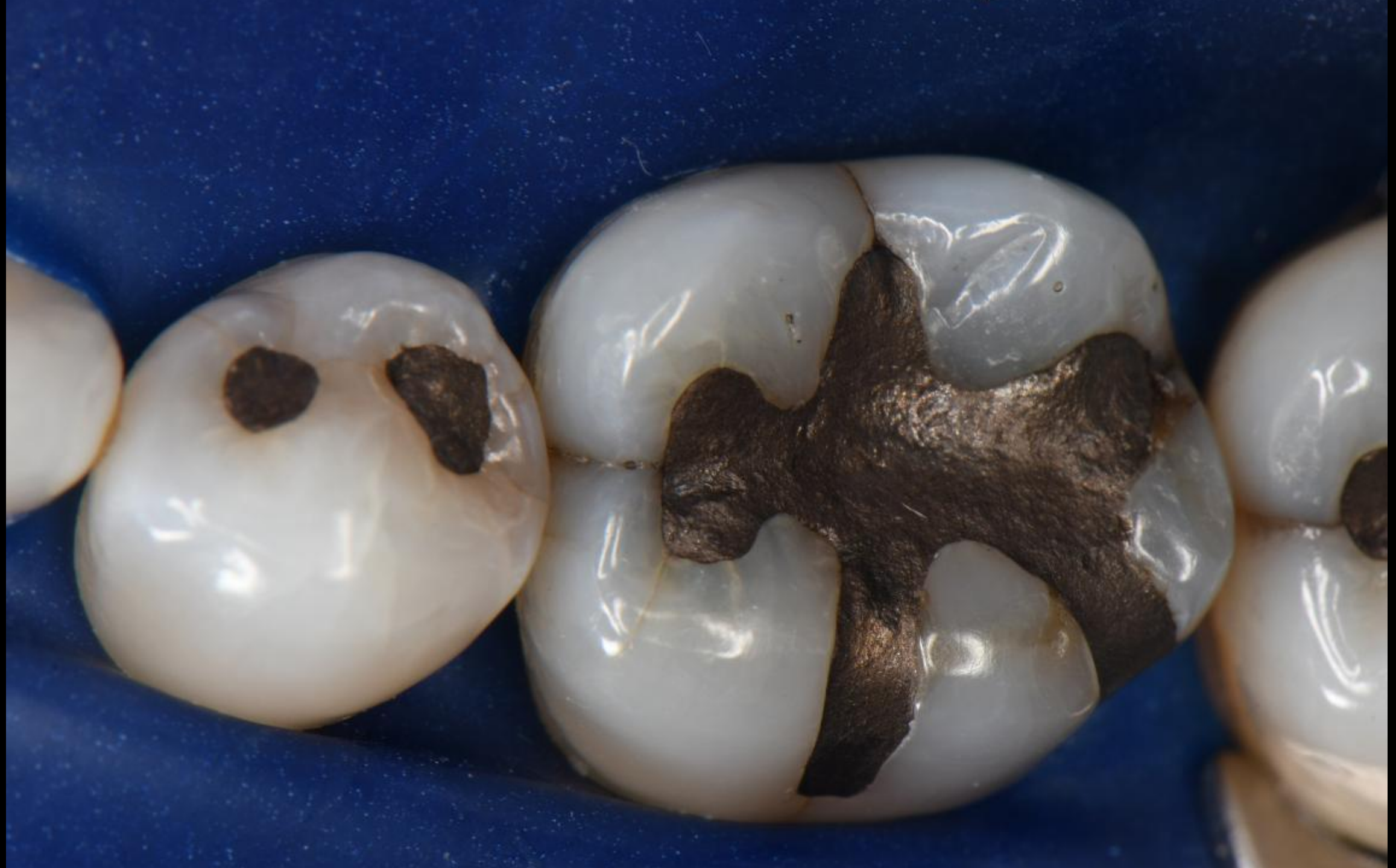


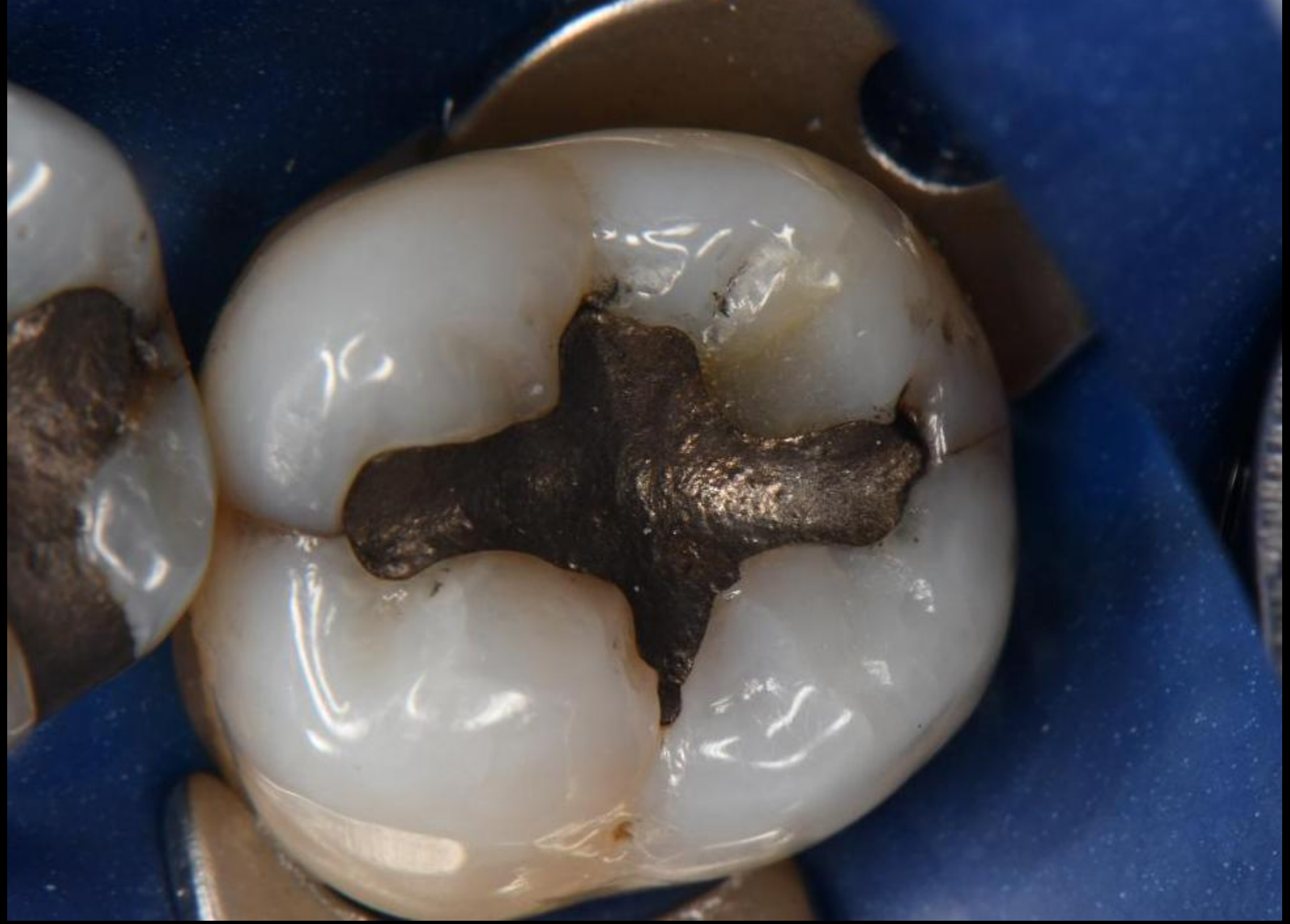
CROWN PREPARATION
Crowns require dentists to **remove an average of 76%** of the tooth structure prior to the procedure

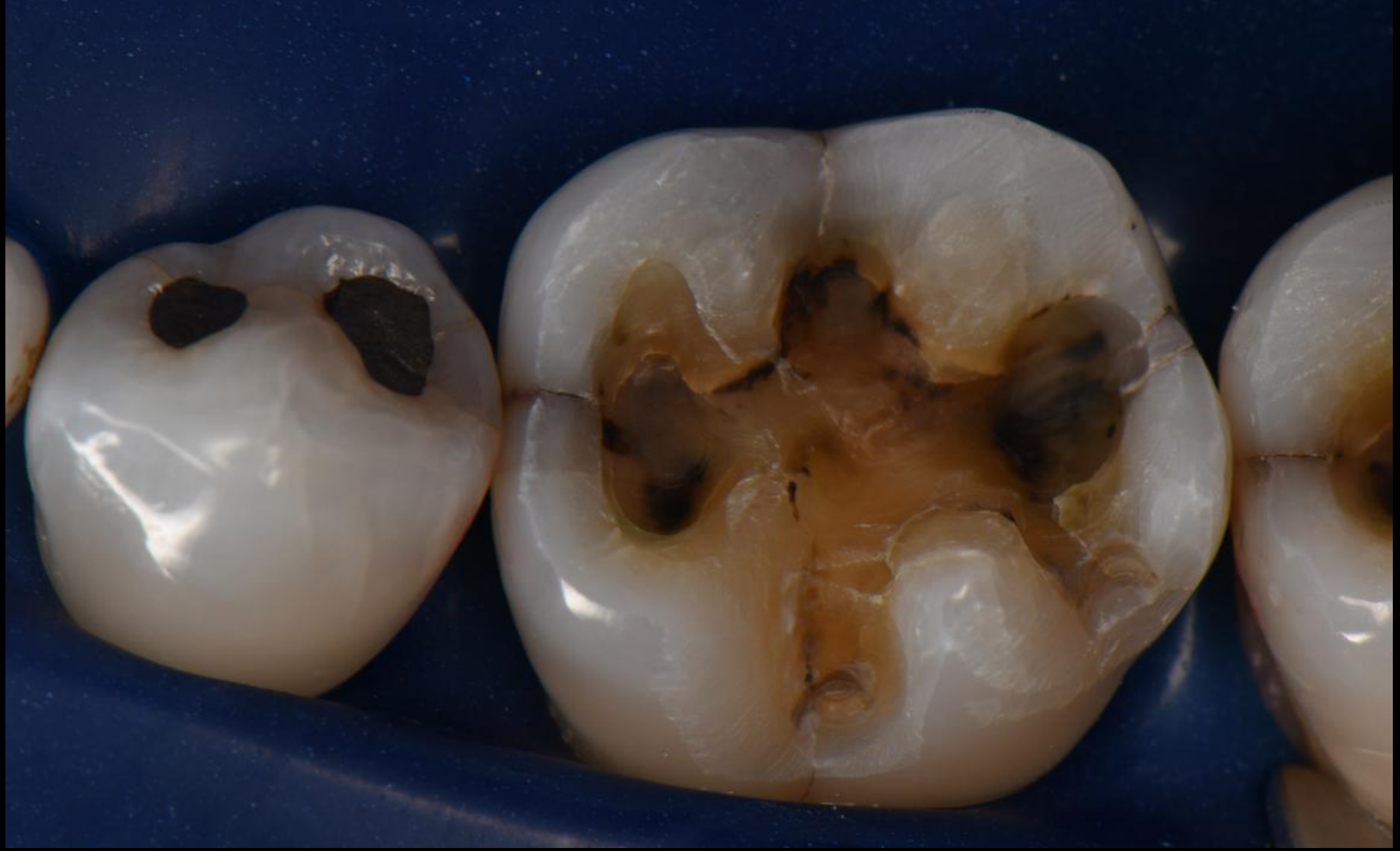


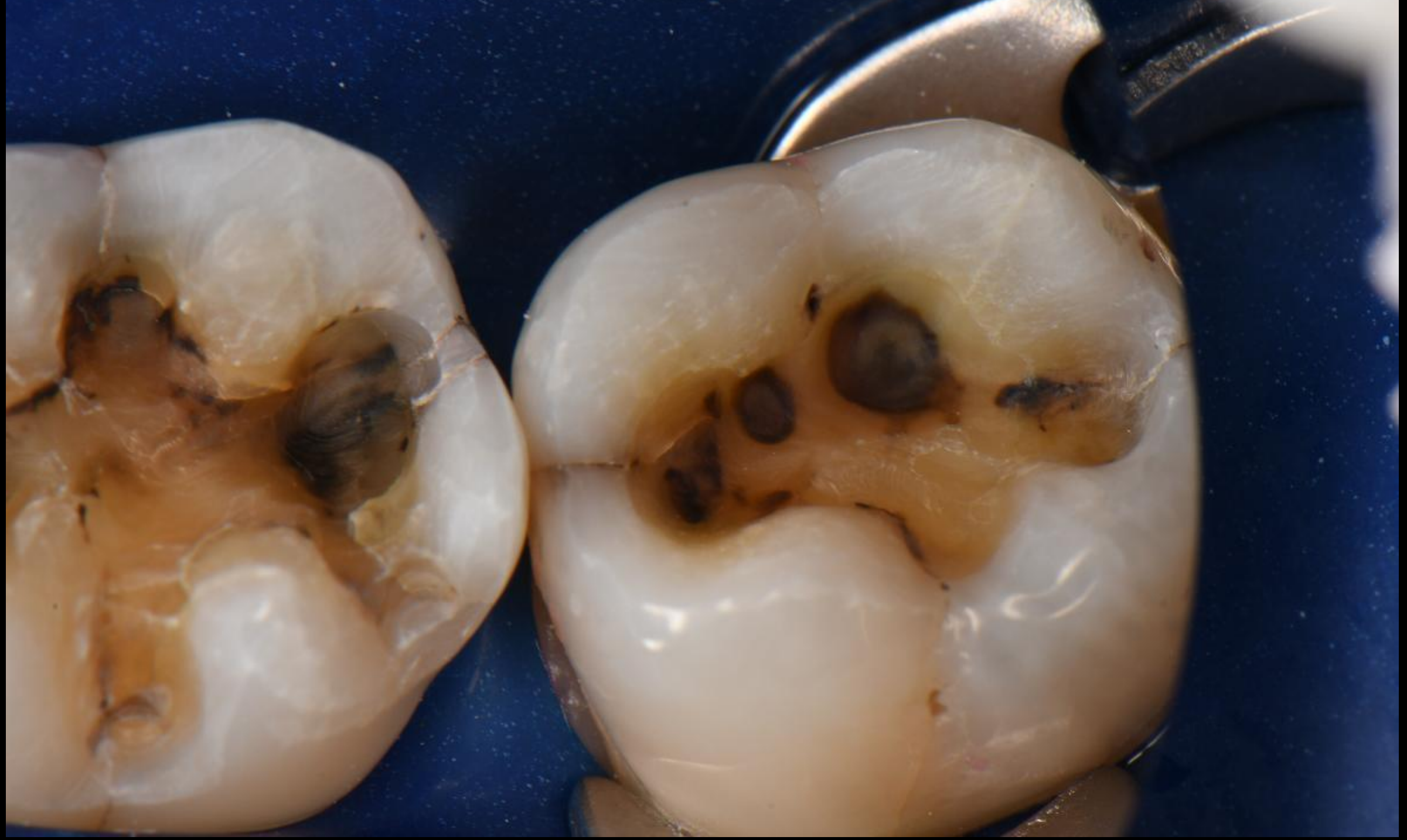
Julia’s overlay treatment images

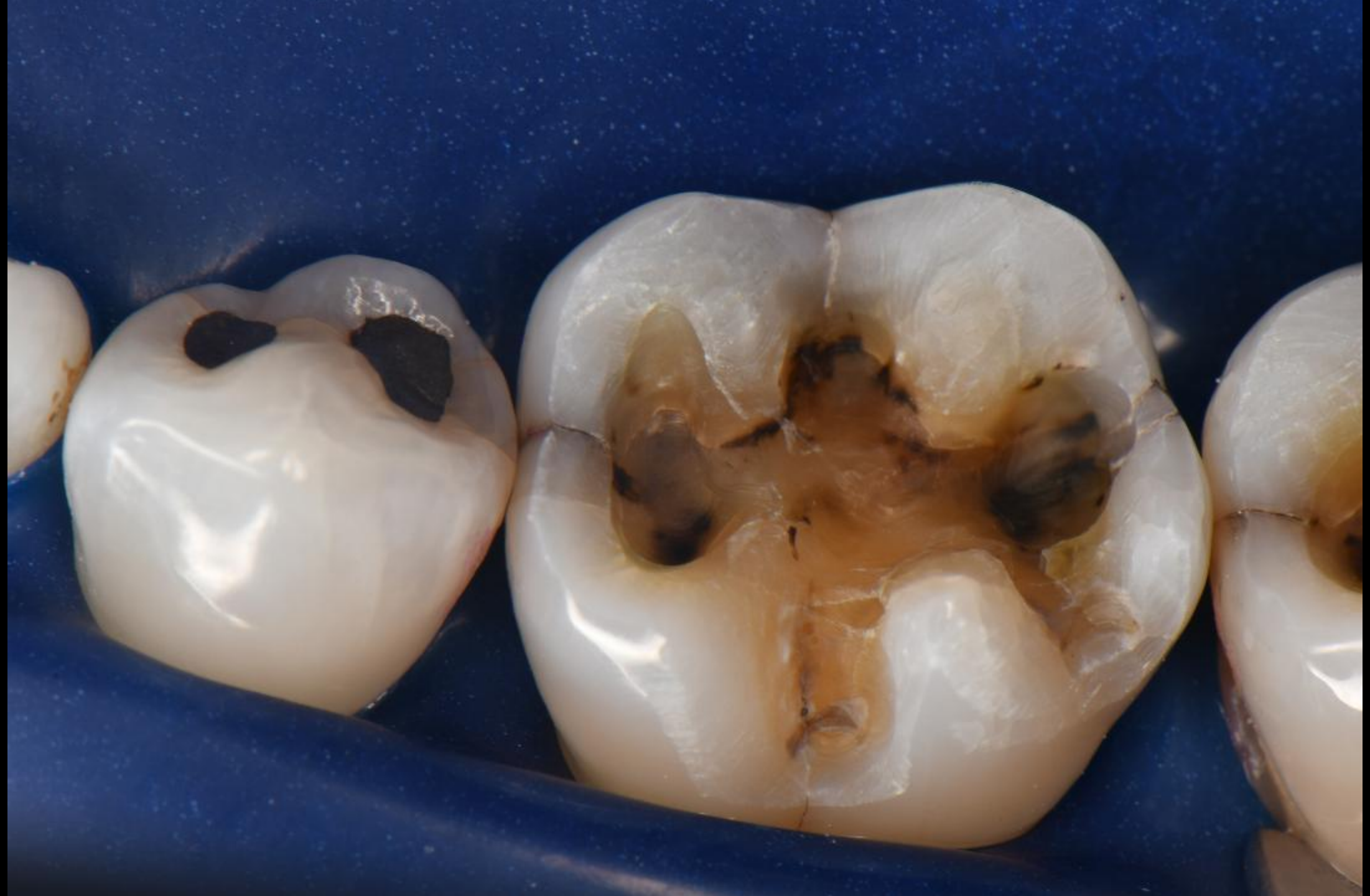


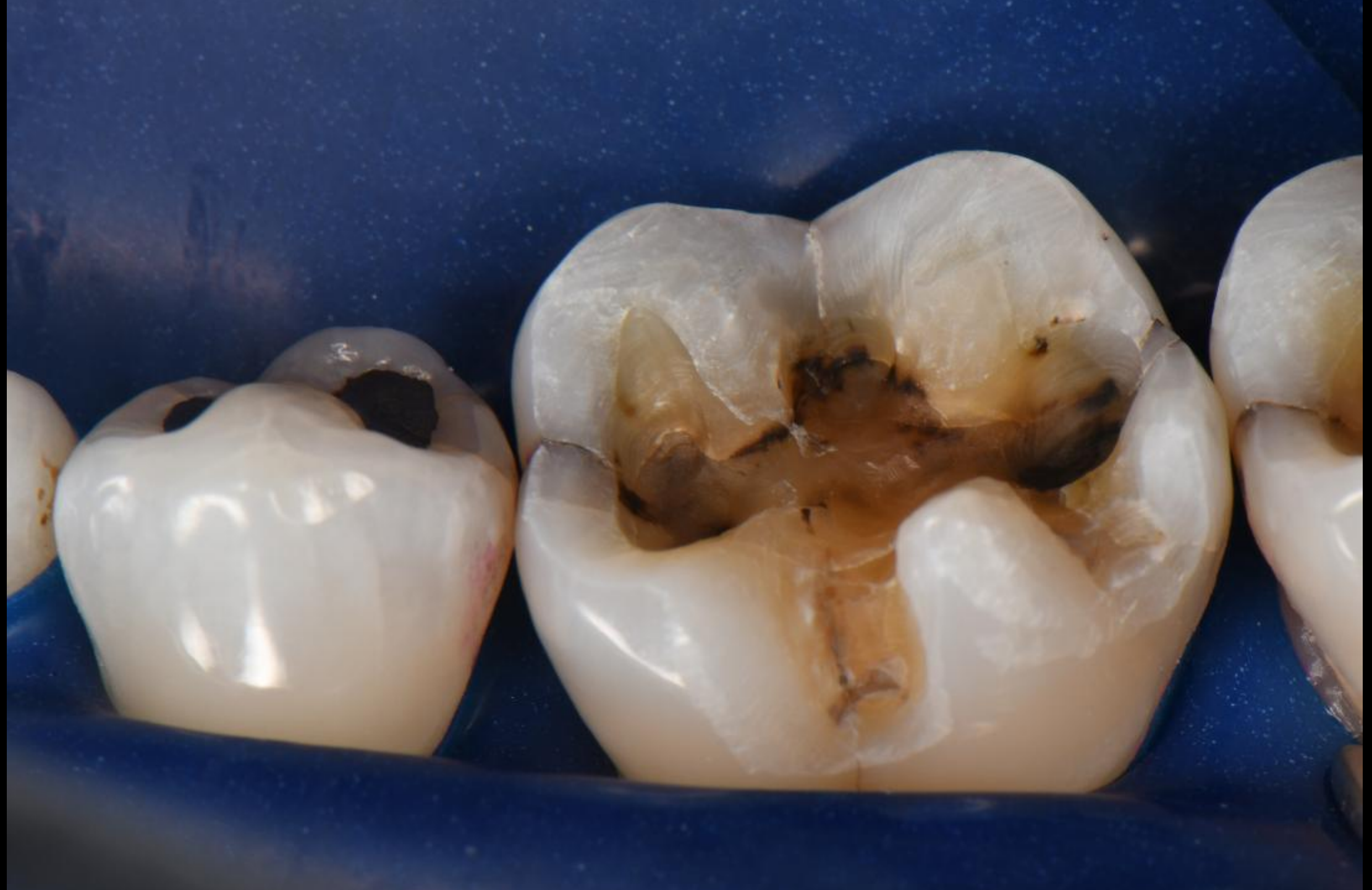


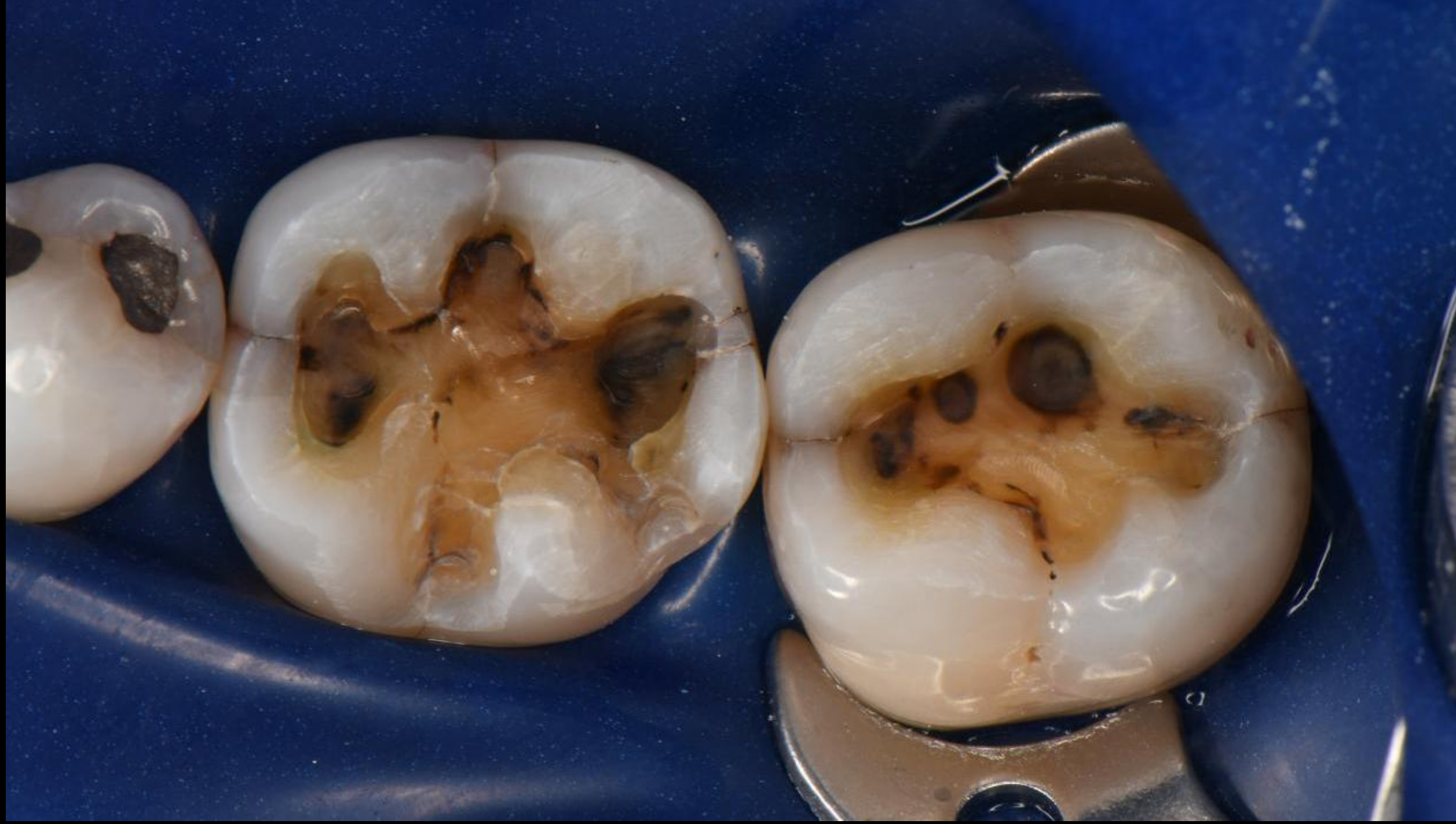


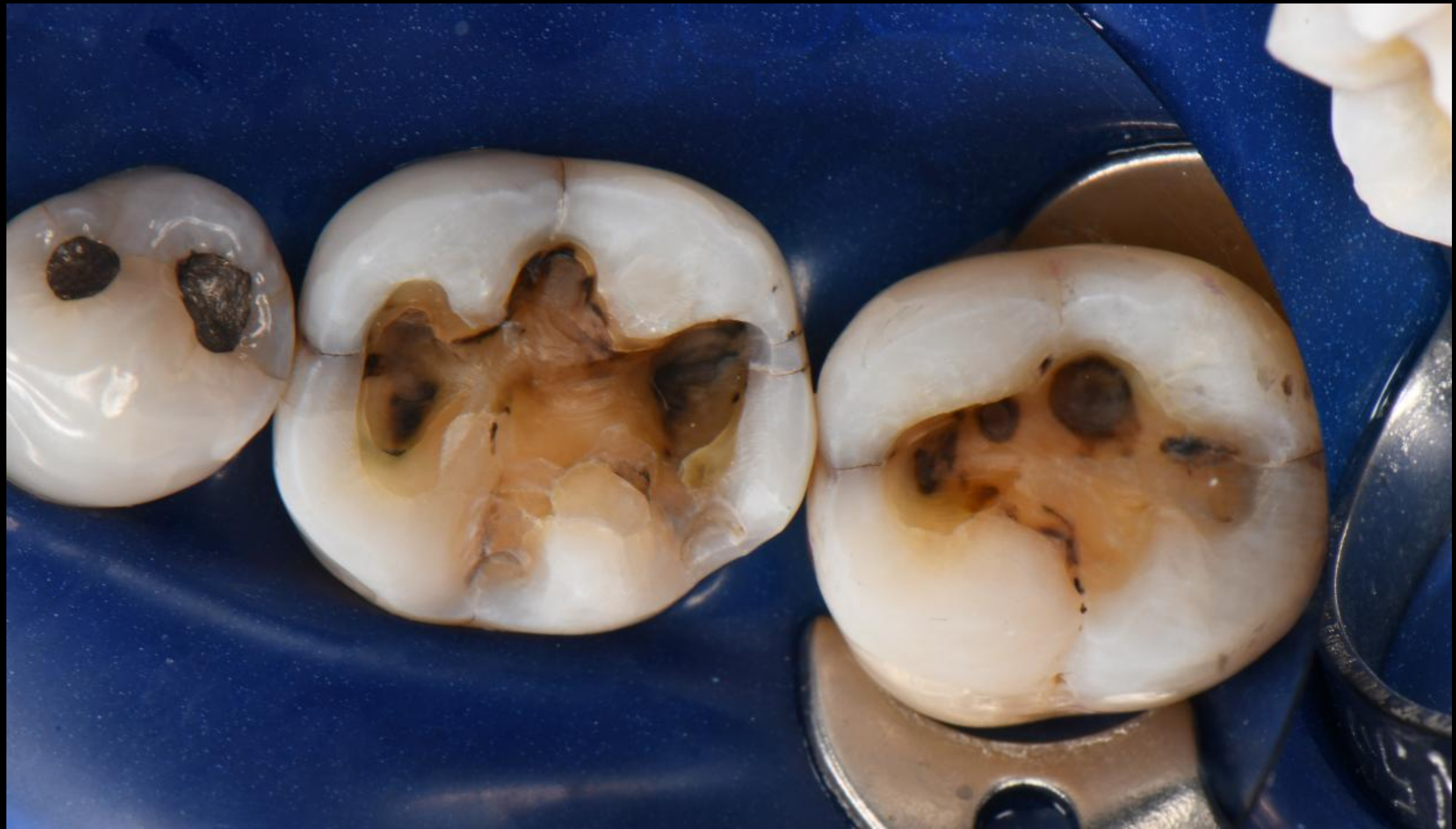


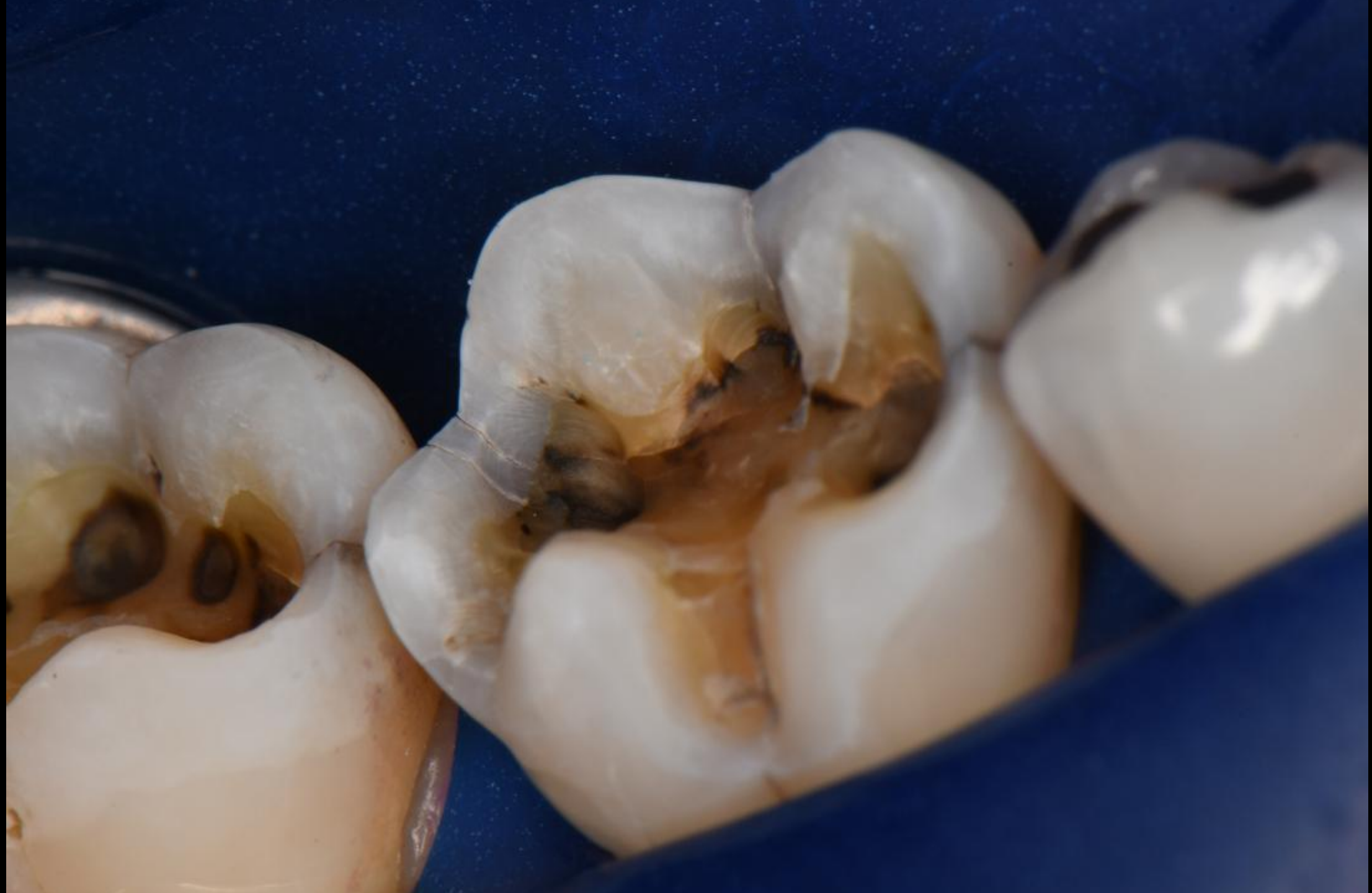


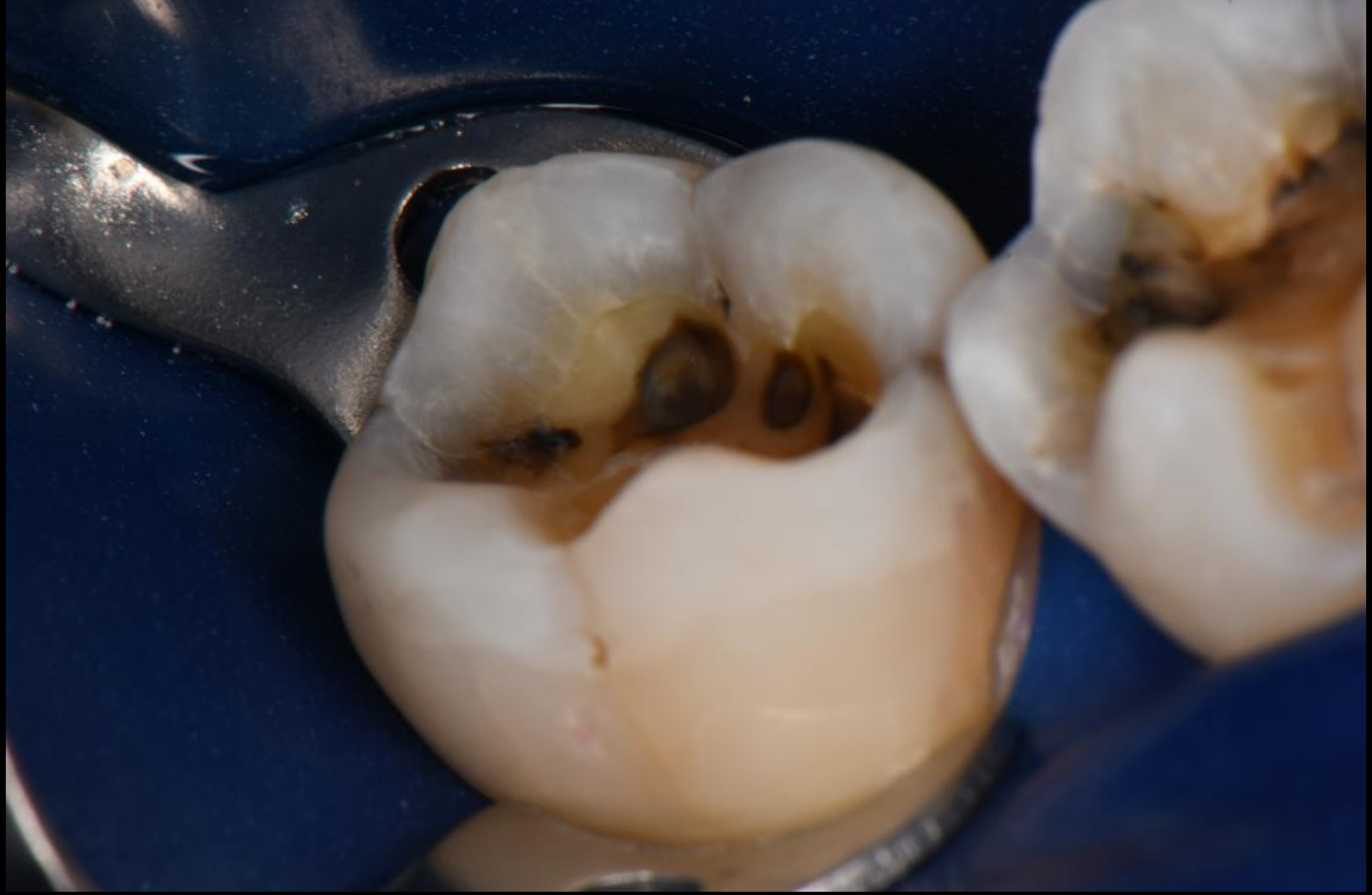


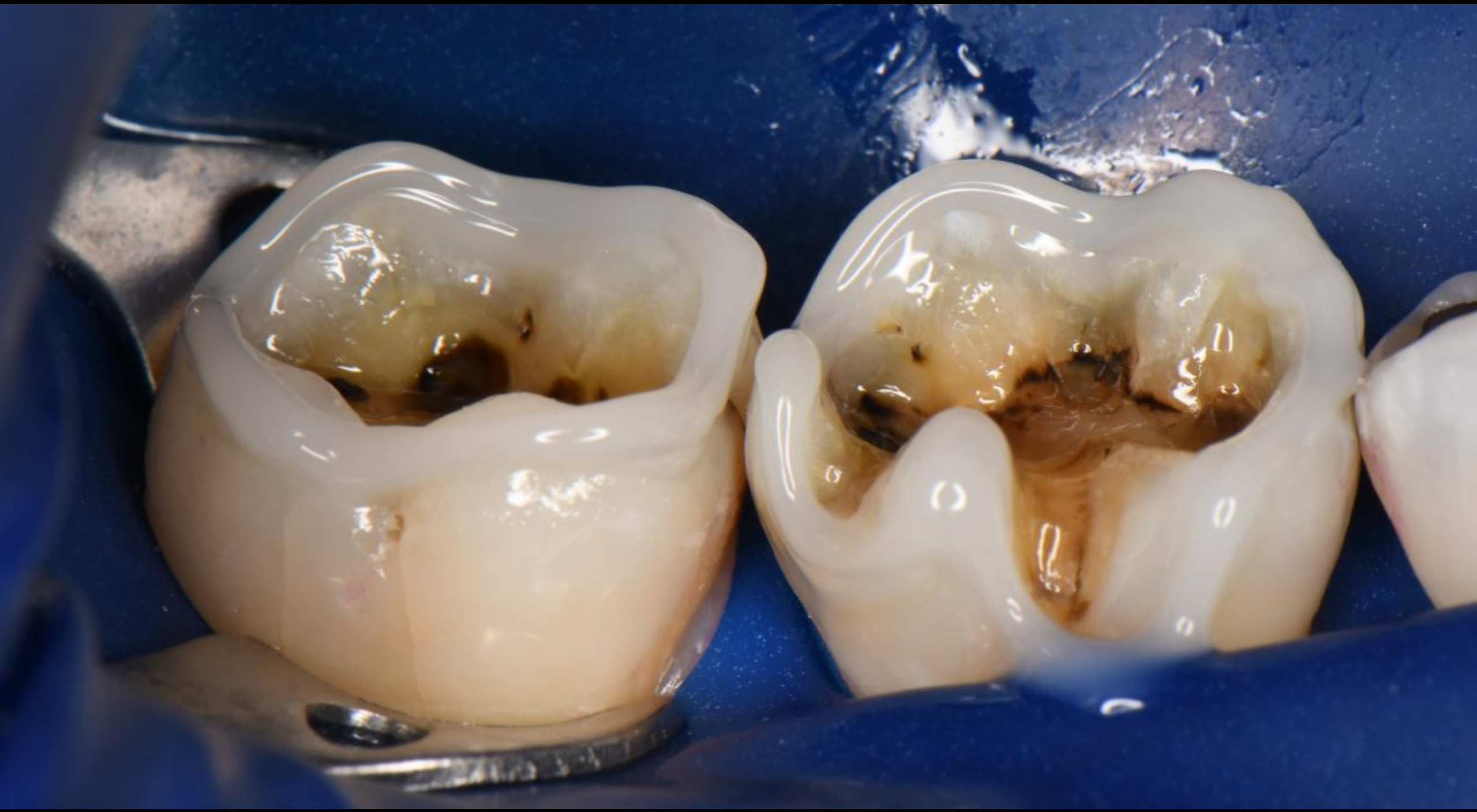


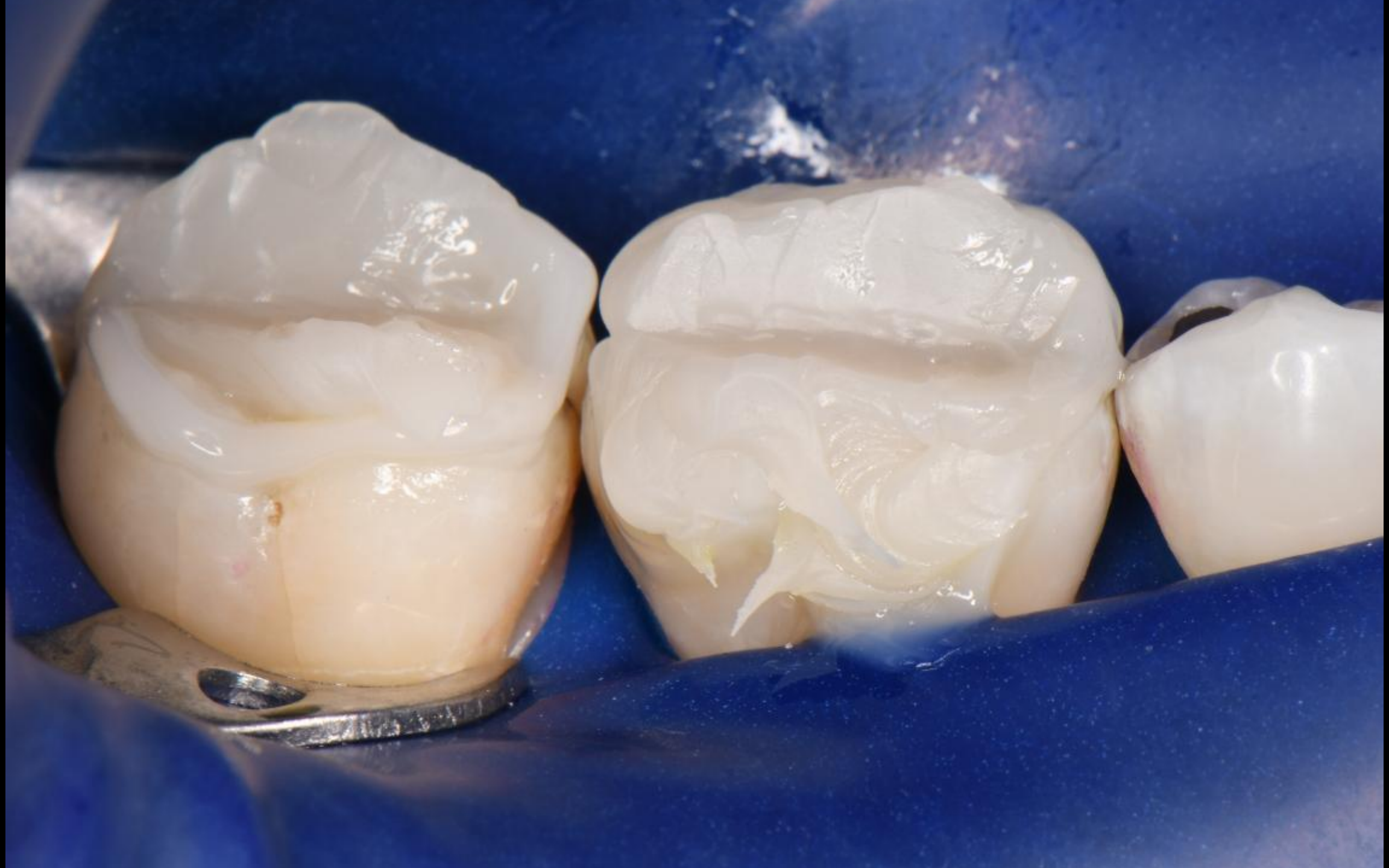


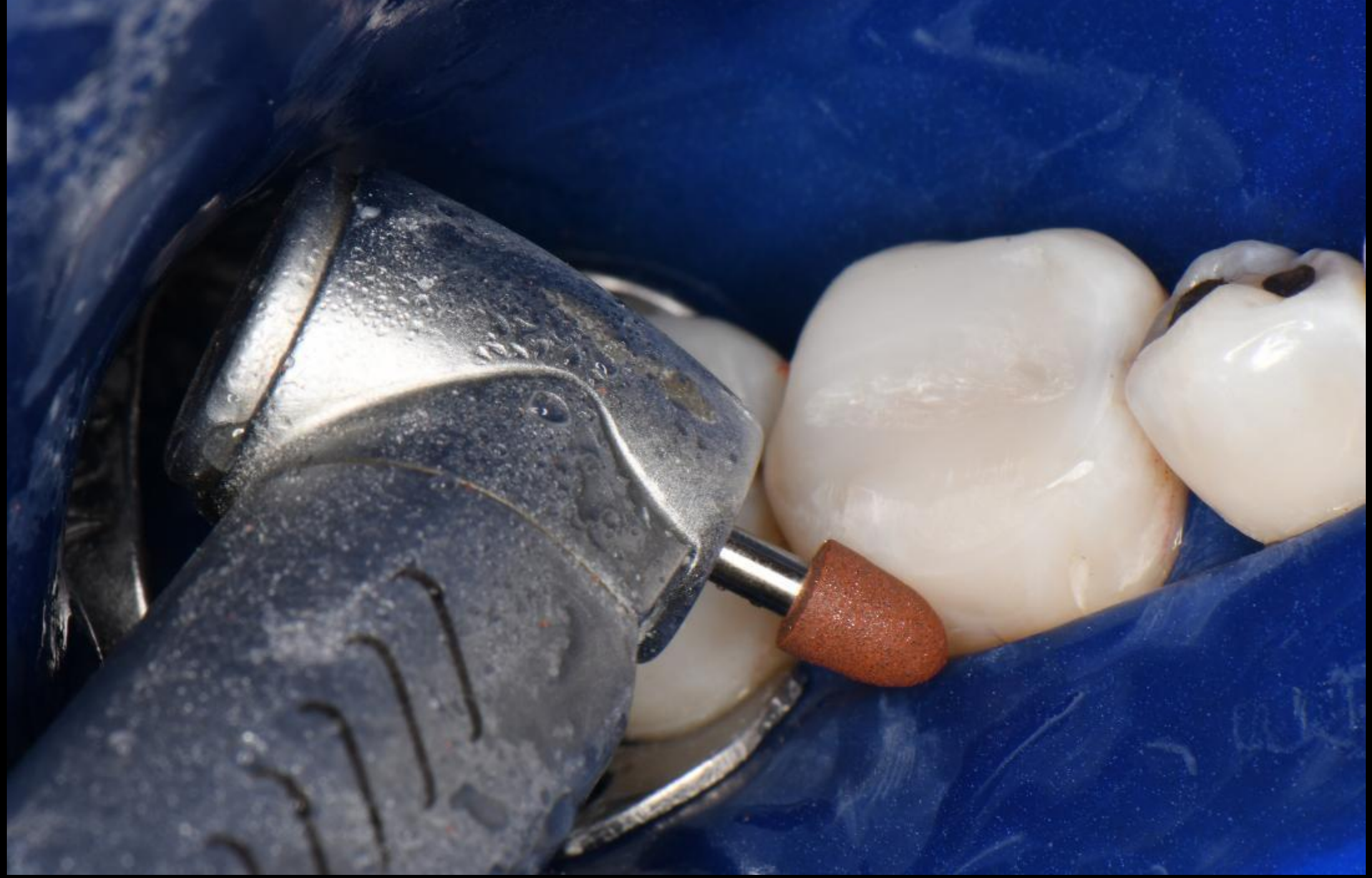


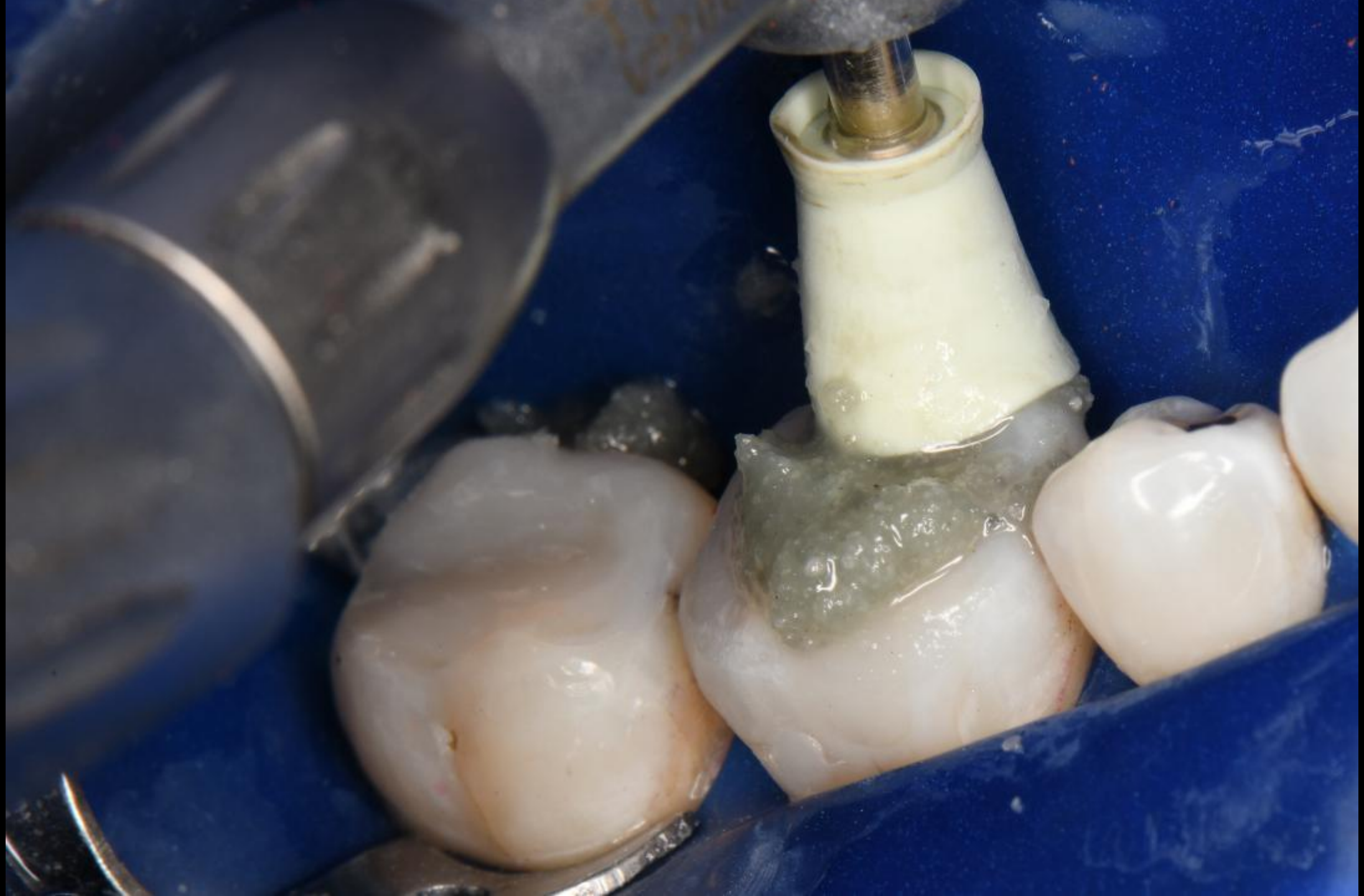


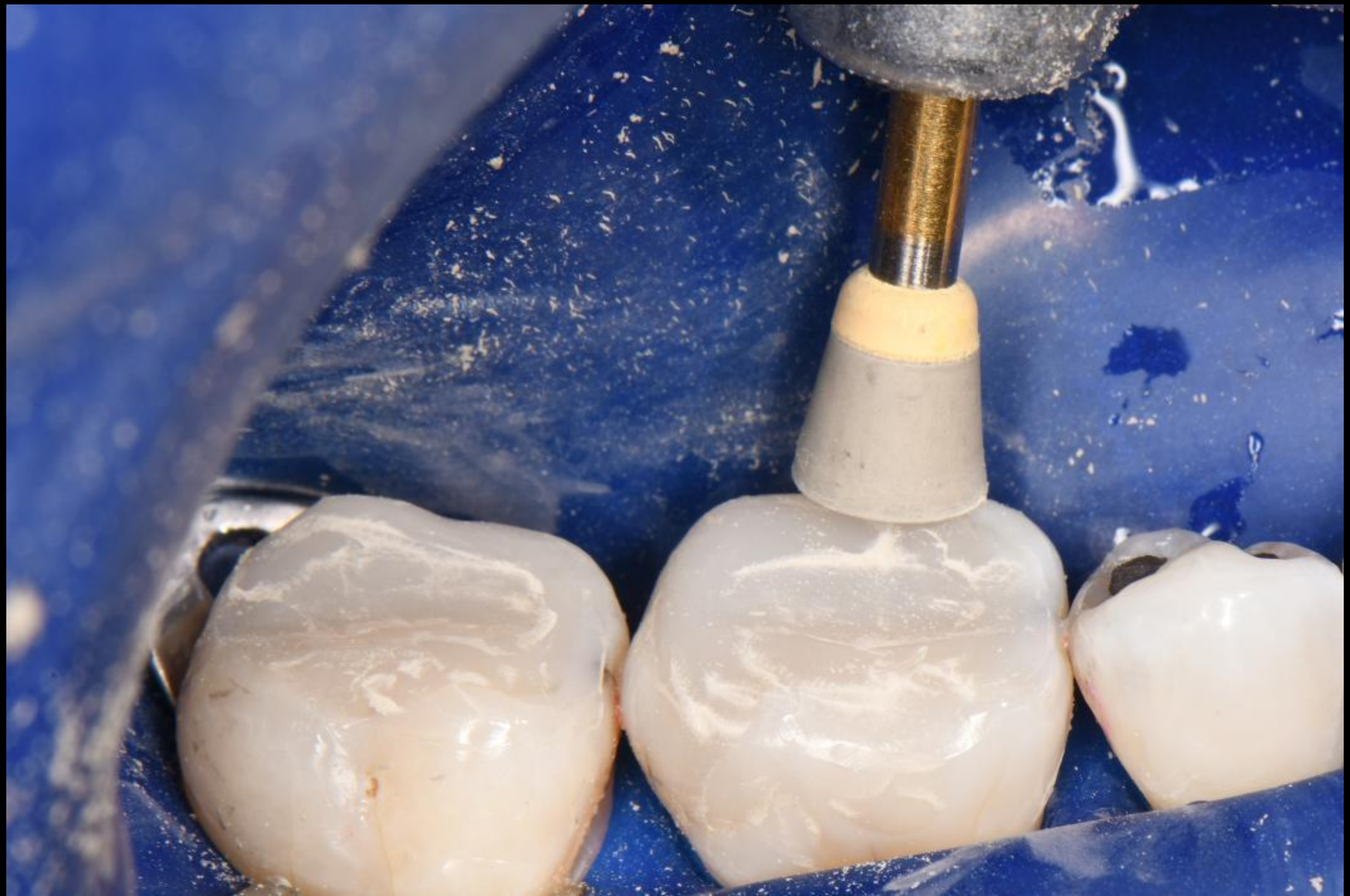




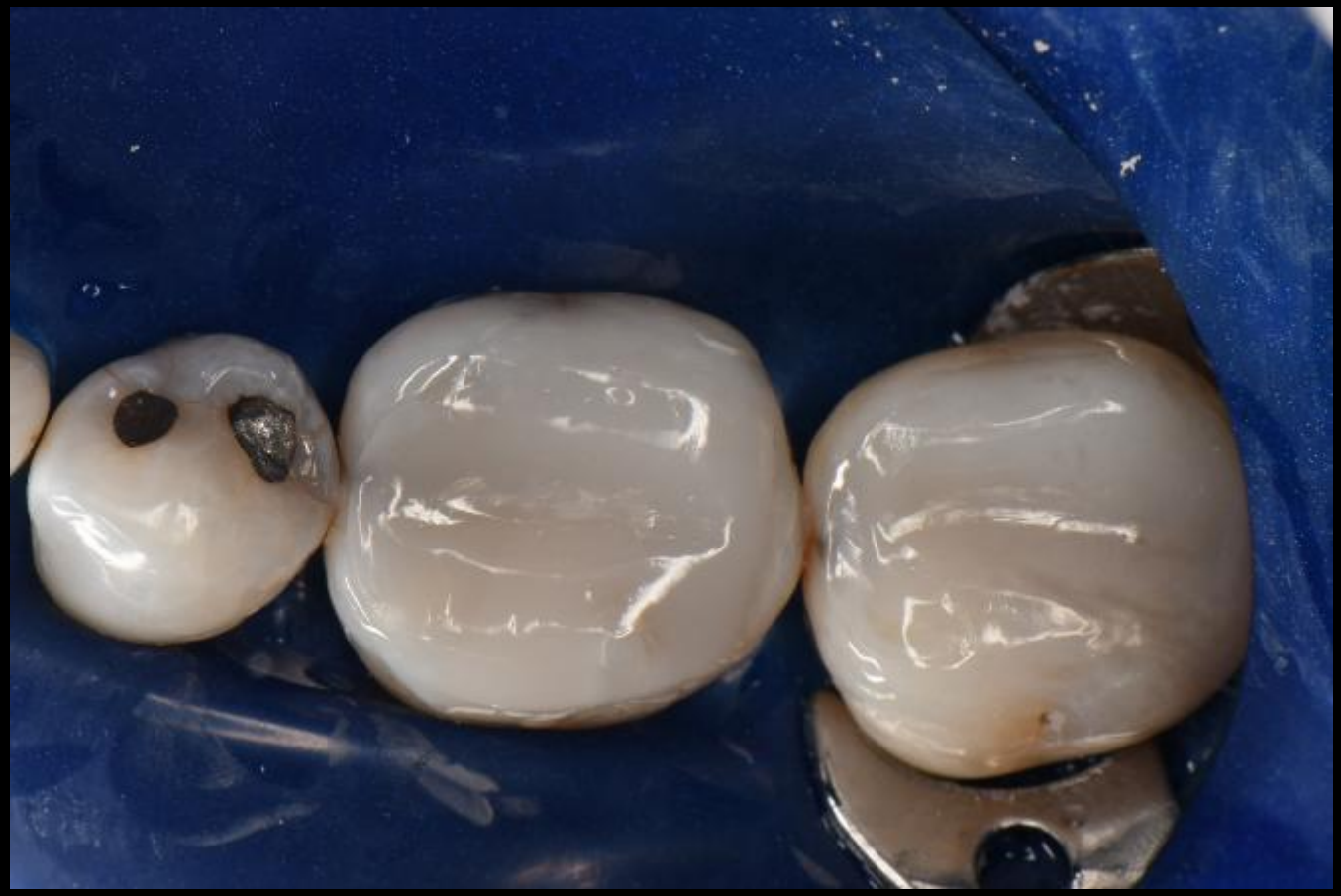


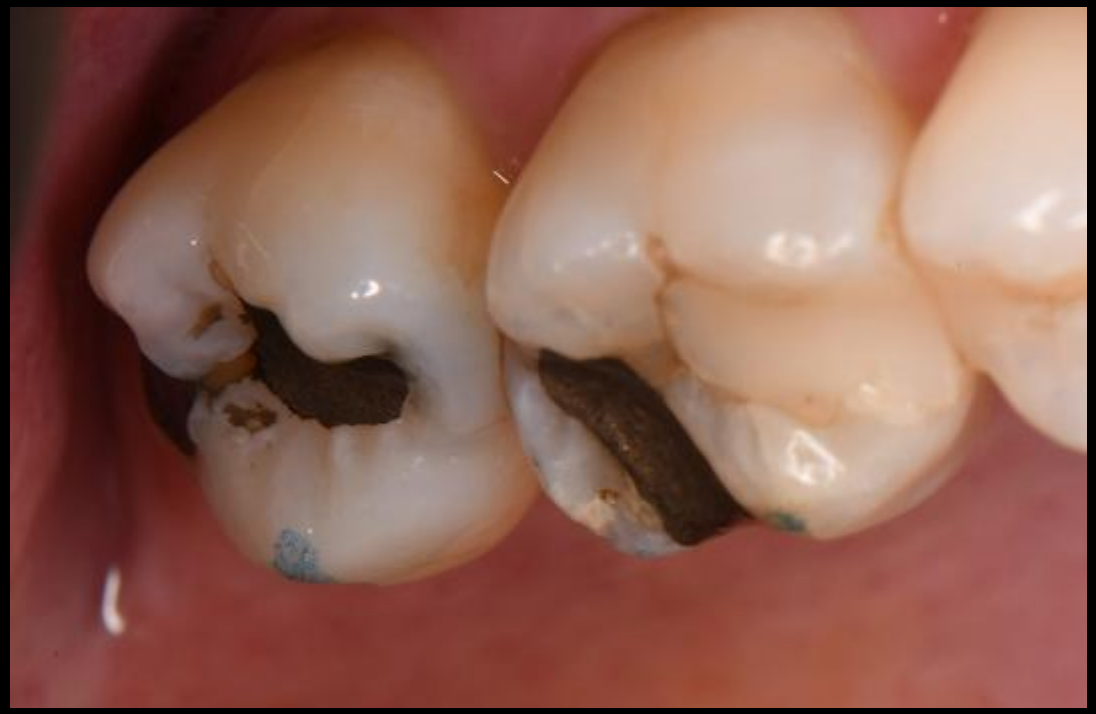


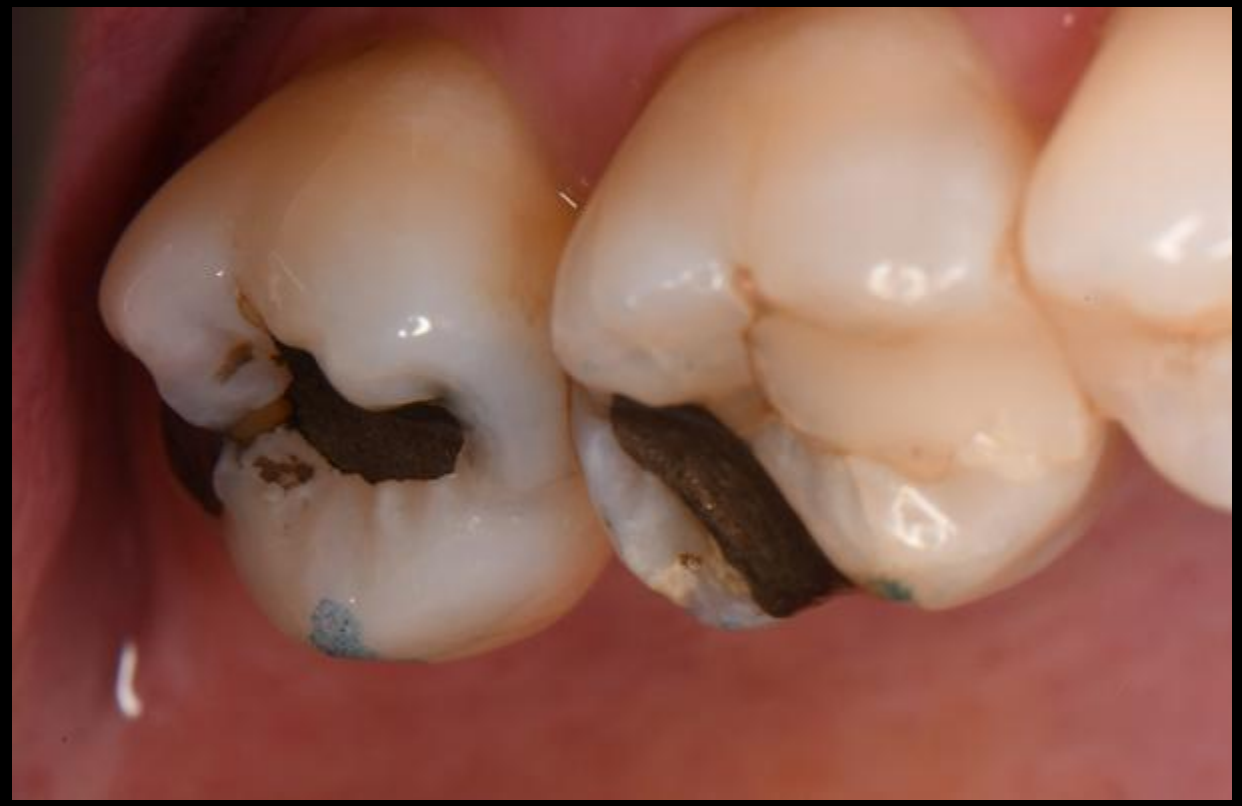




Time to *harmonize* the occlusion



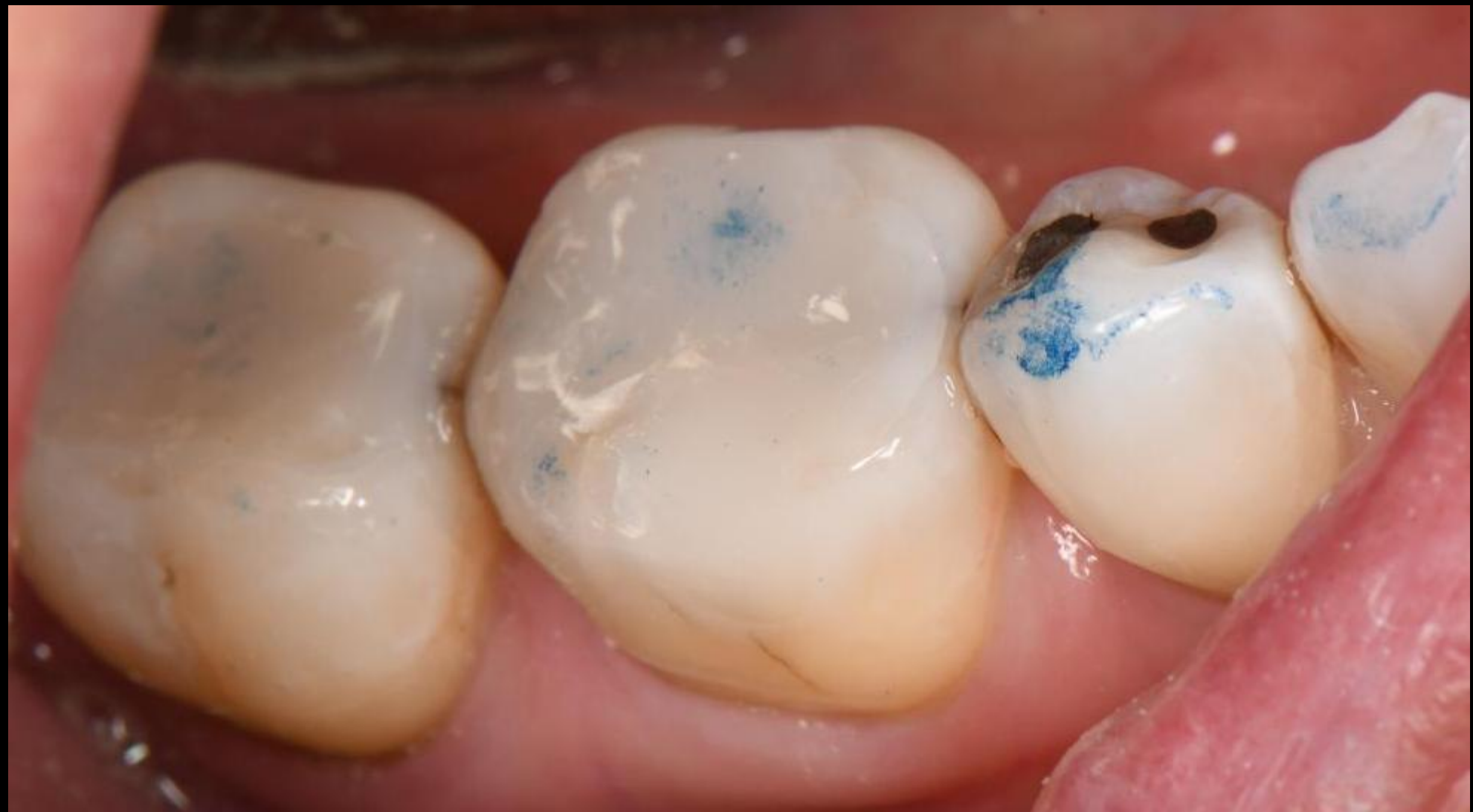




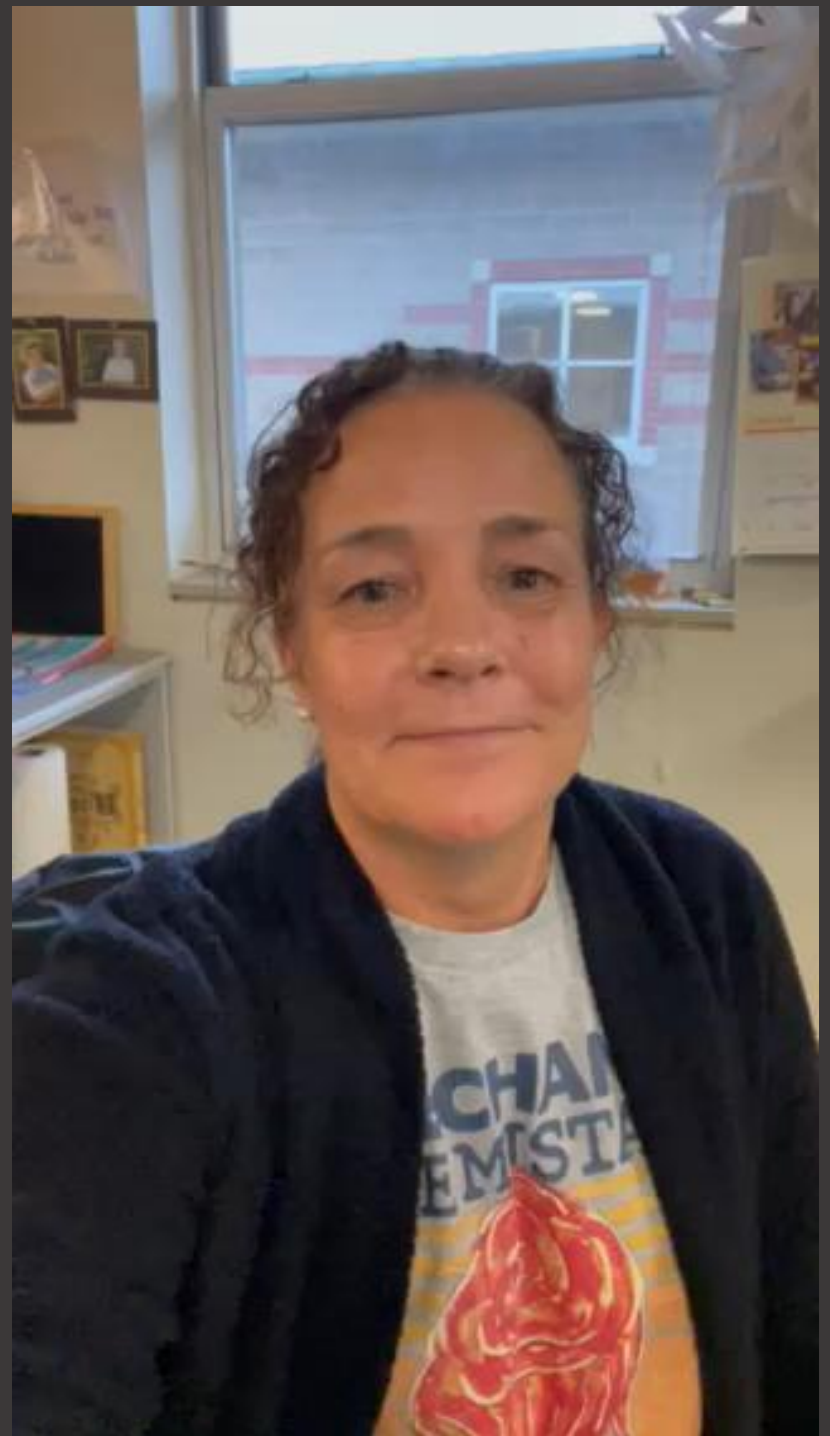
Before Harmonizing

After Harmonizing

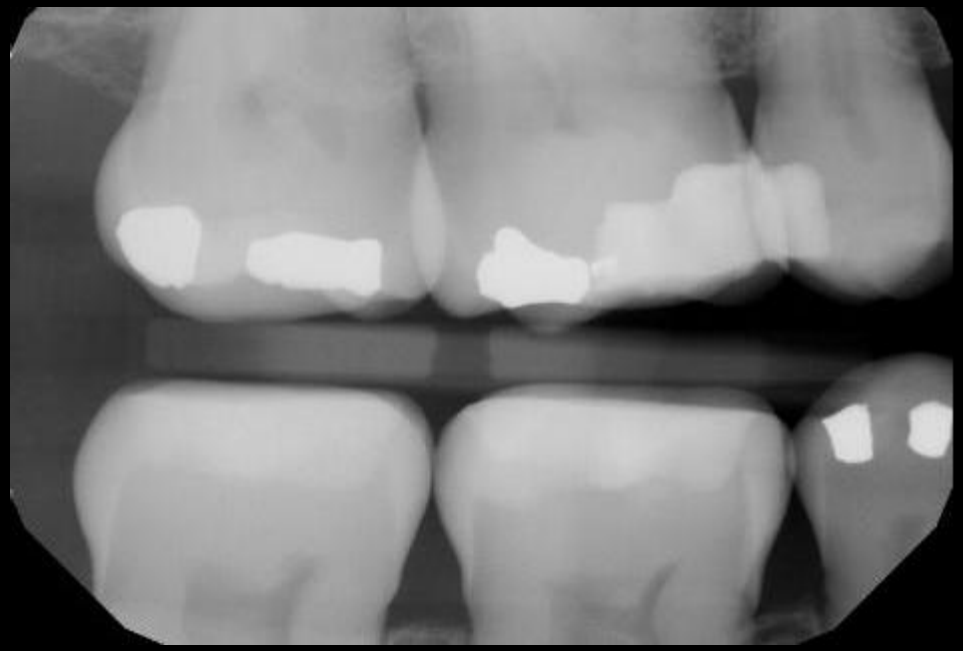
Remember that composite absorbs 1% of its volume in water in 24 hours, so you need HYPO OCCLUSION on composite

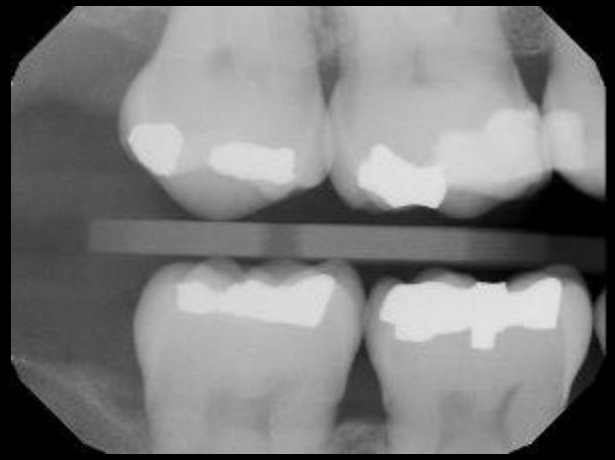


6 week follow up



2.5 year follow up





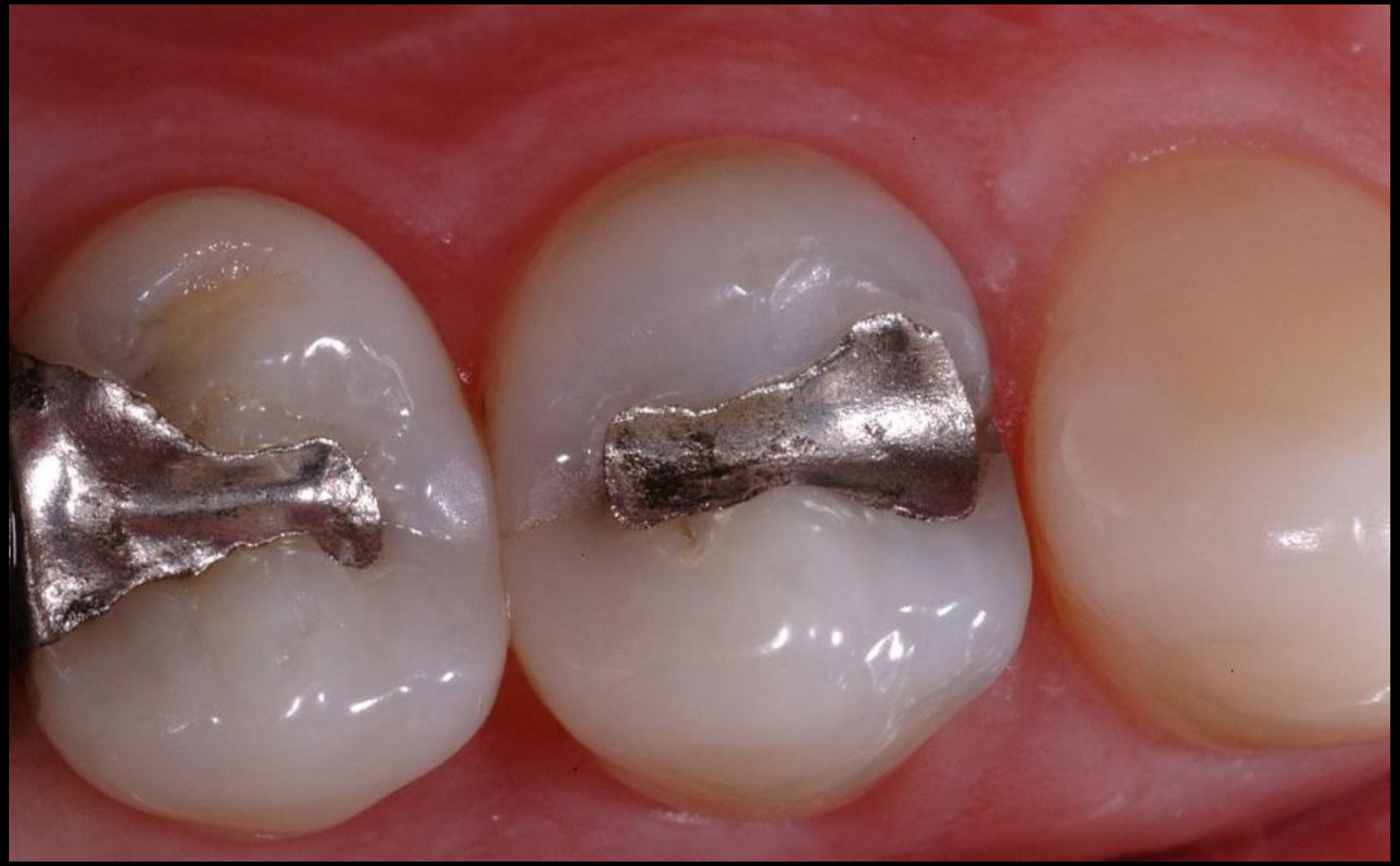
Pre-op

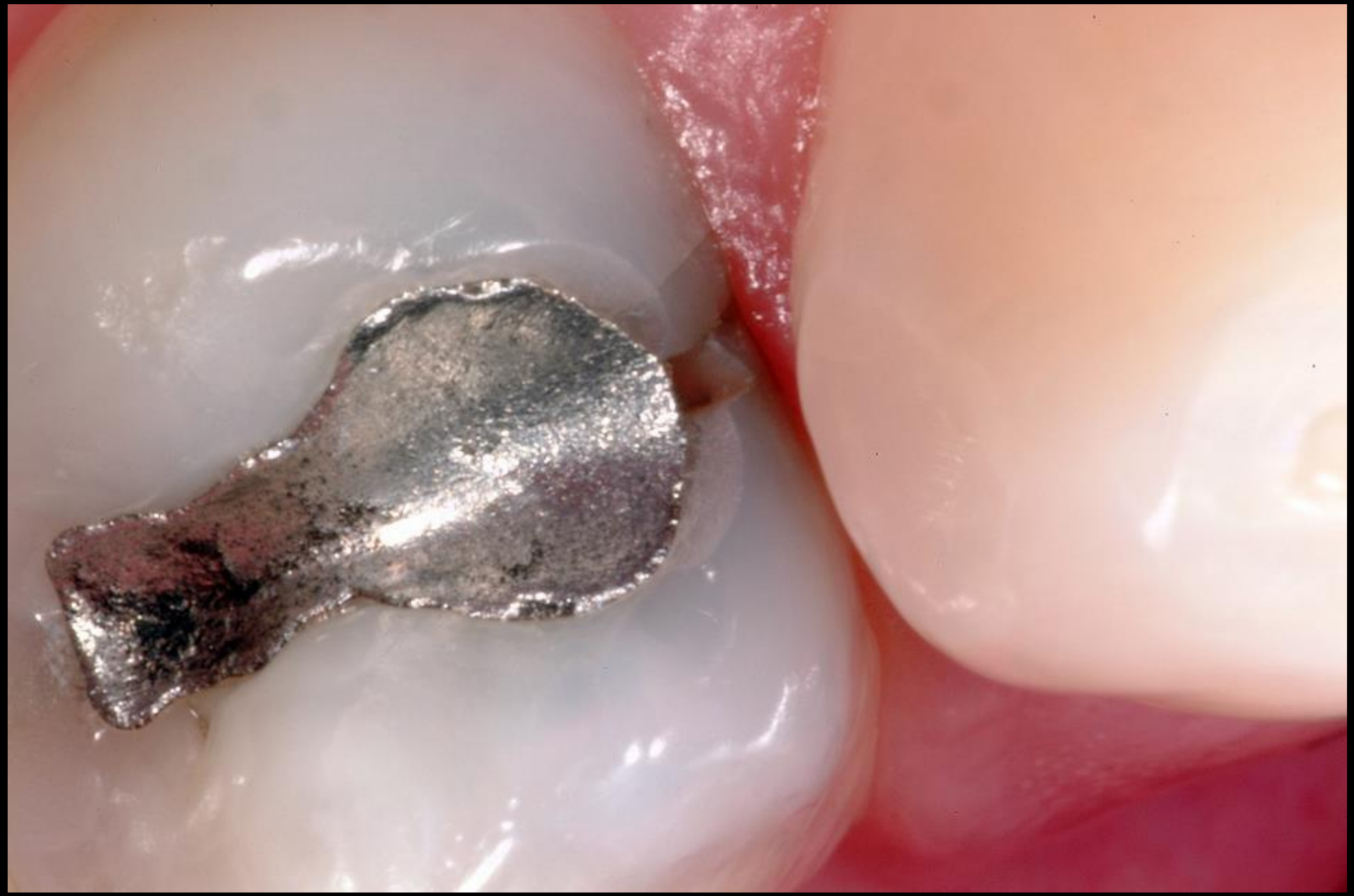
What are the modern occlusal cavity preps?

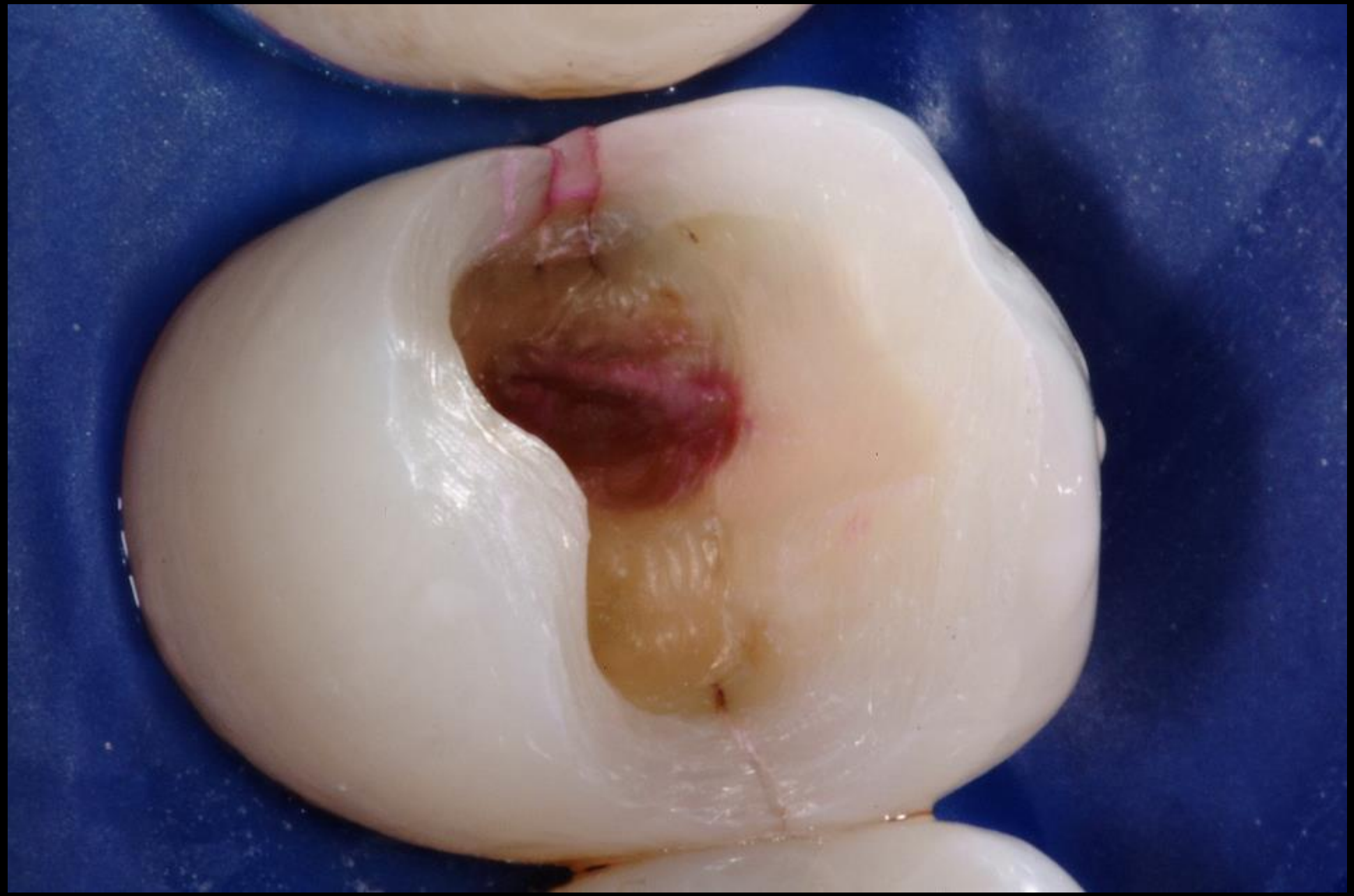
1. Fissurotomy
2. Calla Lily
3. Flattened Calla Lily
4. Cuspal Overlay

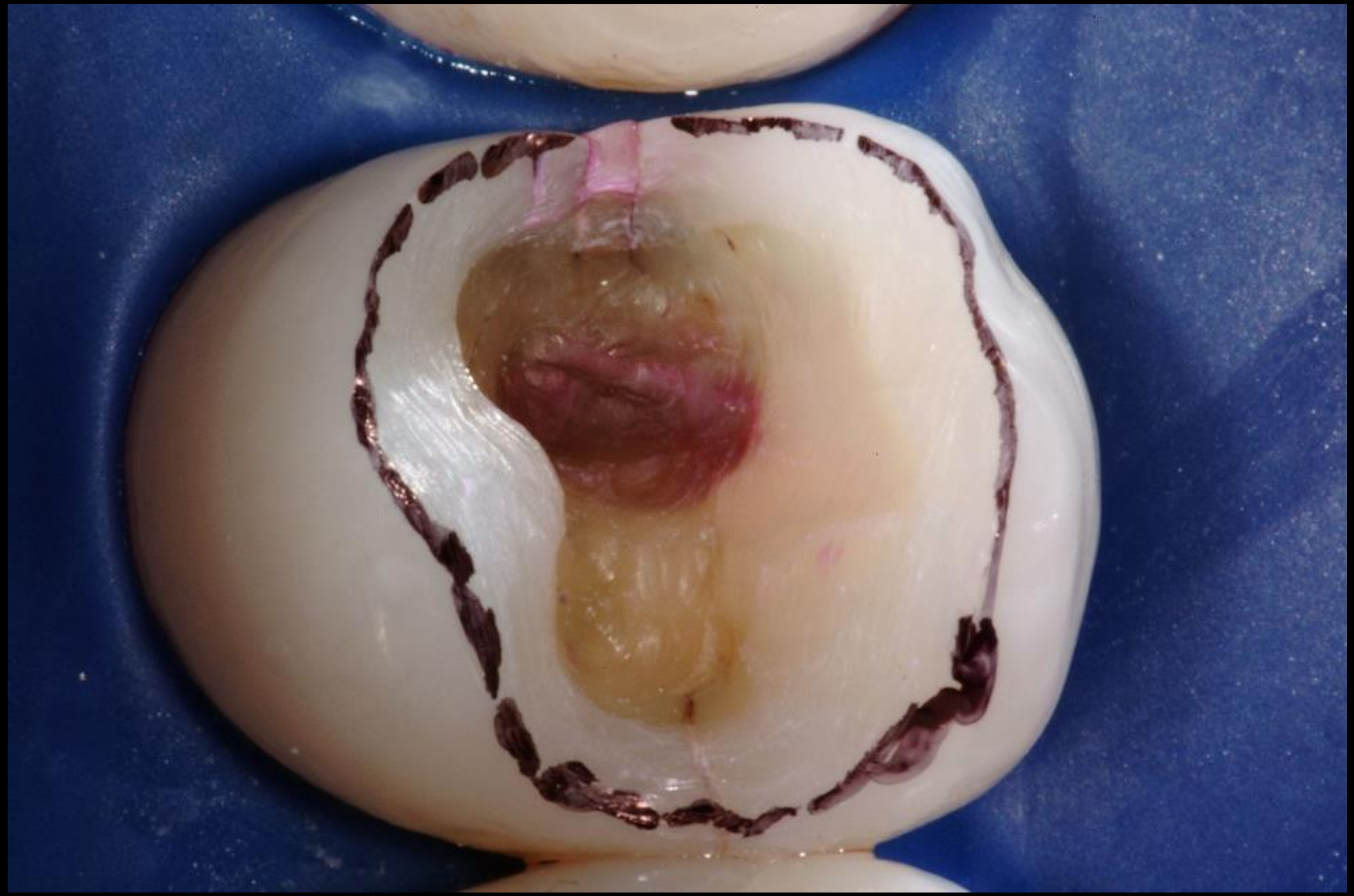
What are the modern Interproximal cavity preps?

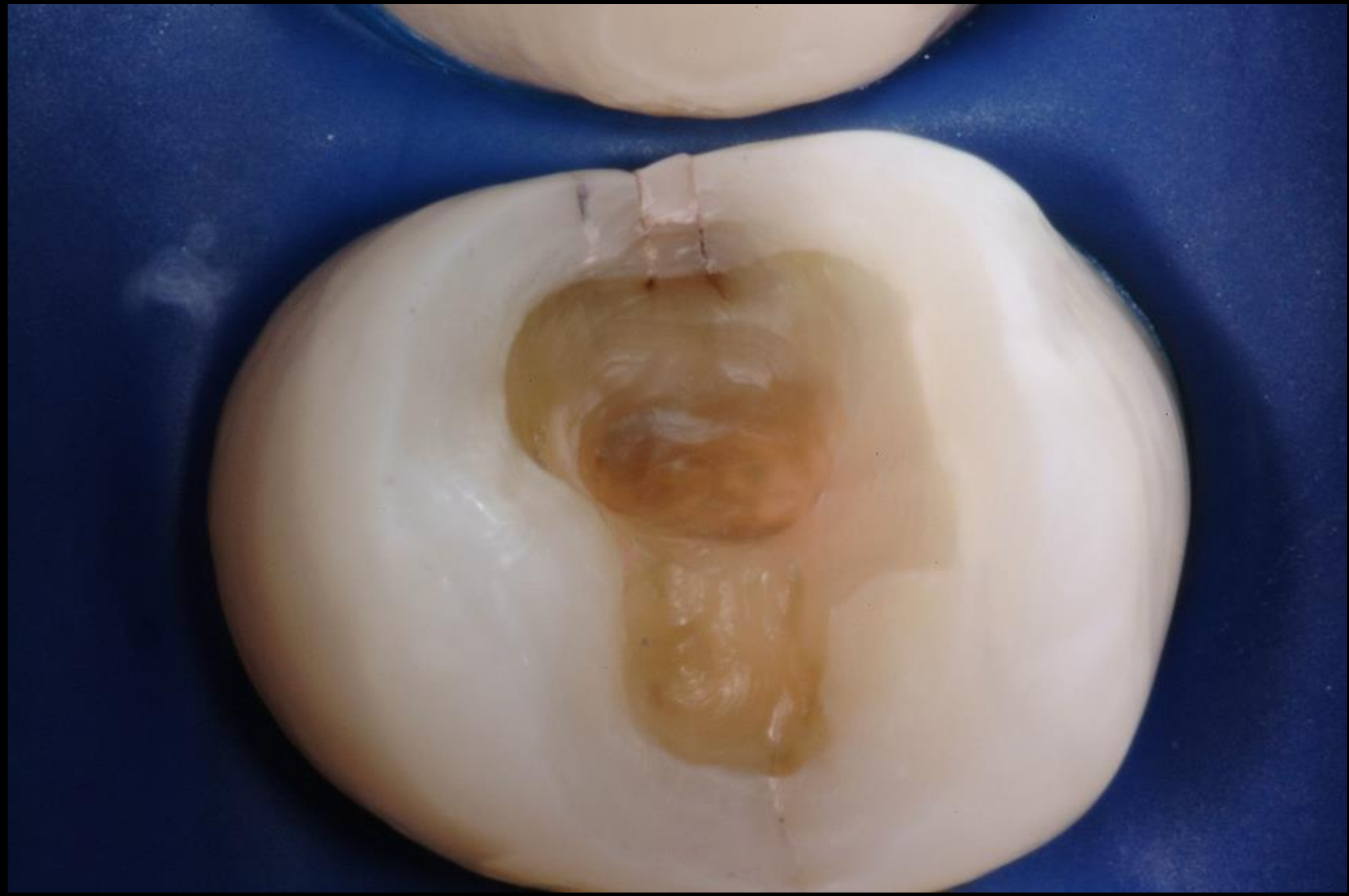
1. Opportunistic Class II
2. Clark Class II…double serpentine, additive and compression based
3. Clark Class II plus Lateral Partial Cuspal Overlay

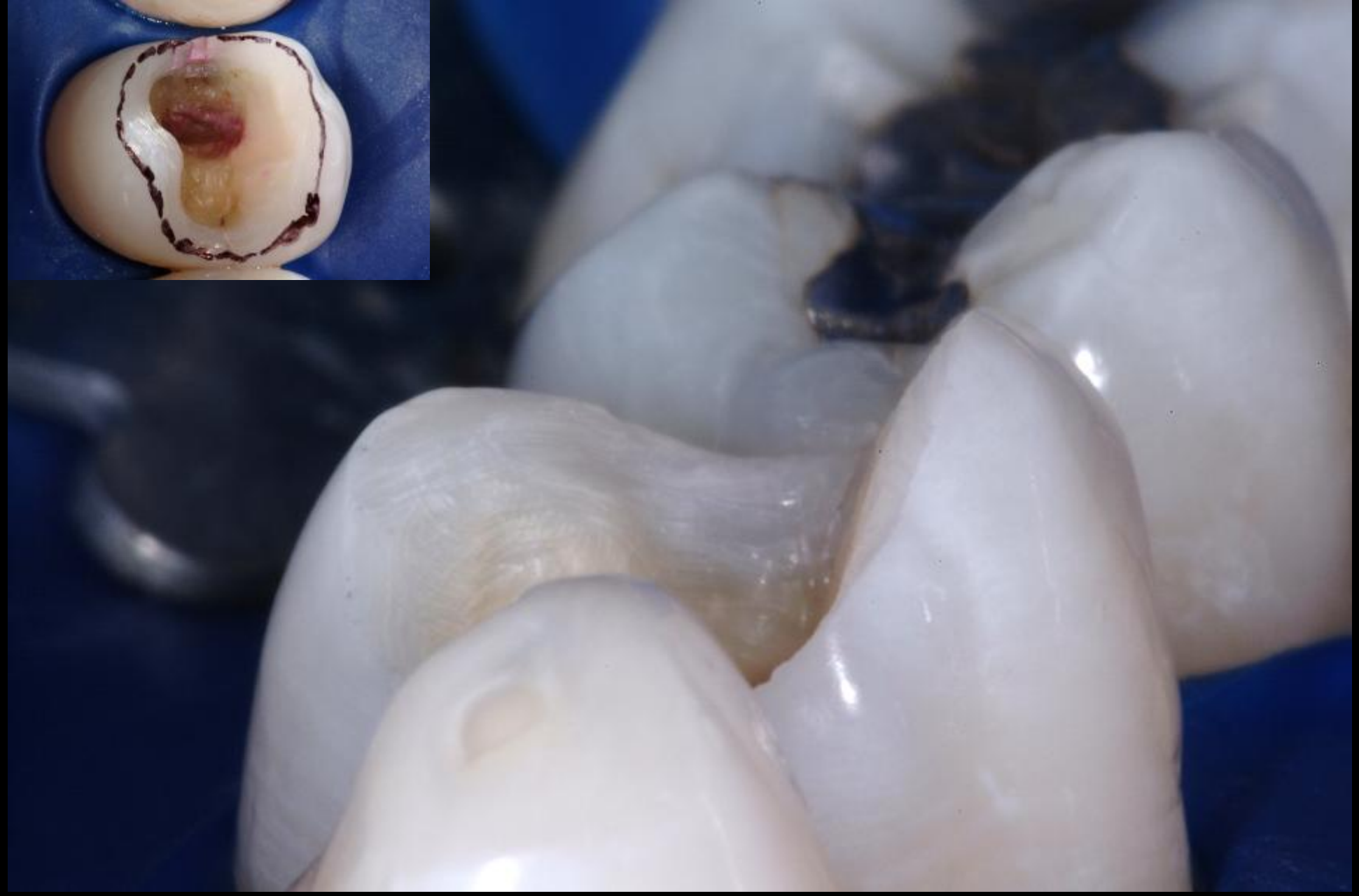




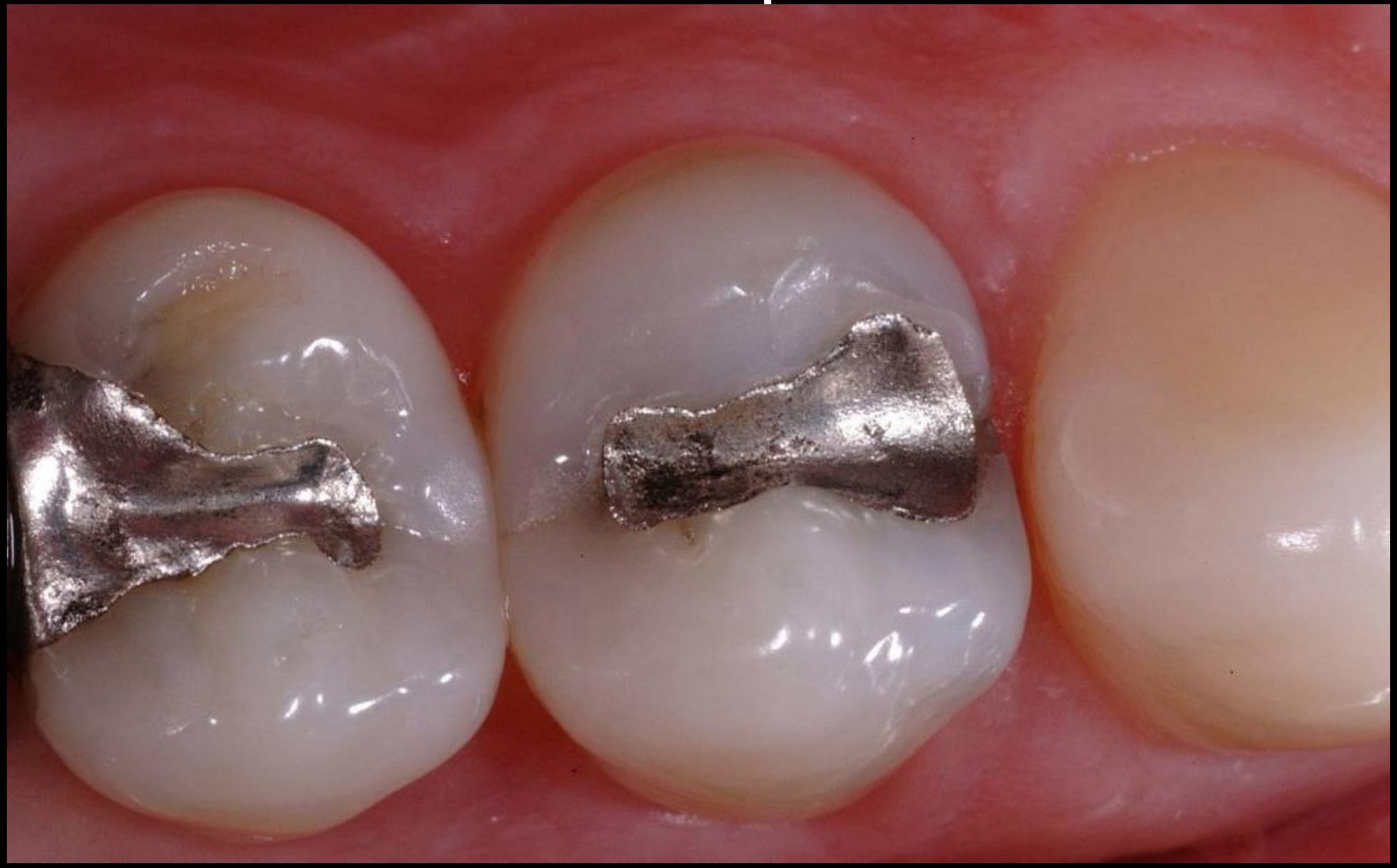




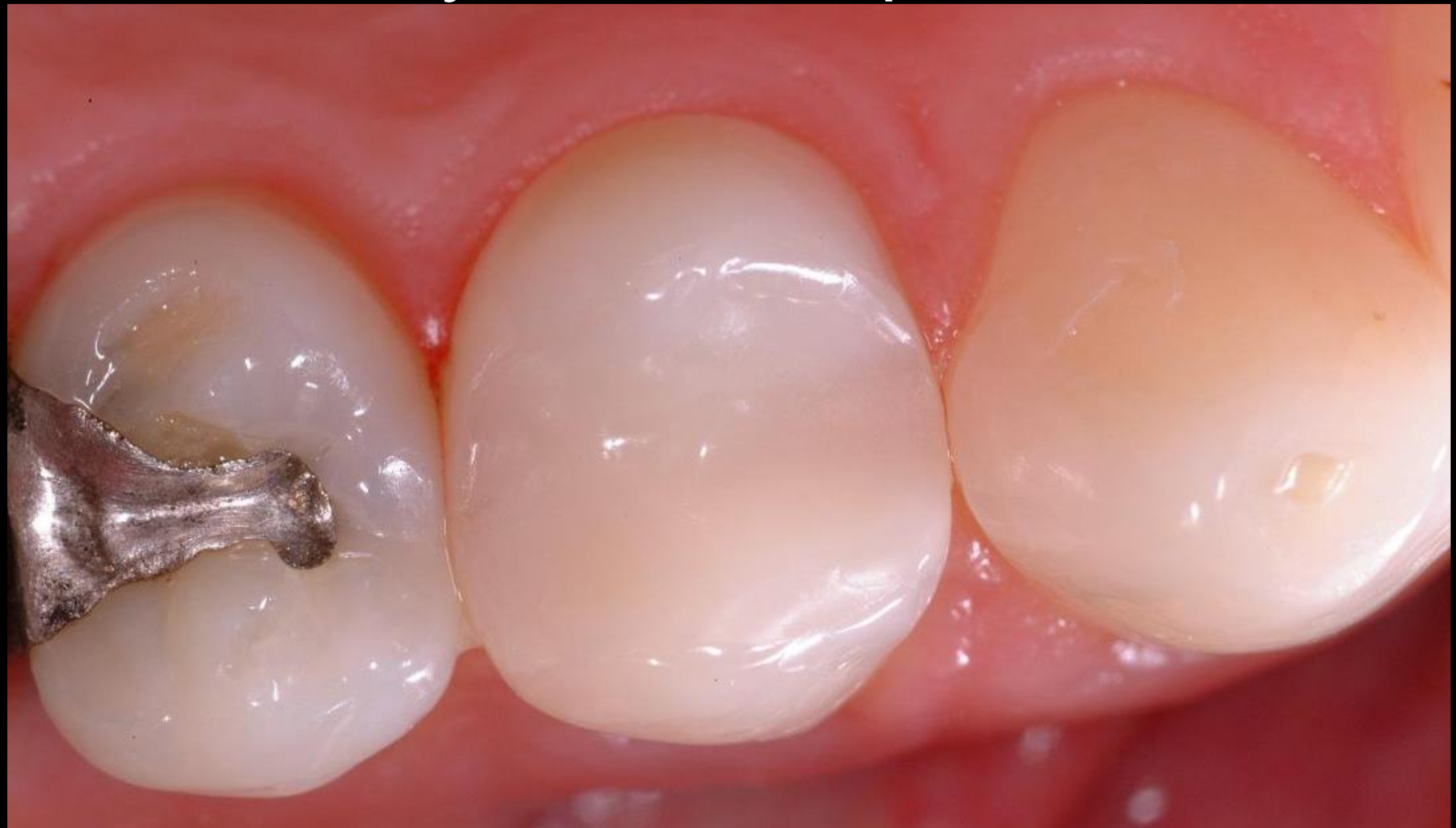




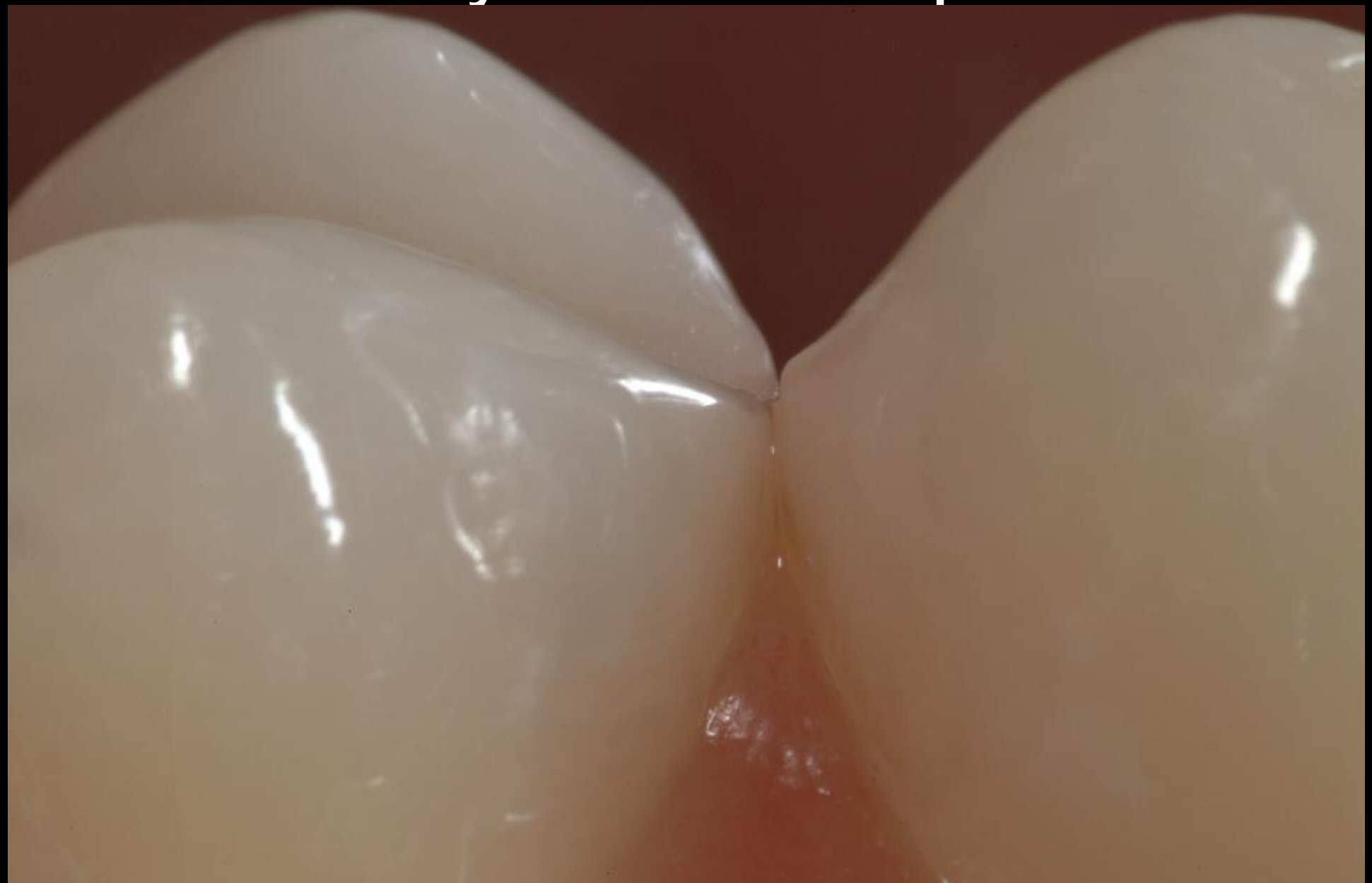
Pre-op



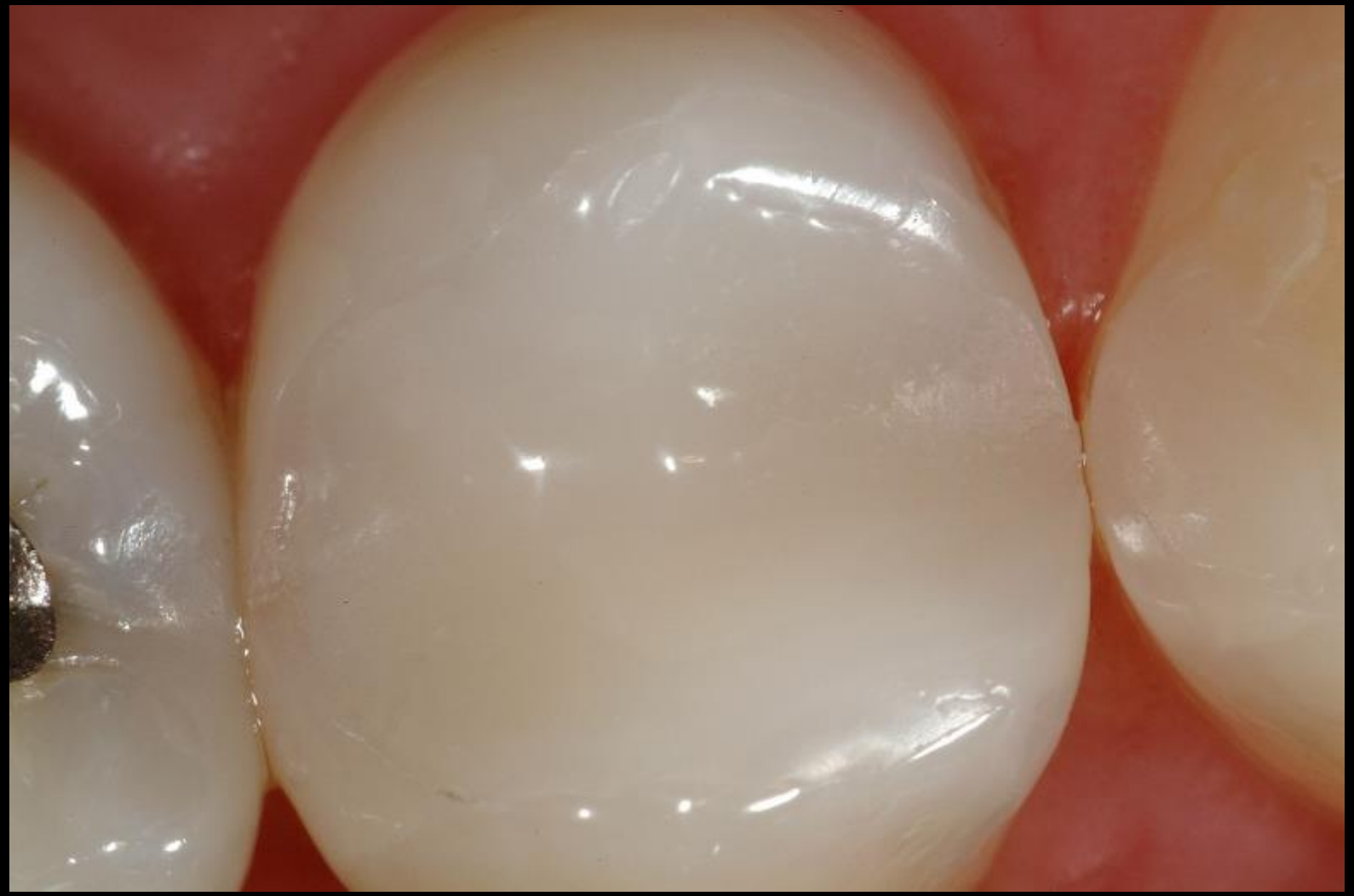
1 year follow up



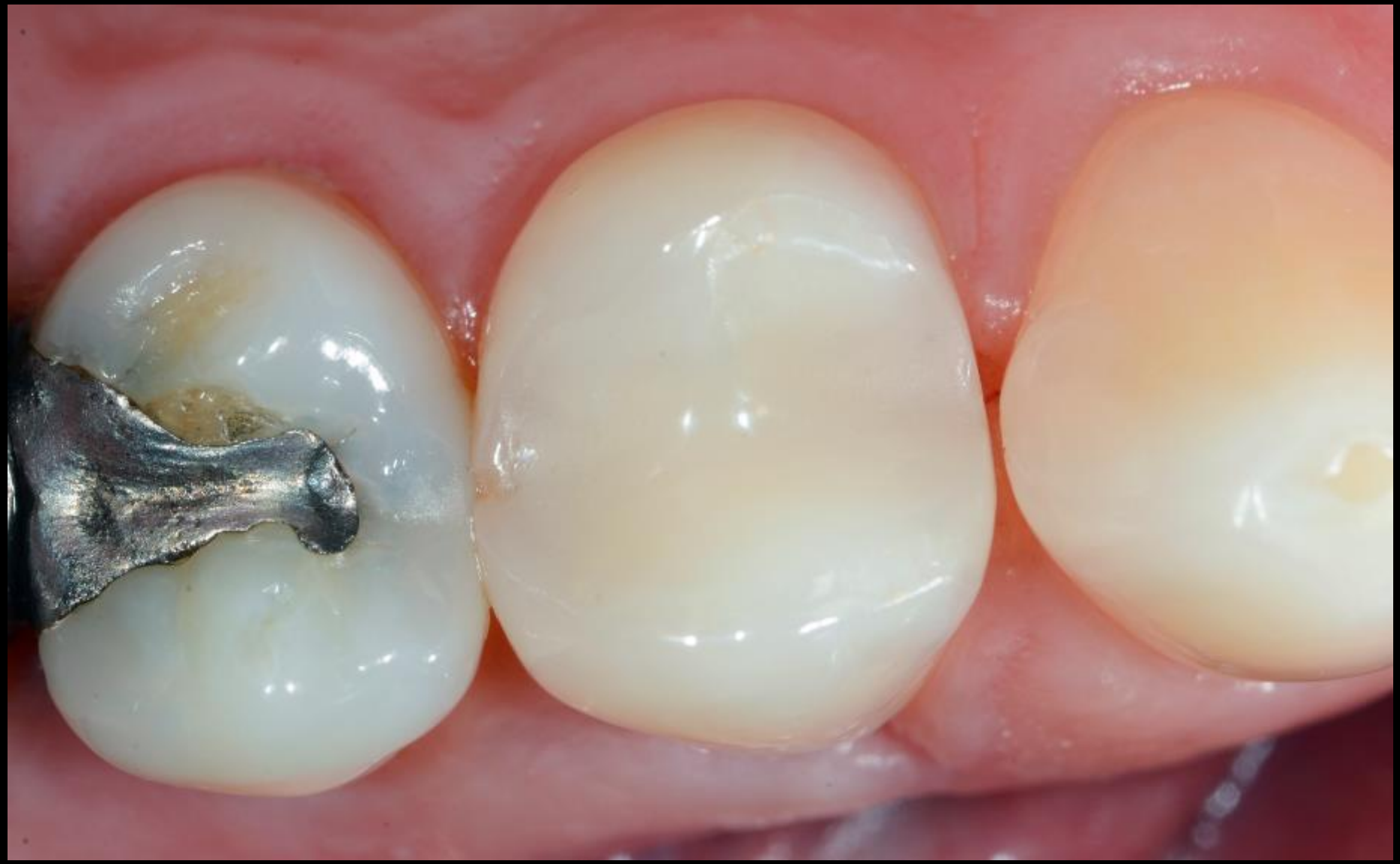
1 year follow up



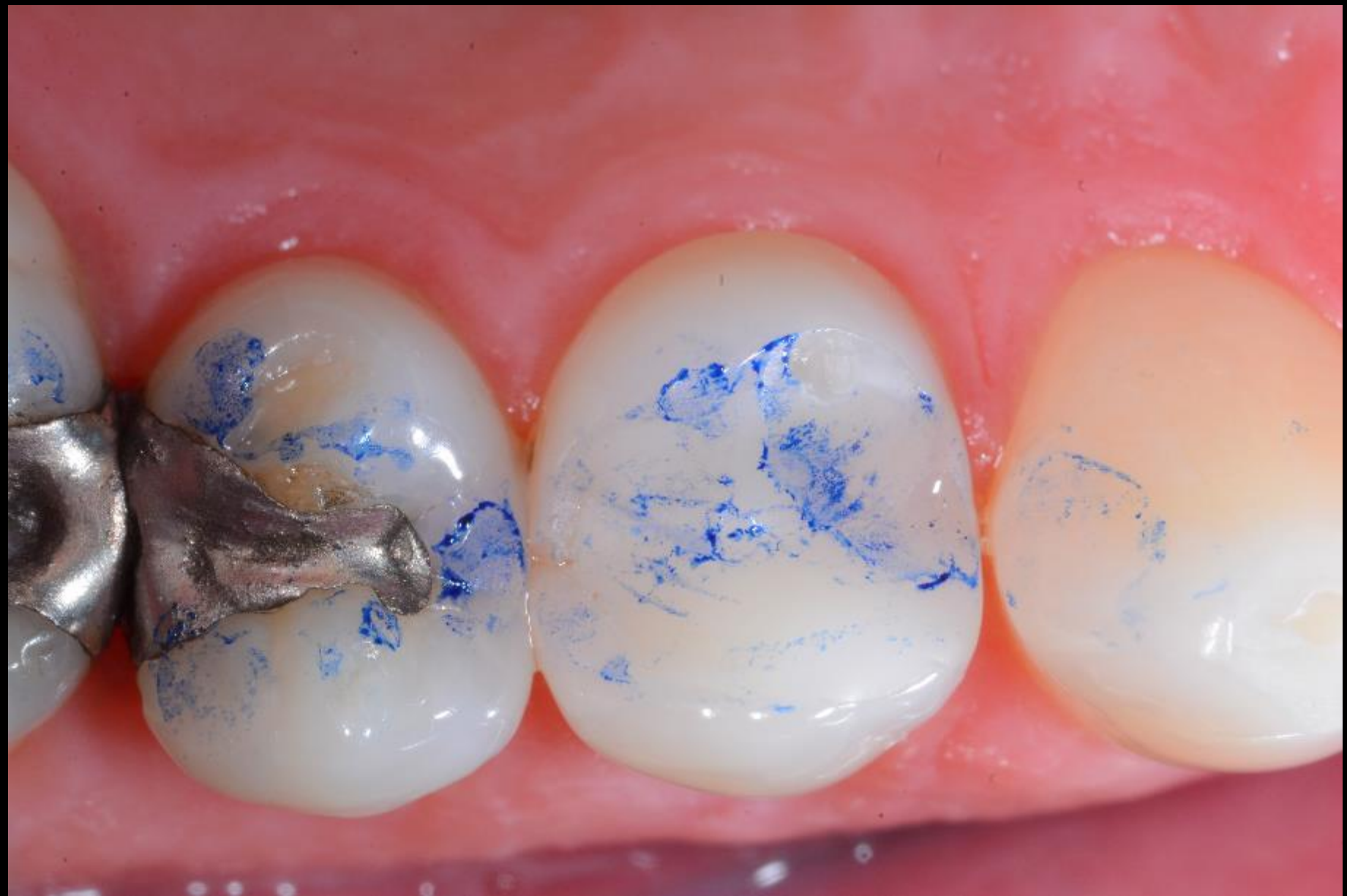
2 year follow up



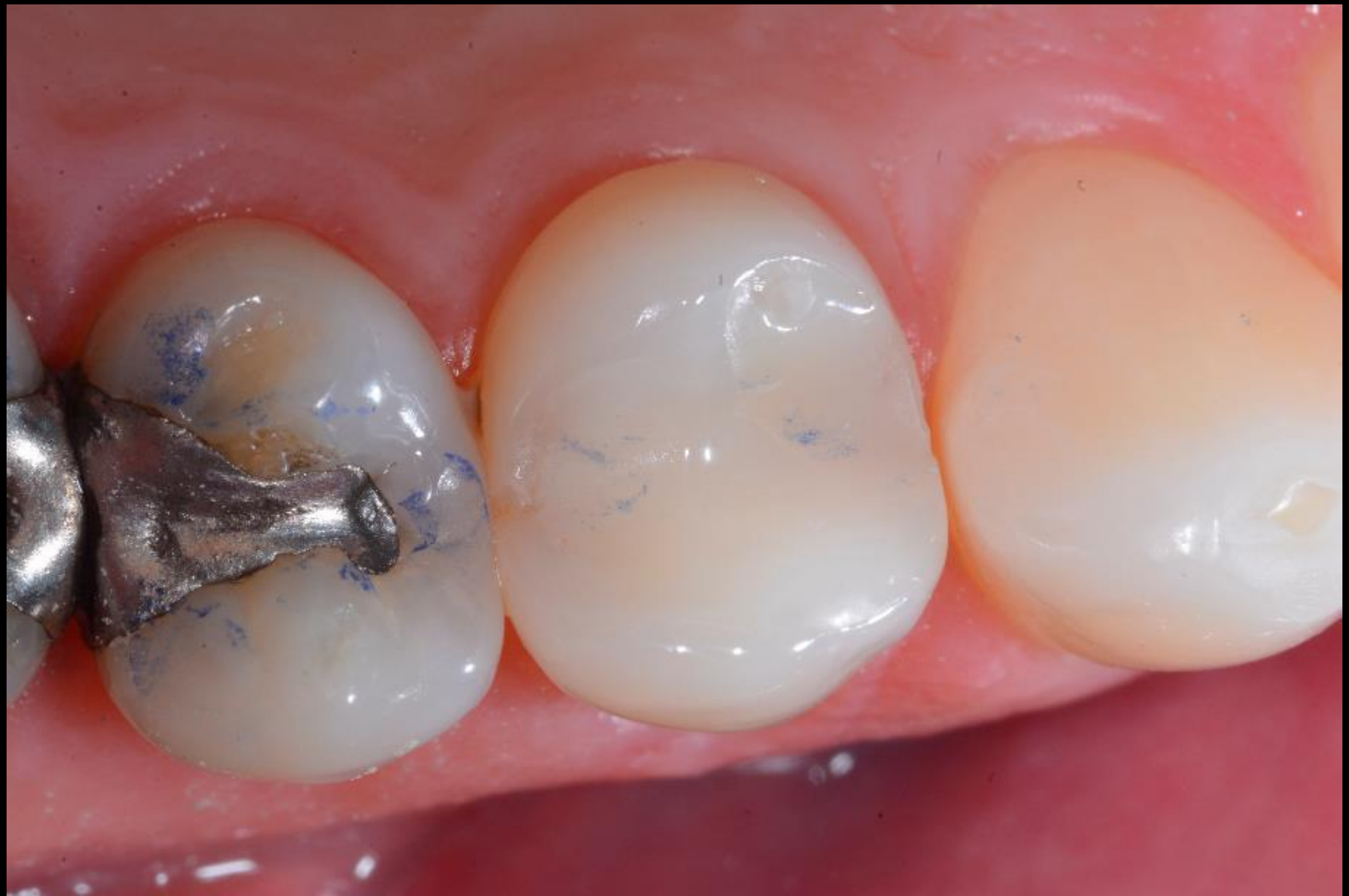
7 year follow up



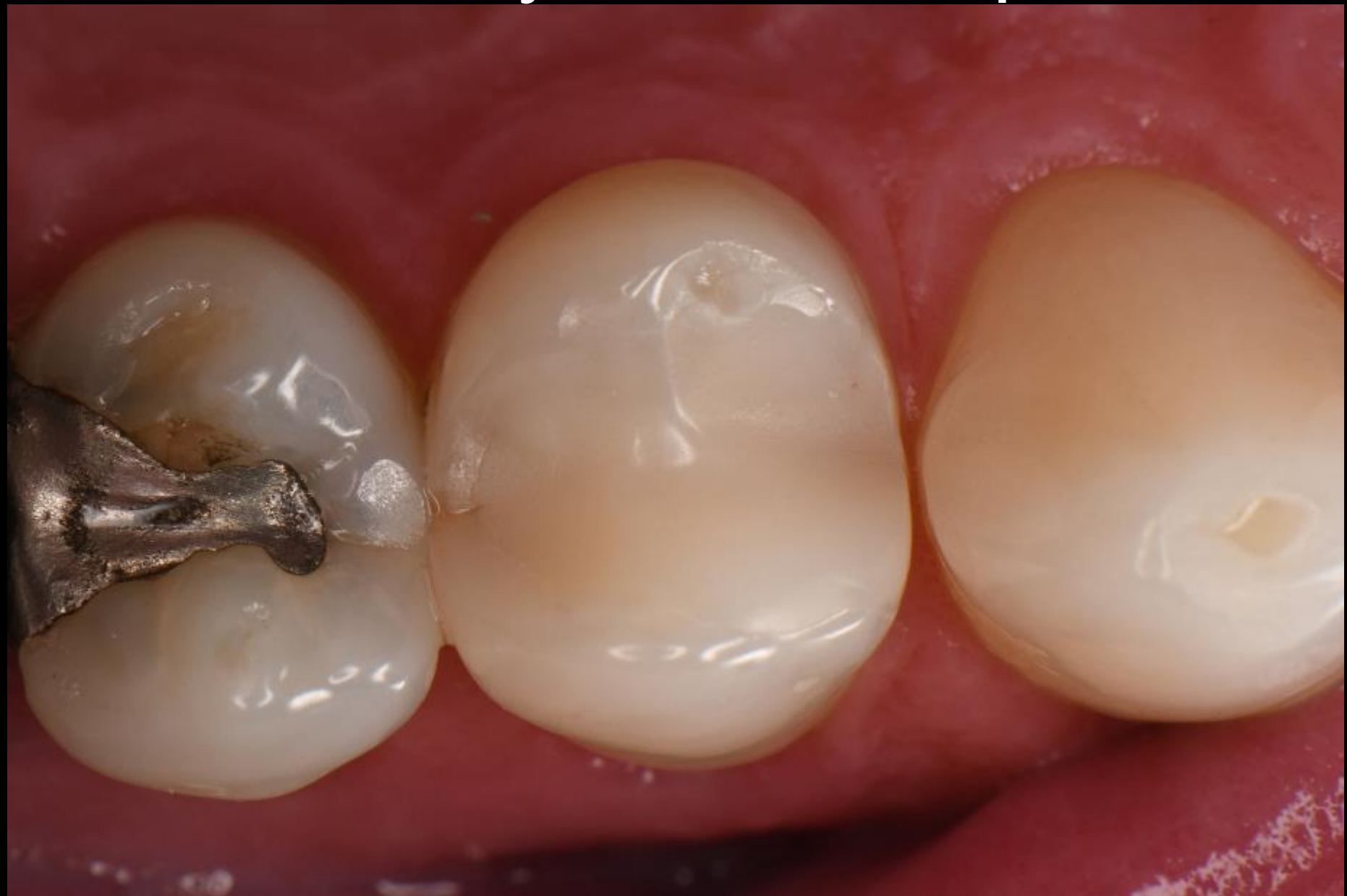
9 year follow up



9 year follow up

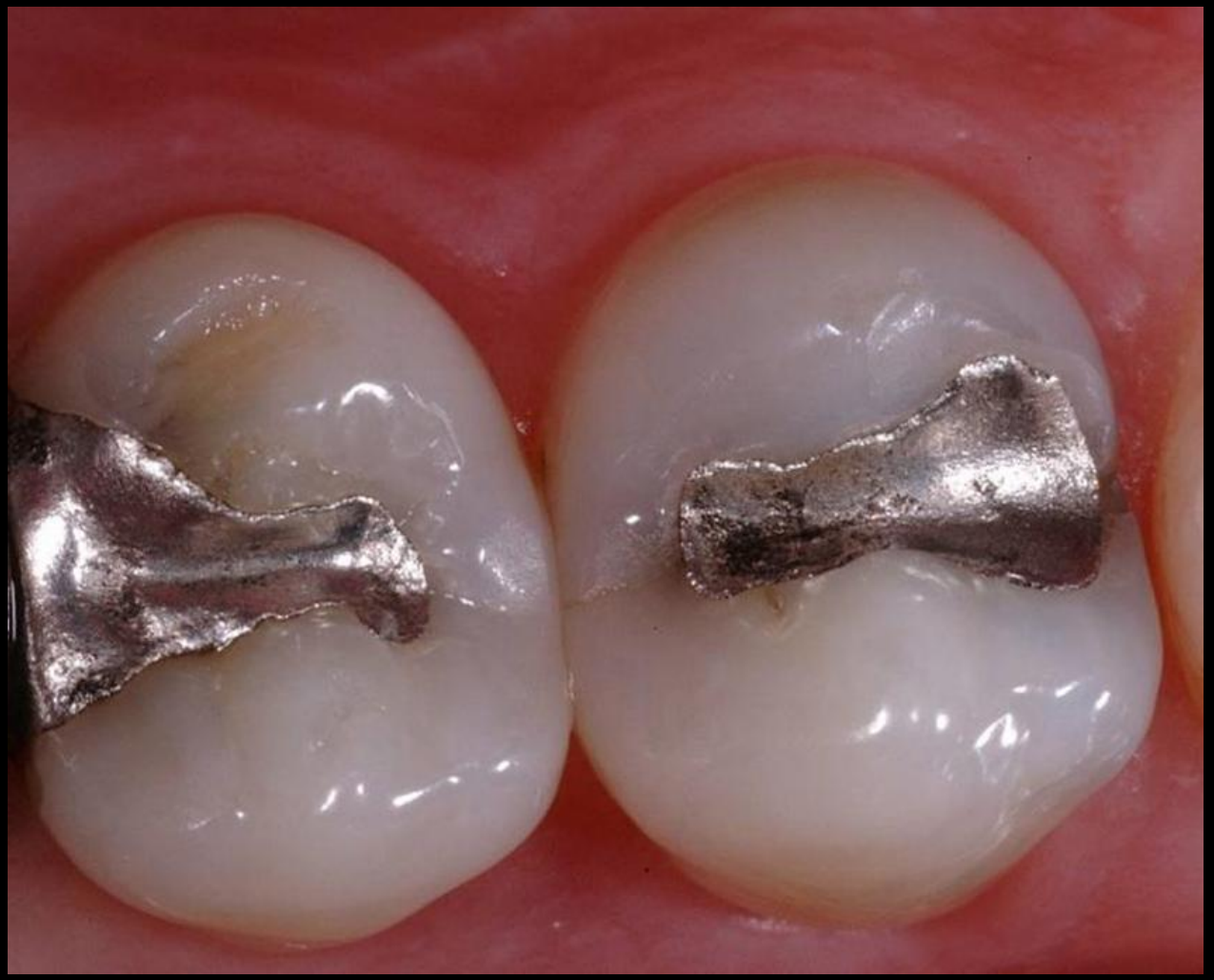


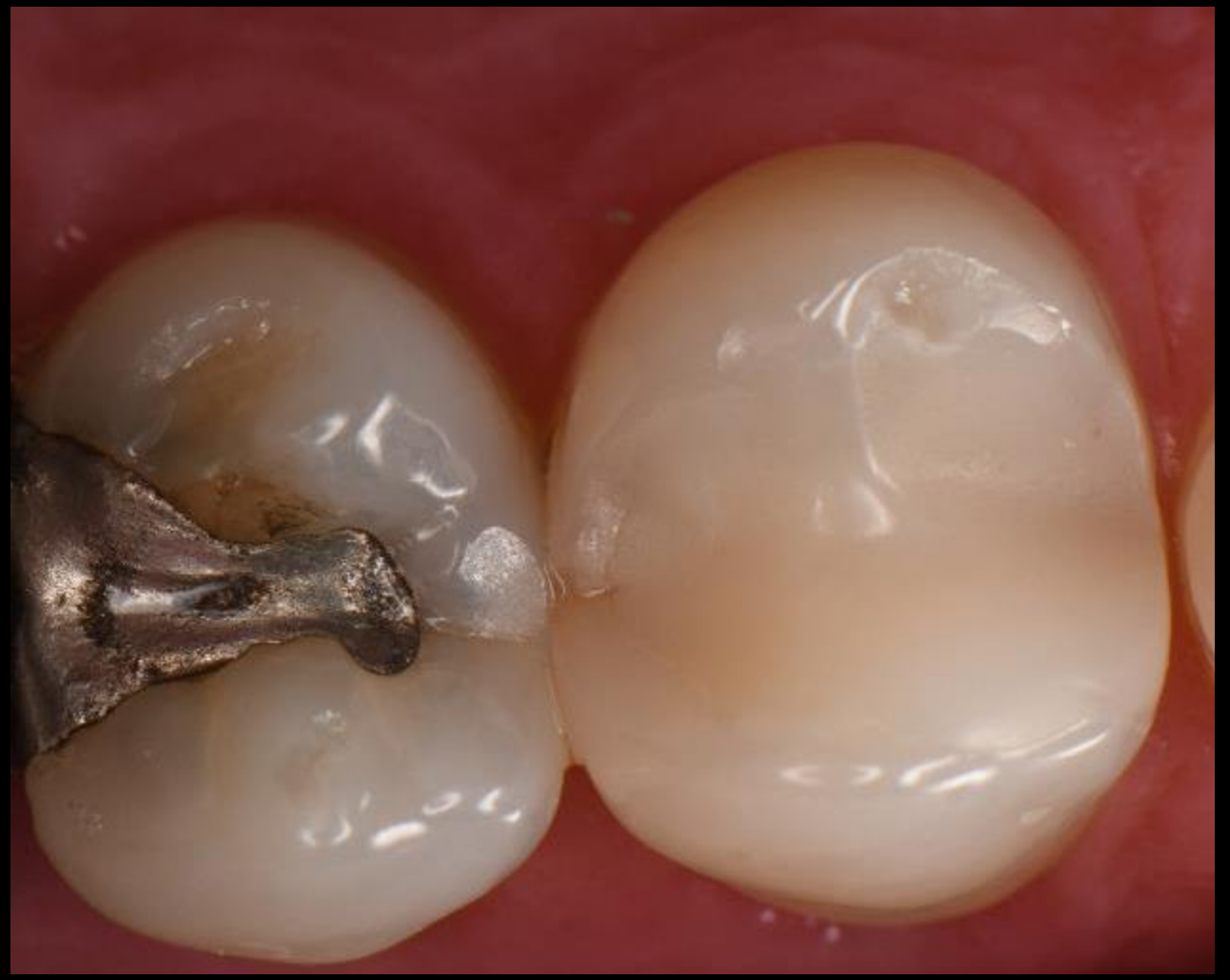
12 year follow up



Pre-op

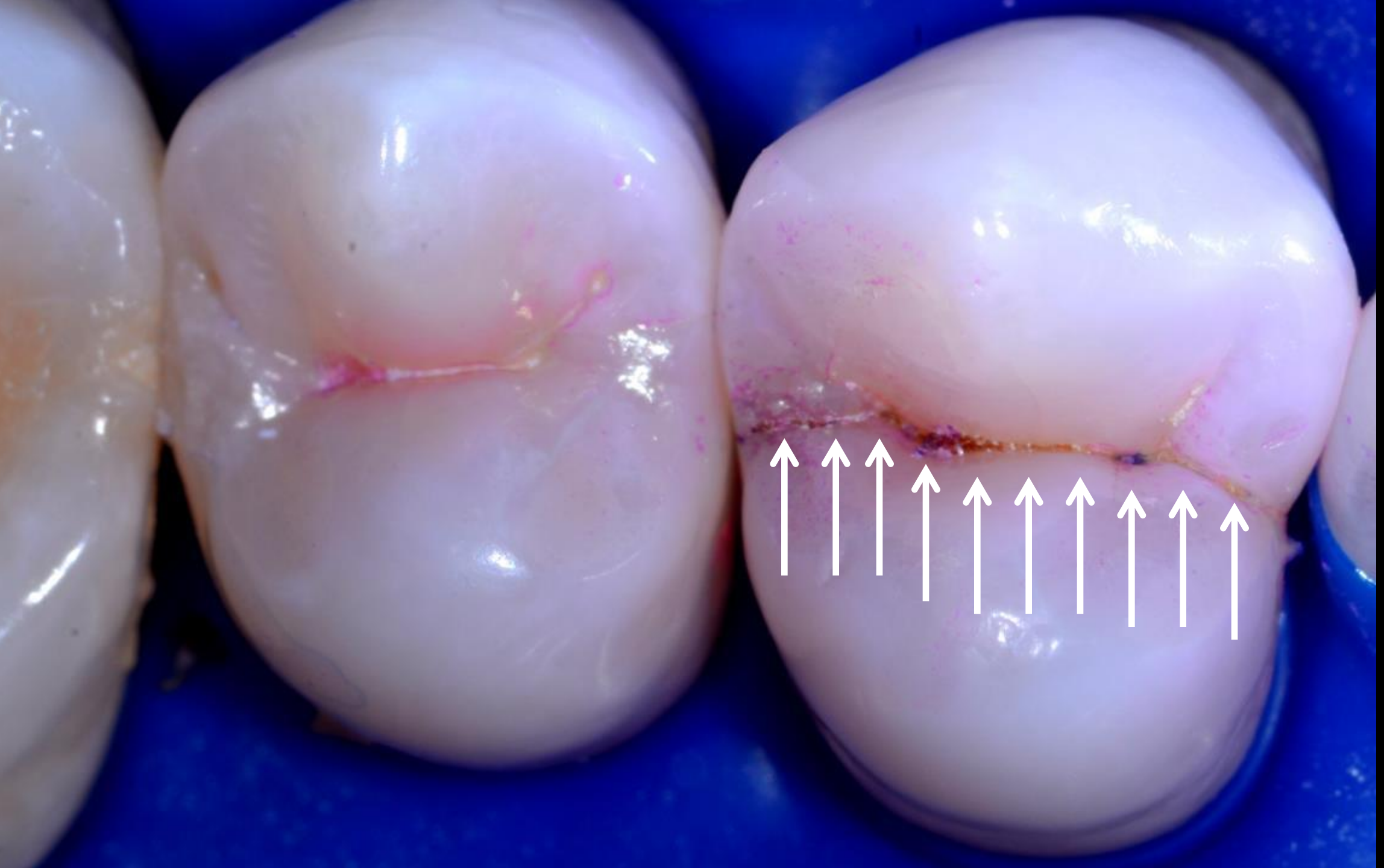
12 year follow up

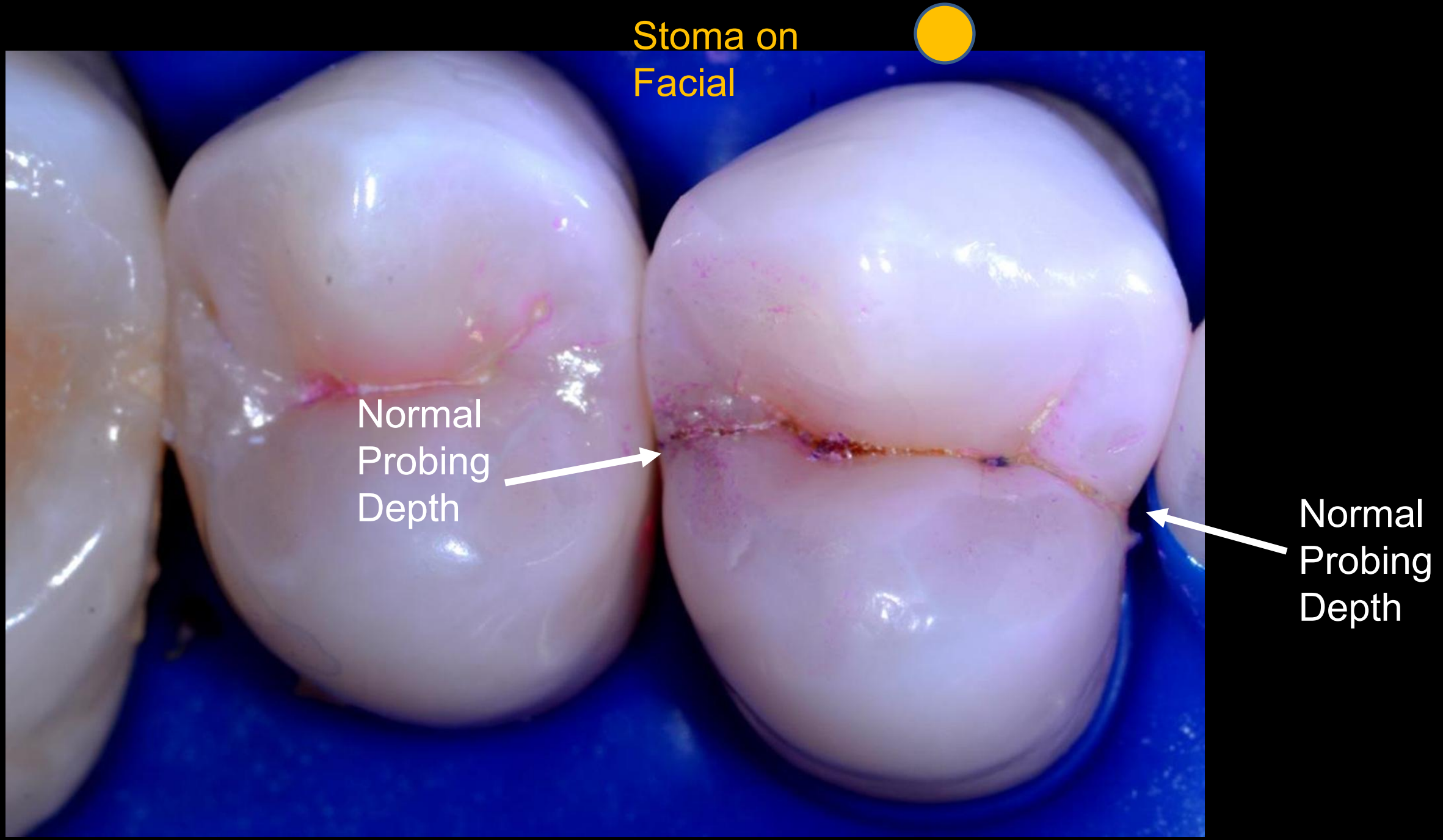




An Extreme Calla Lily Clinical Case


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




Stoma on
Facial
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Probing
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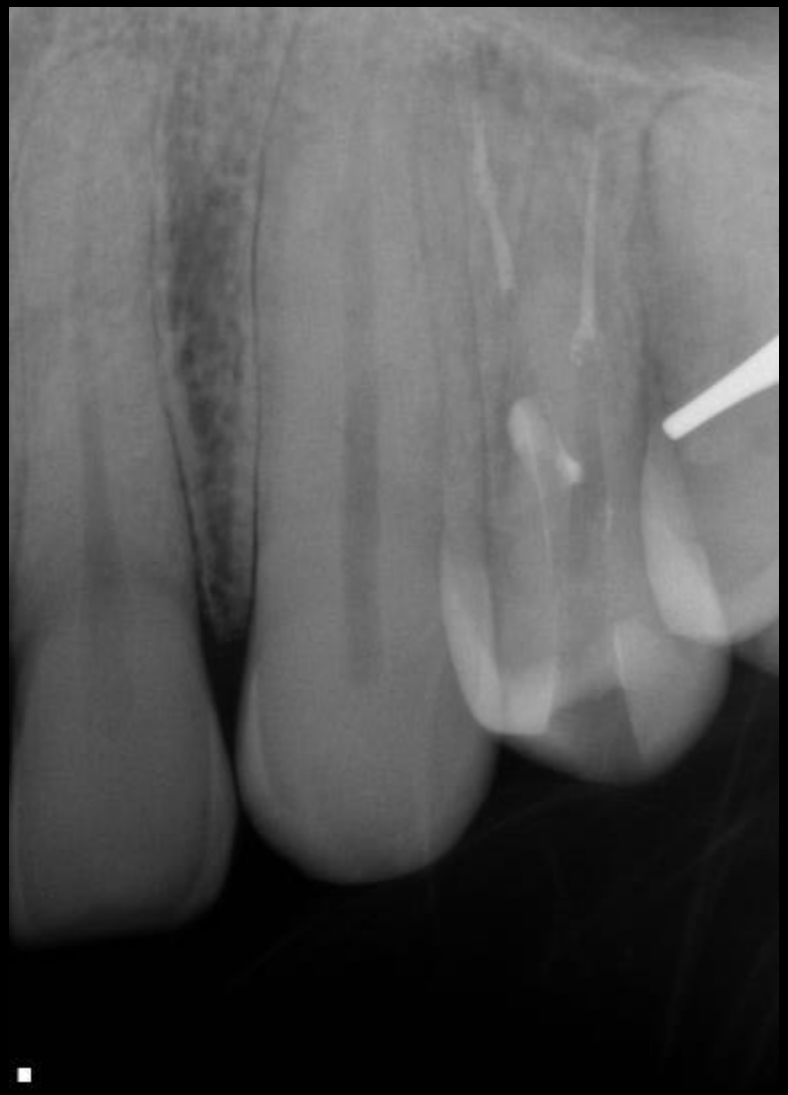
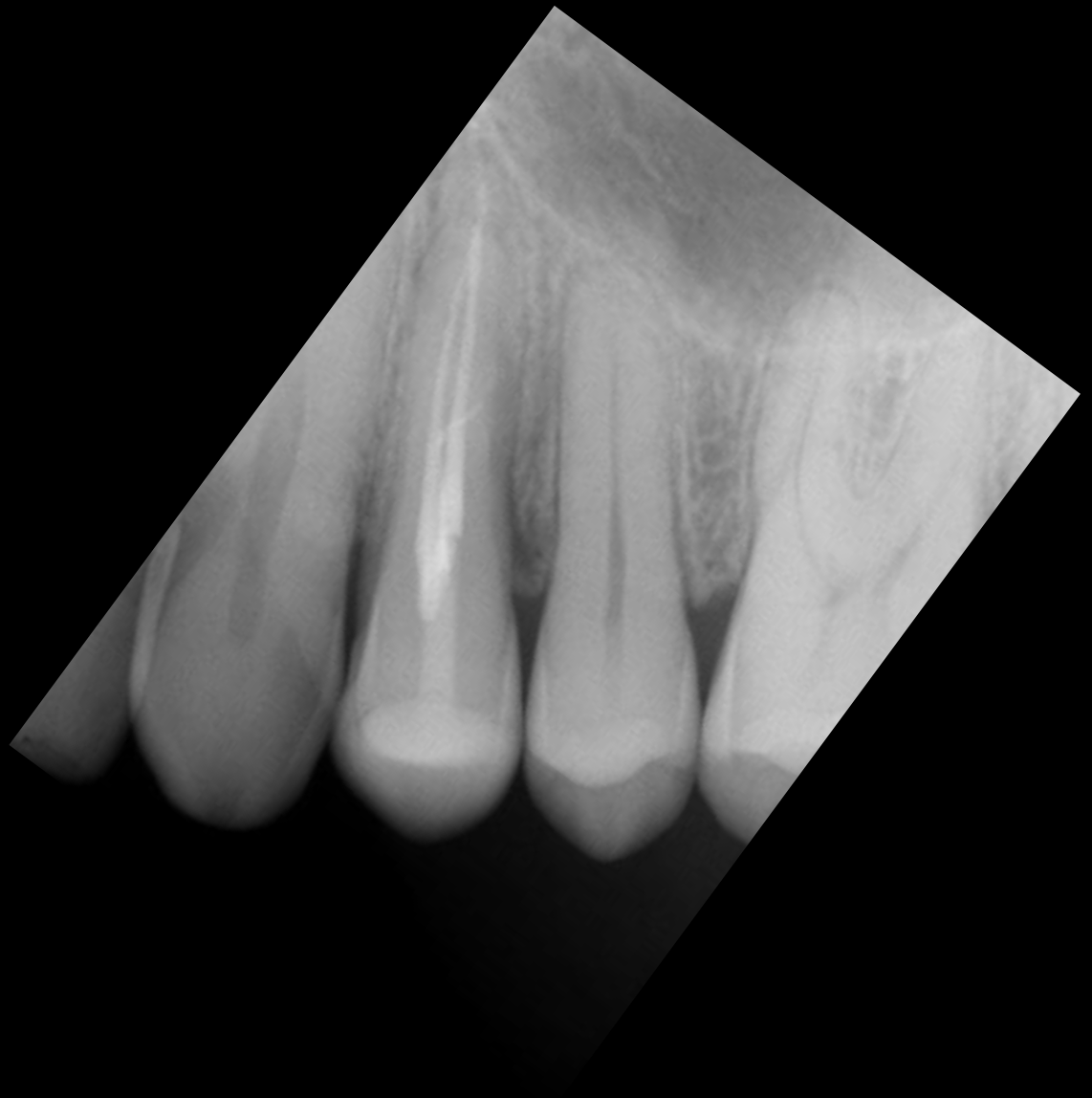
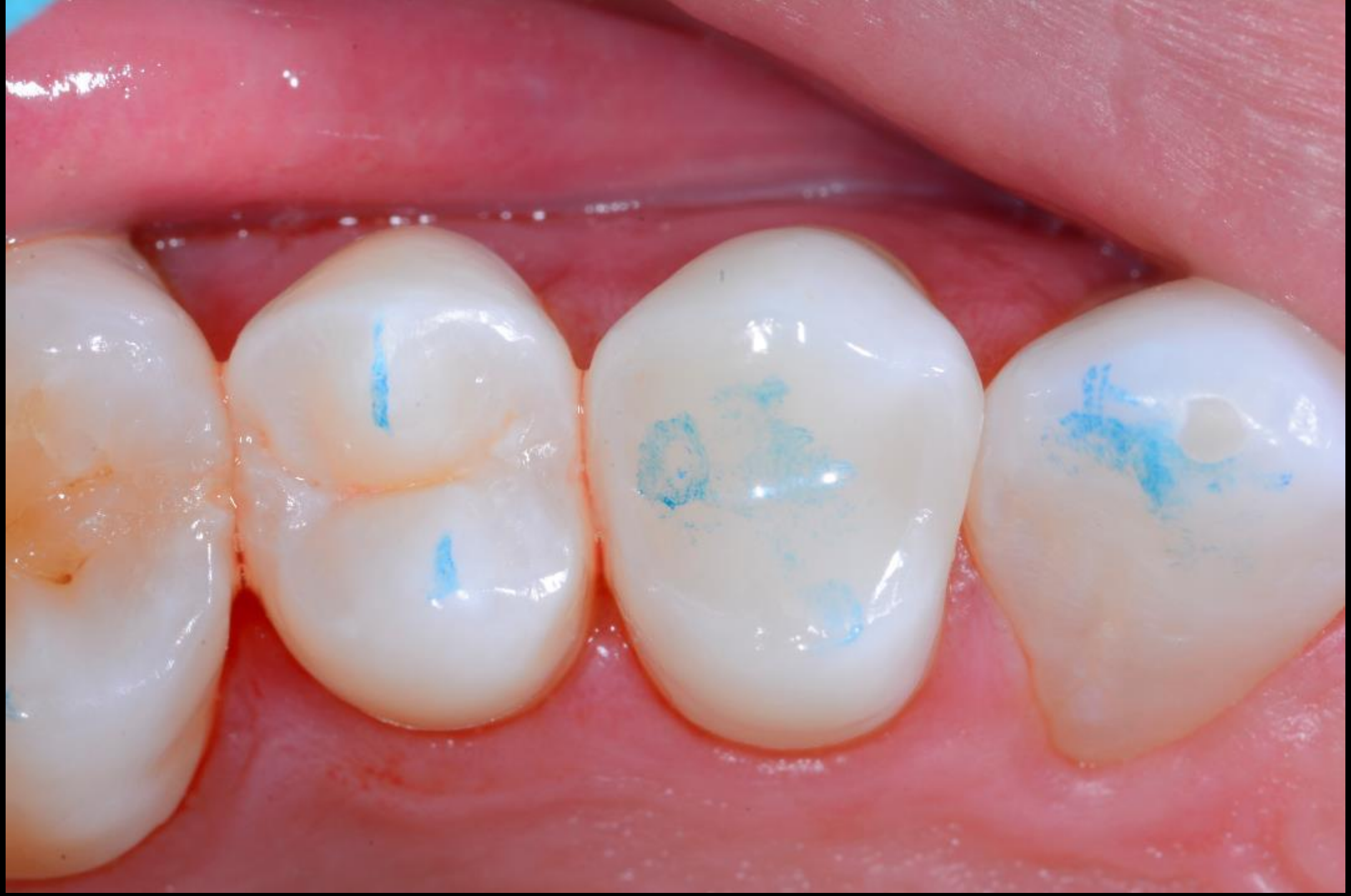
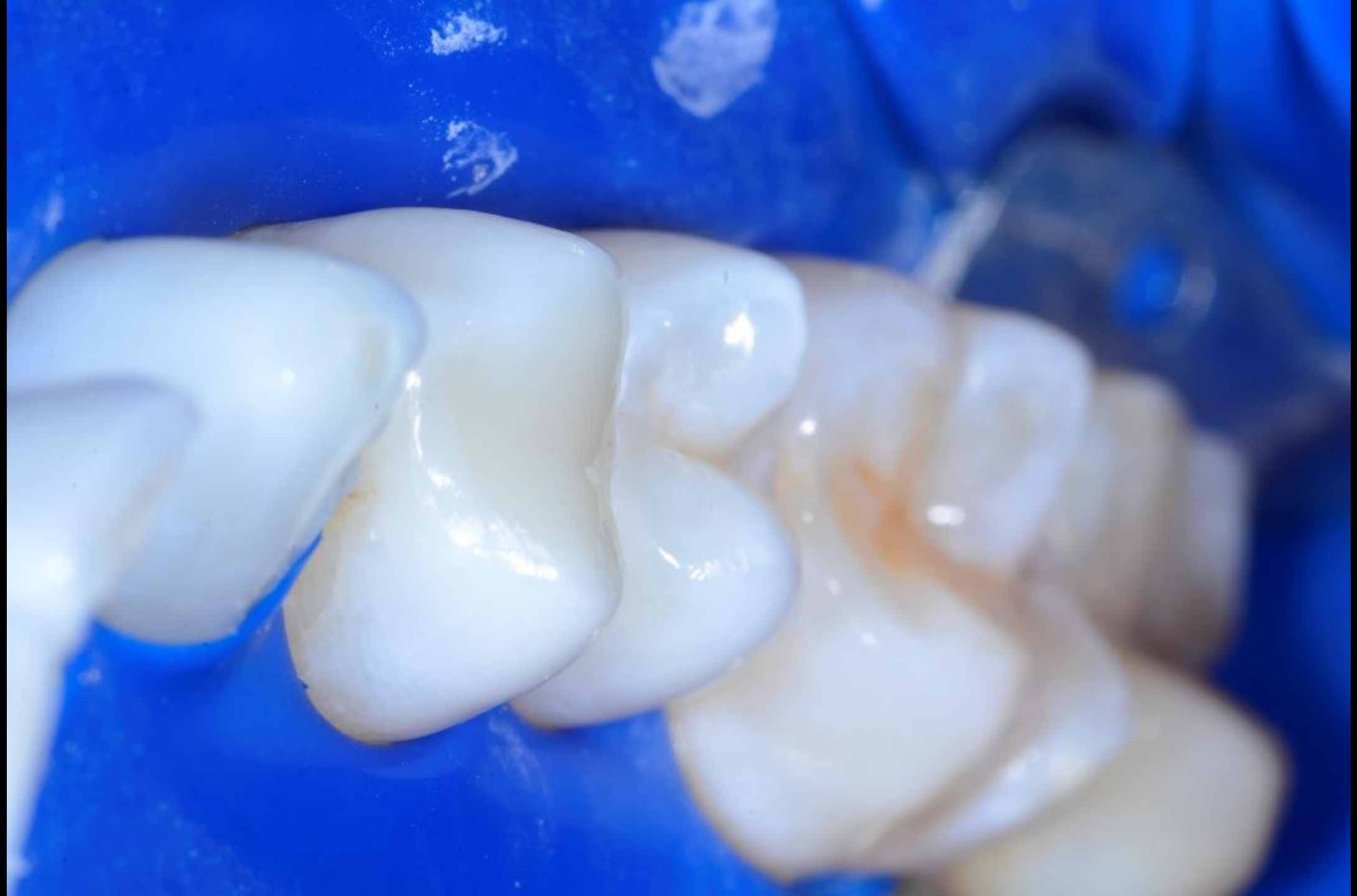
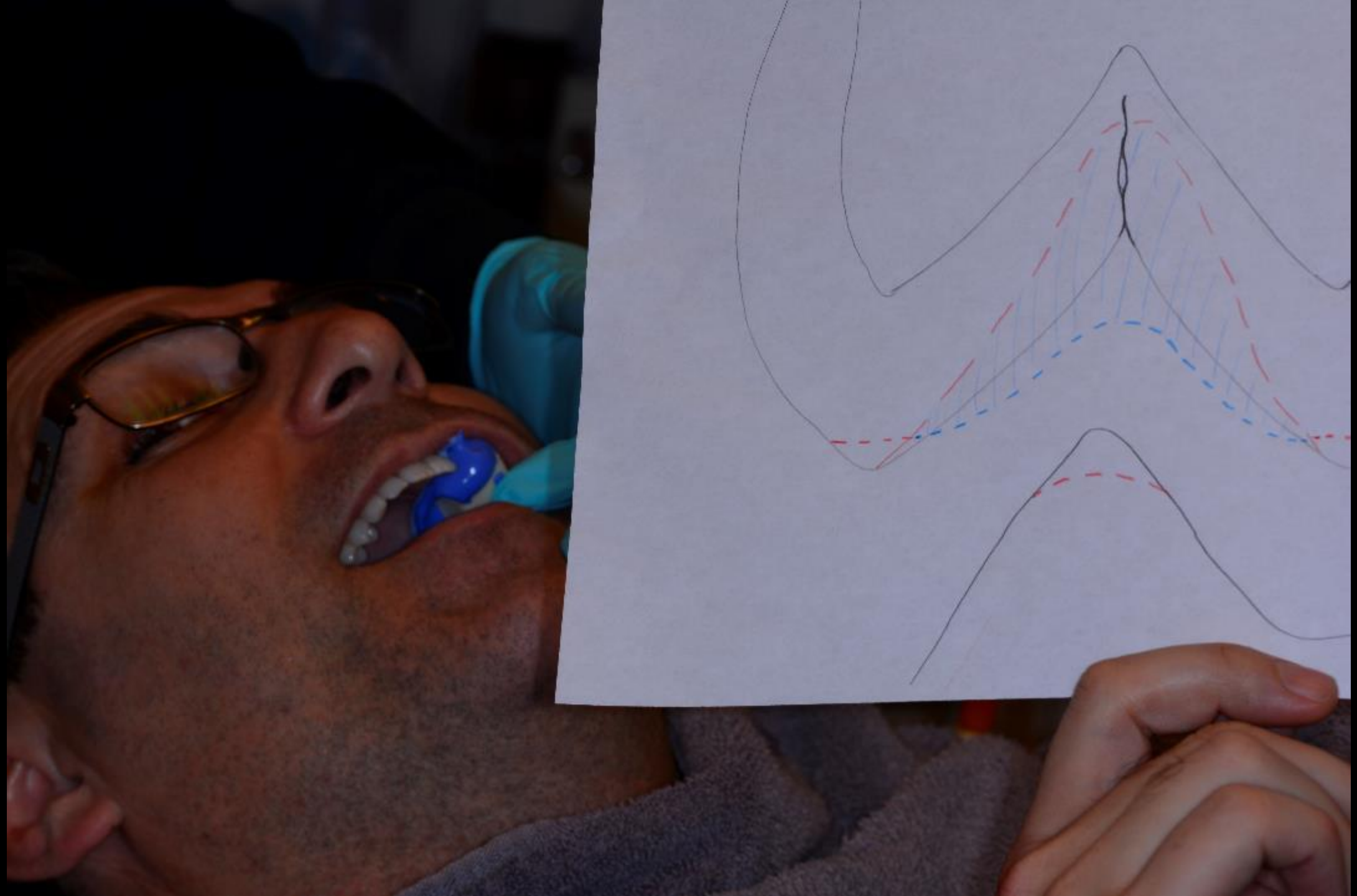


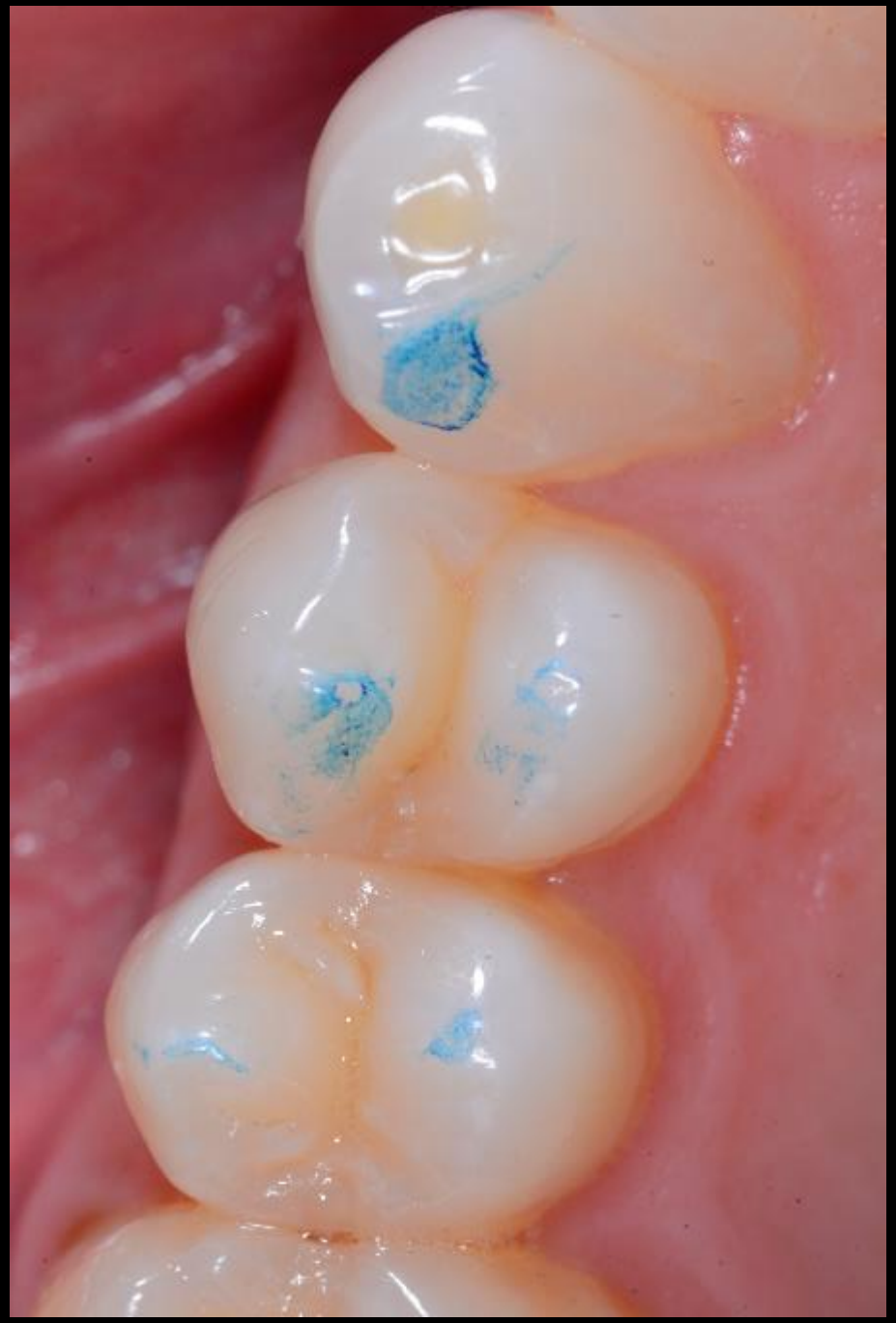


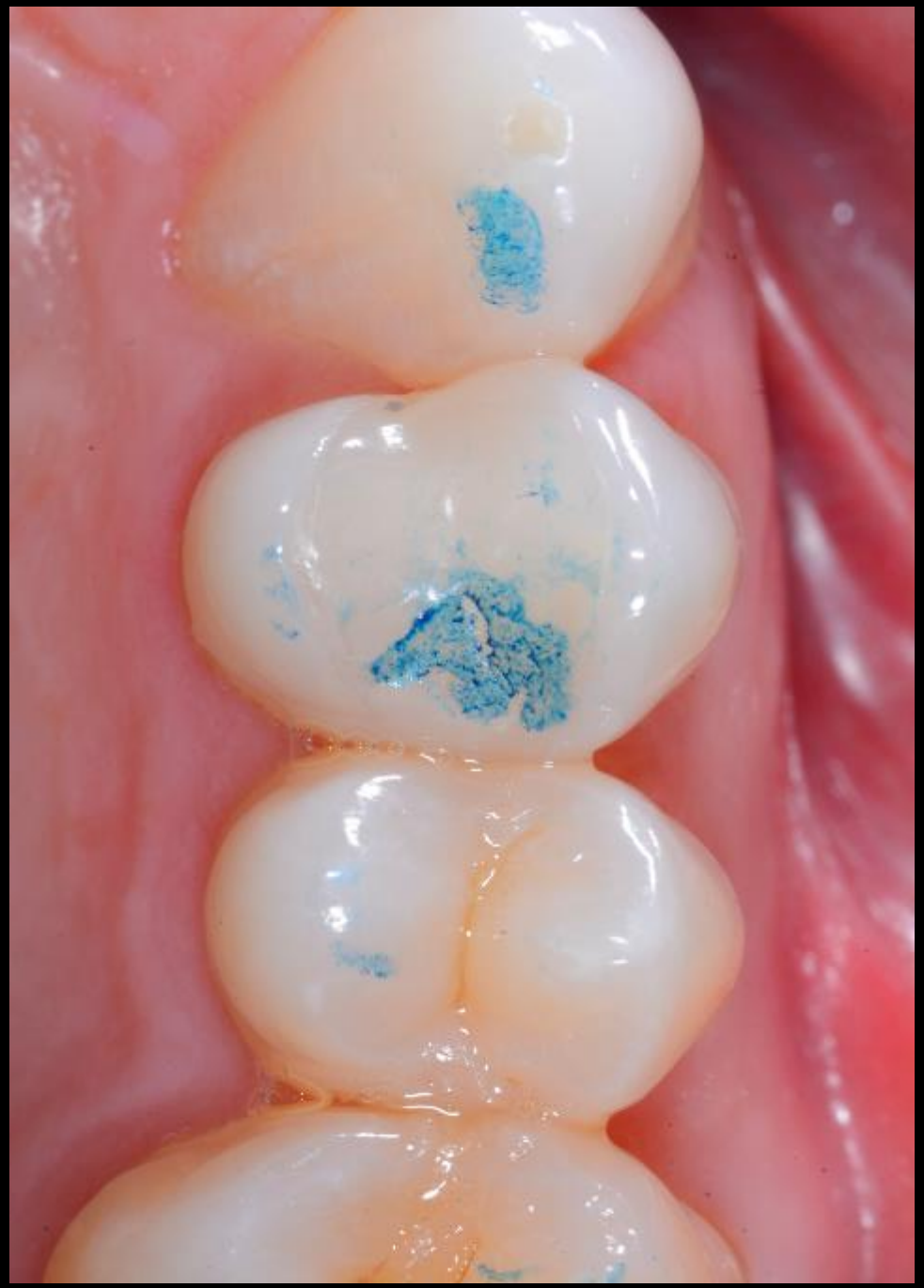


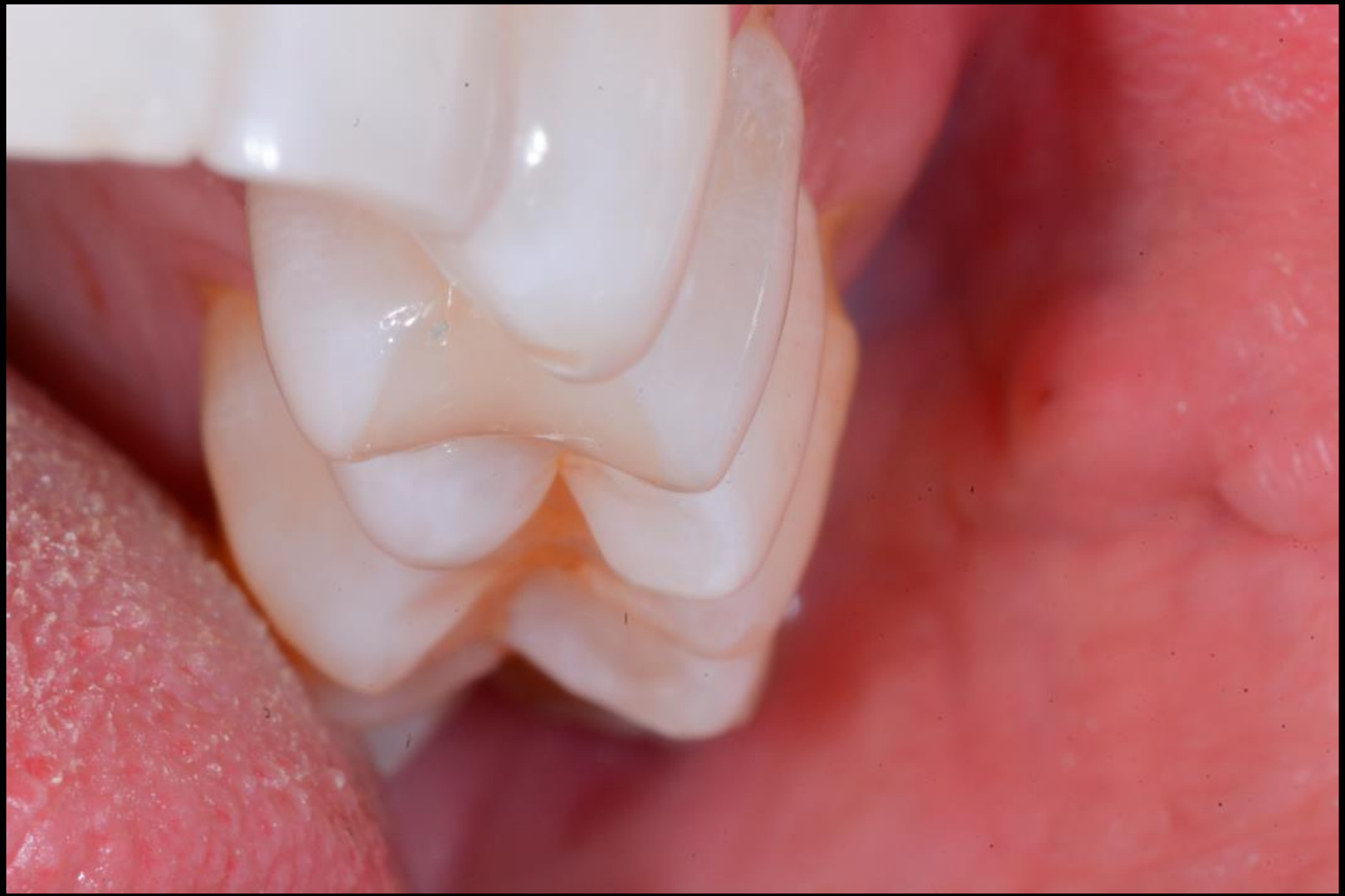


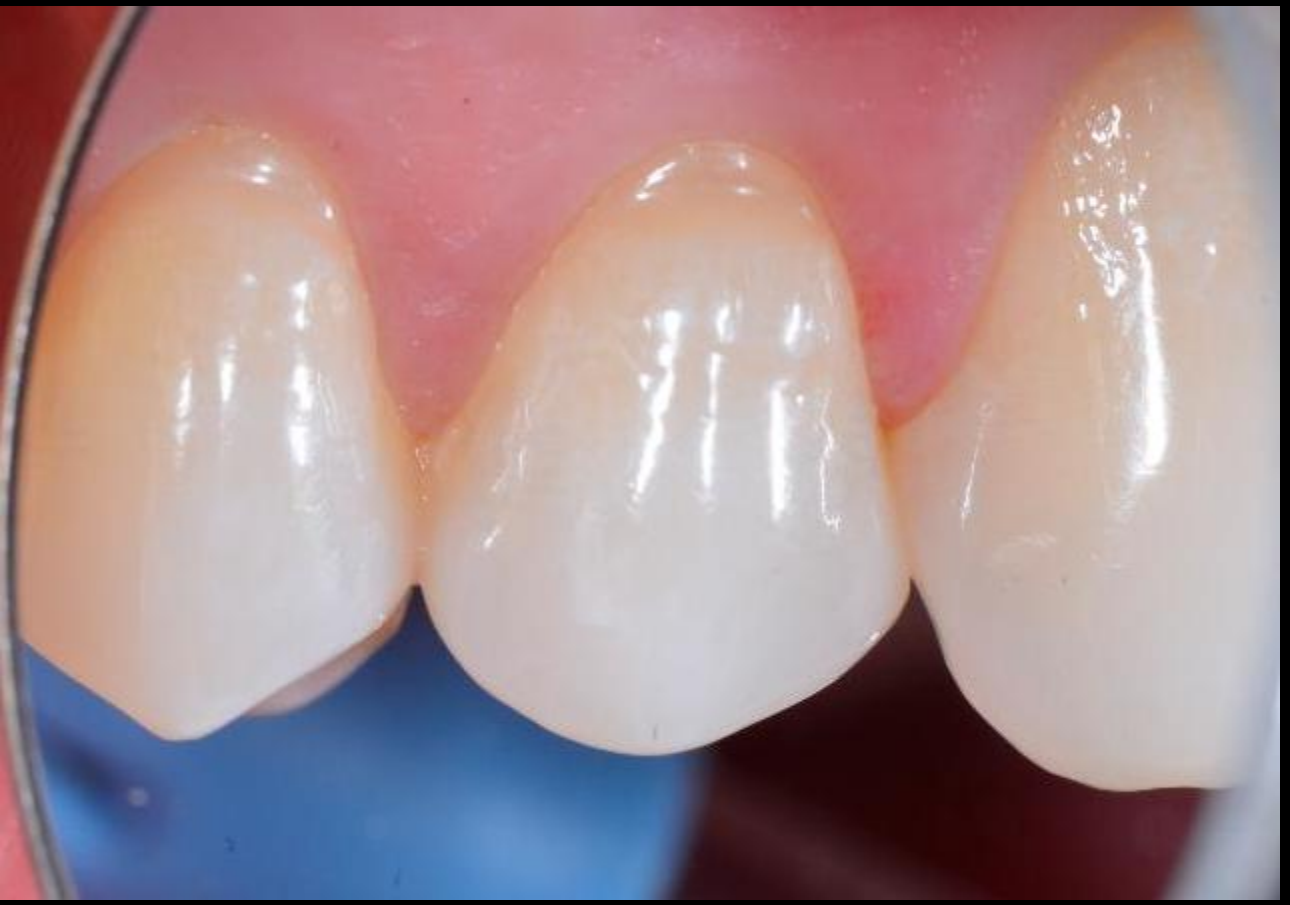


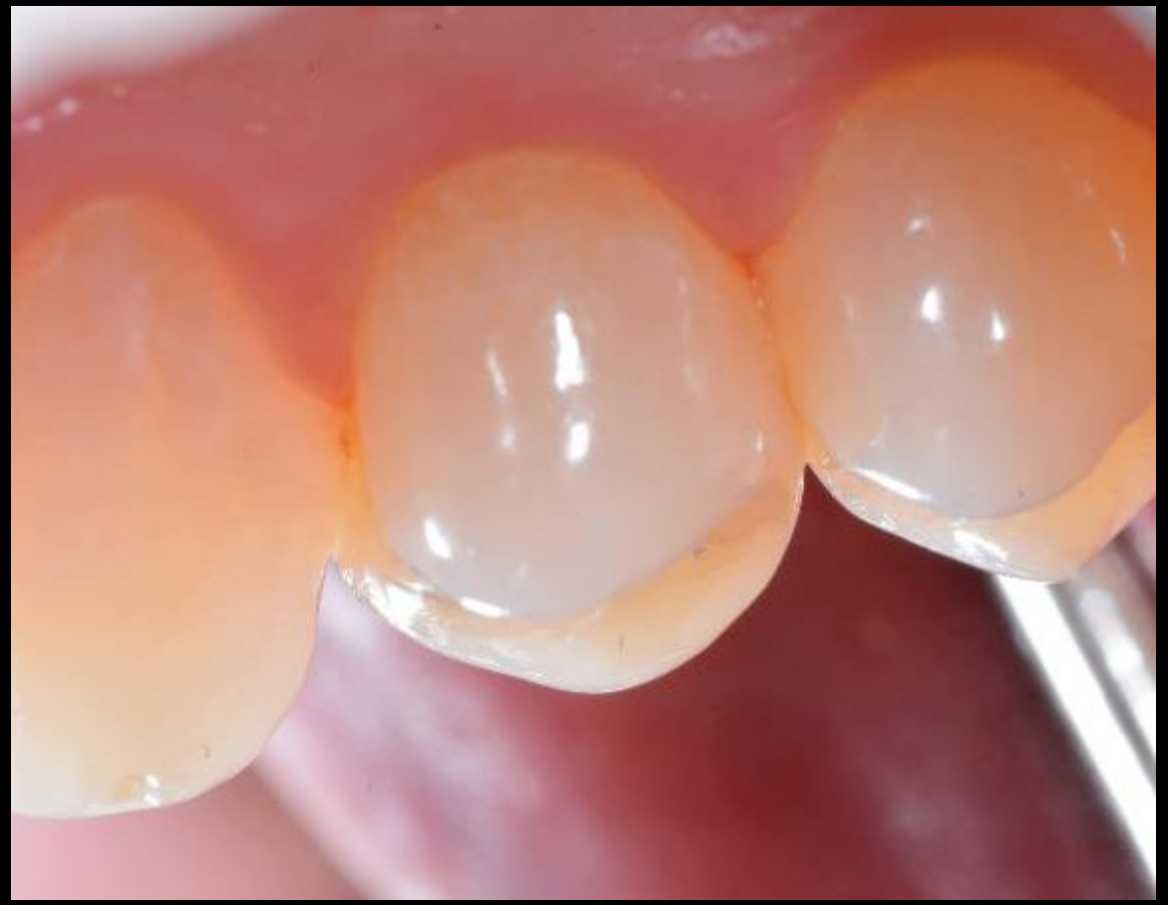
18 month follow up



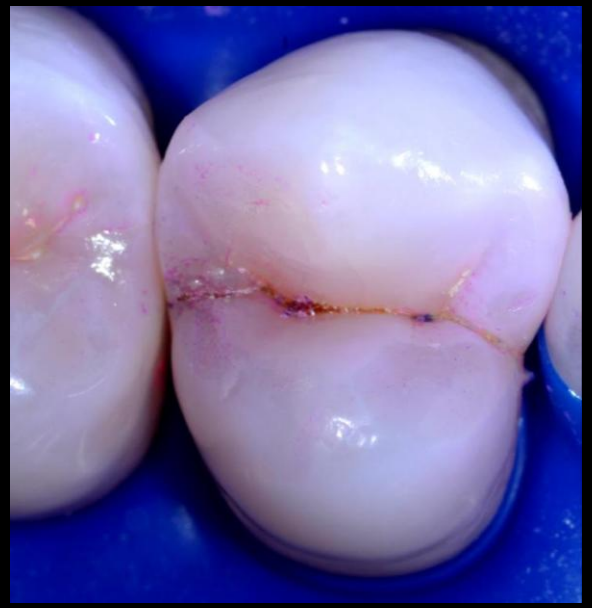




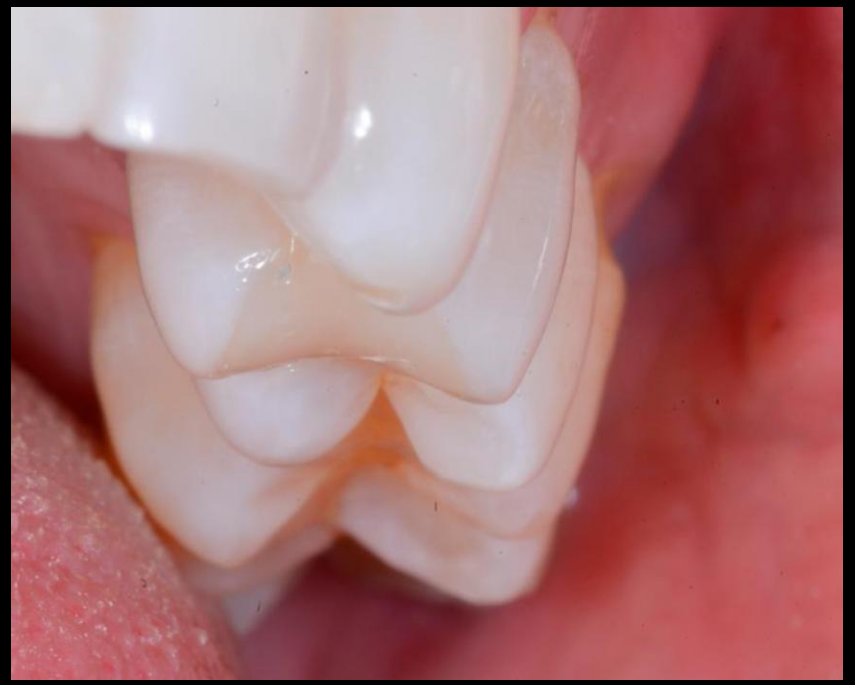




“Build a bridge from buccal to lingual, and the crack(s) becomes dormant.”

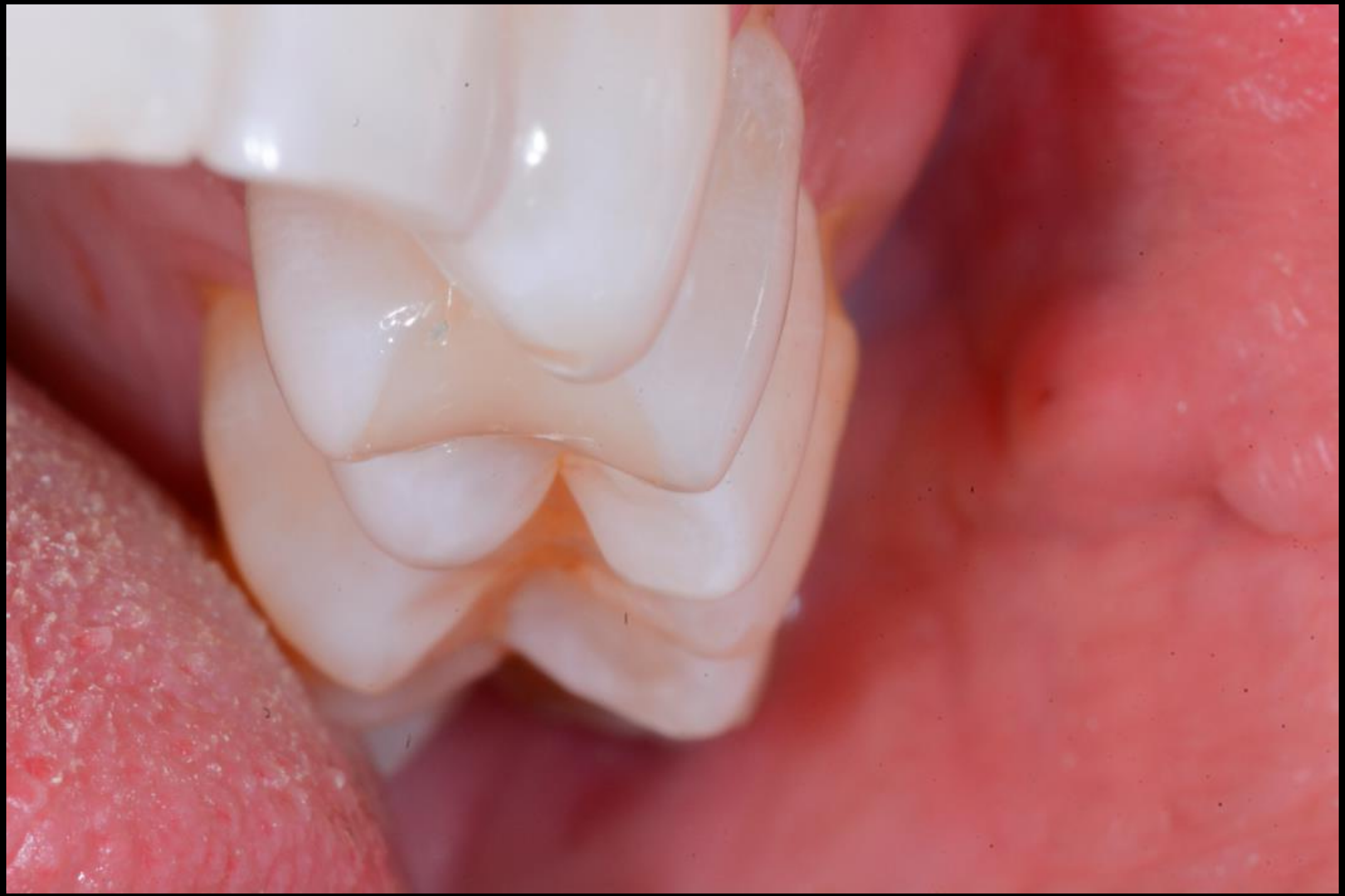


Before

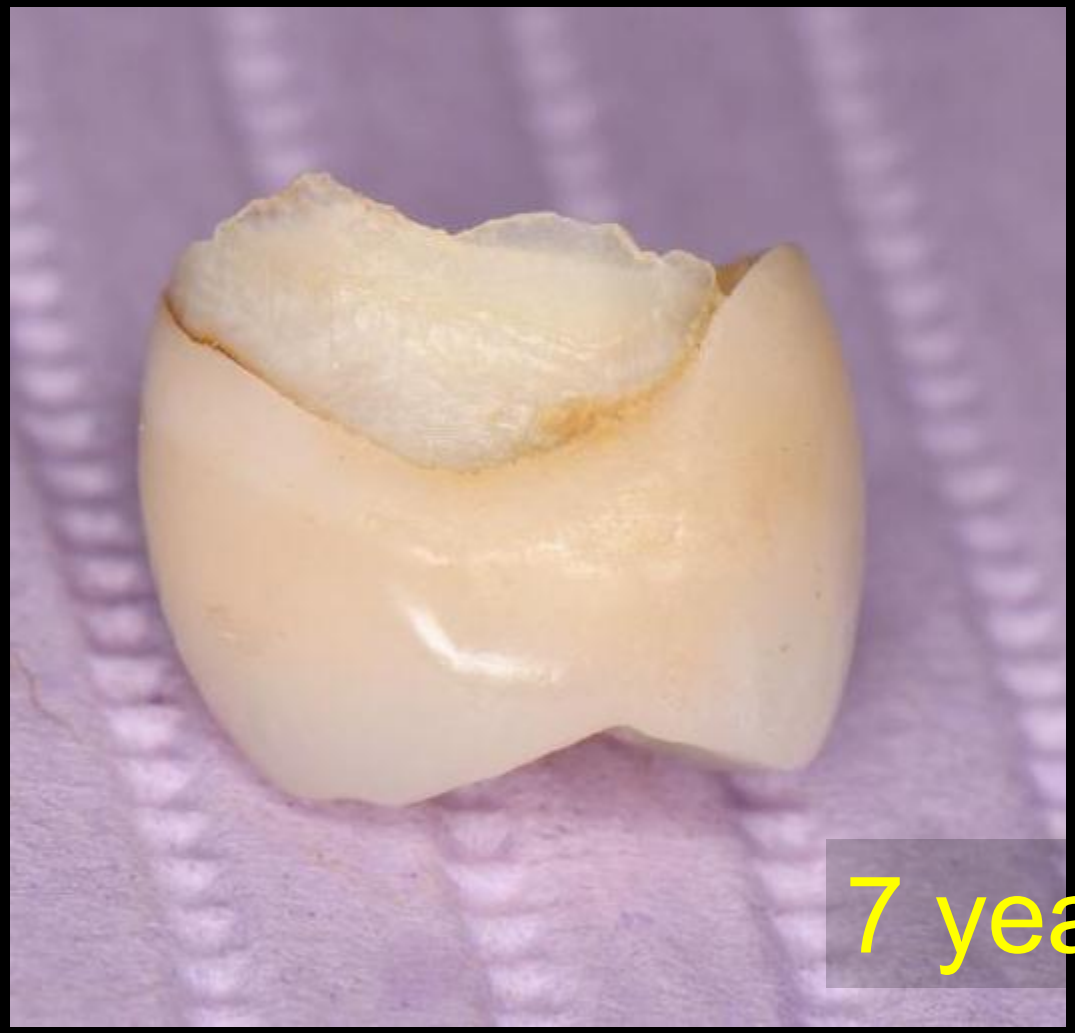


Before

“That’s it”



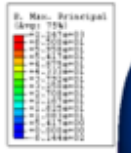
“David that’s not going to work, do a crown.”



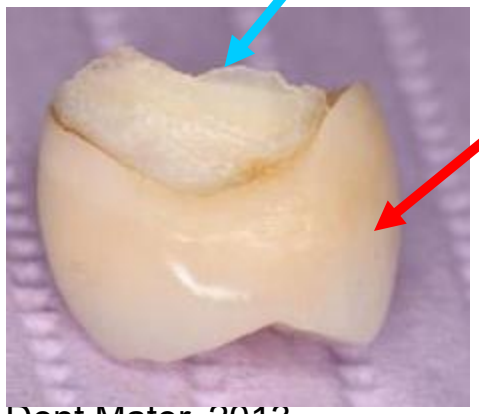
7 years post-op

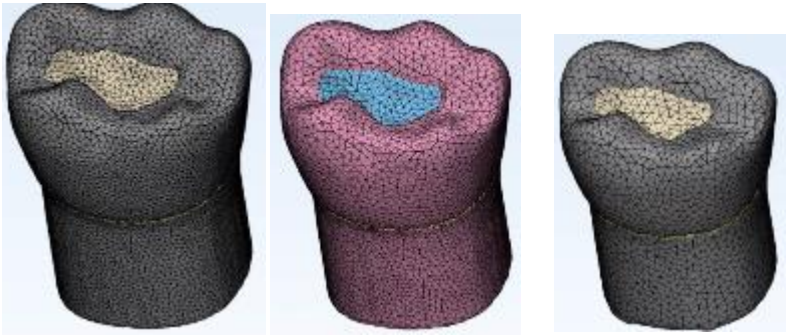
Stress/Strain Concentration

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



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





[1] Alex SL Fok, Dent Mater, 2013

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

When to do endo, when to extract

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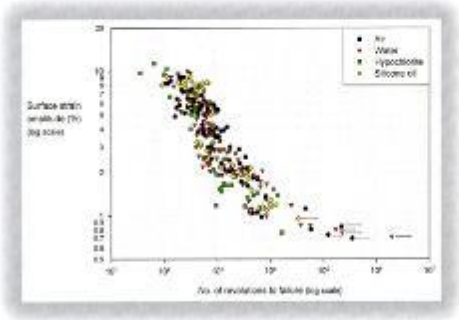
Journal of Endodontics

December 2007 Volume 33, Number 12



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Clinical *page 1405*
Association of Pulpitis in a Cohort of 796 Cracked Teeth

Basic *page 1438*
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

Dec
2007

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Key Words

Cracked teeth, reversible pulpitis

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0099-2399/$0 - see front matter

doi:10.1016/j.joen.2007.08.015

The Fall/Winter 1997 AAE Colleagues for Excellence article entitled "Cracking the Cracked Tooth Code" (http://www.aae.org/NR/rdonlyres/7D73B05C-FEE4-4B00-AB37-0860056F163BC/0/fw97ccfe.pdf) defined 5 types of tooth cracks. Four of the 5 cracks are associated with coronal defects generated from chewing and biting events (1). Teeth with craze lines have no pain, show lines in the enamel, but no "shadows" in the dentin with transillumination. Teeth with fractured cusps have mild pain to biting on a specific cusp, usually a marginal ridge and buccal or lingual groove crack in the dentin, seen as a shadow with transillumination and a Class II restoration. Removal of the restoration might result in the cusp breaking off. Cracked teeth might or might not have a restoration, will exhibit acute pain on mastication, early brief pain to cold, centrally located mesial-to distal marginal ridge crack(s) seen in the dentin as a shadow(s) with transillumination, normal-to-deep periodontal probings associated with the crack, no detectable movement of cusps with an explorer, and might require removal of existing restorations to definitively diagnose. The pulpal and periapical diagnoses are dependent on the extent of the crack and duration of the symptoms. Split teeth usually have marked pain to chewing, can be considered an extension of the cracked tooth, have mesiodistal cracks extending across both marginal ridges with detectable buccal and lingual cusp separation with an explorer, and deep probings with both marginal ridges. Vertical root fractures begin in the roots of teeth that usually have had endodontic treatment, extend in the buccal-to-lingual plane, usually have minimal signs or symptoms, might have normal probings, and require surgical assessment to complete the diagnosis.

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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.
(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 [illegible]).

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 pathosis.

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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".

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REV- >IP or NEC.	3	9			8	7			27
%	25	27	0	0	28	17			21

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

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

1) Is the pain spontaneous?

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

BIOCLEAR LEARNING CENTER

3) Has the pain ever woken you?

BIOCLEAR
LEARNING CENTER

4) Lingering pain to heat?

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

- 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

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.
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How many pulps eventually died?

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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. Hiatt (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.

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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

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

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What is the pulpal death rate for bridge abutments?

32%

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Big picture:

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

Big picture:

Bioclear Composite Overlays have shown immediate elimination of symptoms*

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

Big picture:

PROBE!
PROBE!
PROBE!

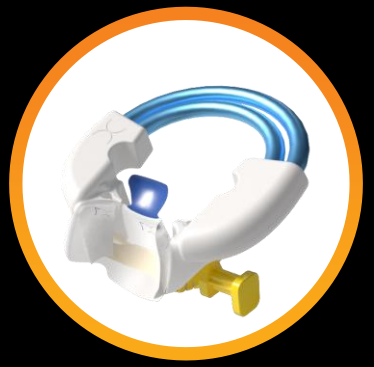
What is our most reliable clinical test for irreversible pulpitis?

PERCUSSION TEST, and REPEAT

A Moden Method for Composite Restorations

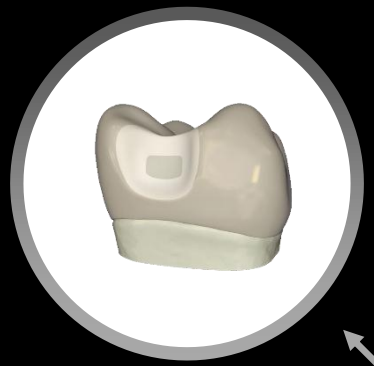
Anatomic HD Clear Matrices

- Anterior & Posterior Matrices designed to mimic nature



Preparation Design

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



Injection Mold Composite

- Injection mold warmed Kuraray Majesty anterior composites and 3M bulk fill in Class I and Class II restorations
- Like the inverse of my mullet haircut: Party in the front Business in the back

Bioclear Blaster or Equivalent for Biofilm Removal

- Uses aluminum tryihydroxide w/ water
- Allows bonding to uncut enamel
- Allows infinity edge margins

Systematic restorative protocol for esthetic long-term clinical outcomes

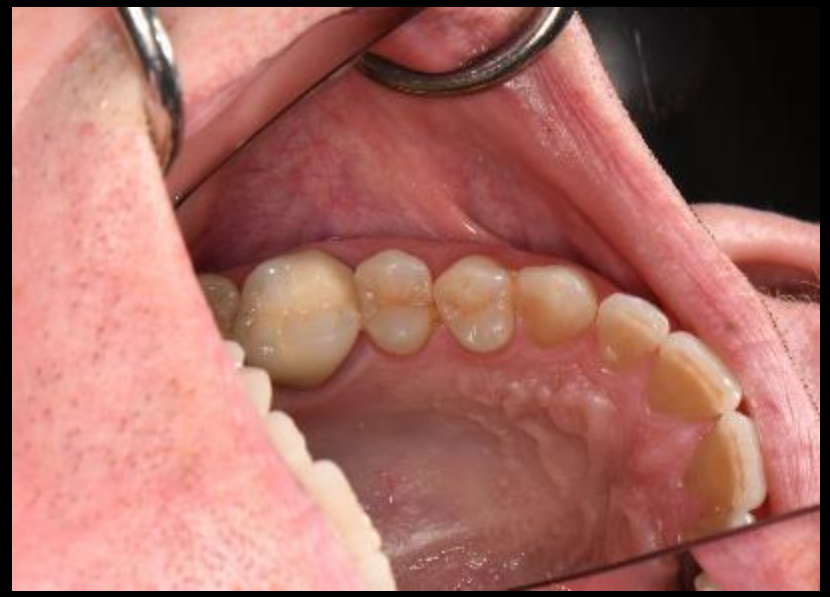
Rock Star Polish

- **Coarse discs for reduction**
- **“Rock Star” polish with Bioclear Magic Mix and disposable cup**
- **Bioclear RS Diamond Polisher**

BIOCLEAR

Step by Step Guide for Injection Molded Class II

Which tooth is cracked?



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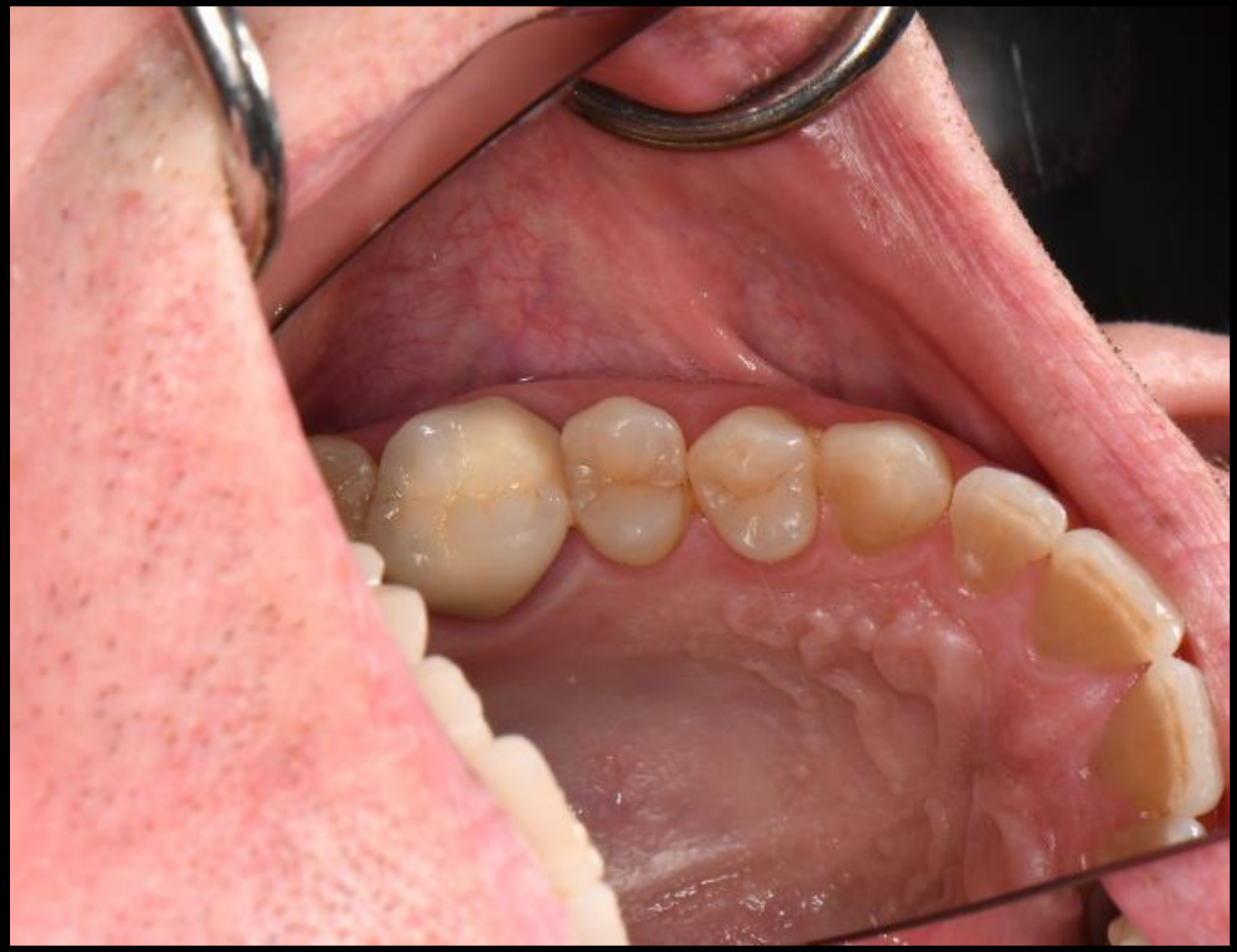

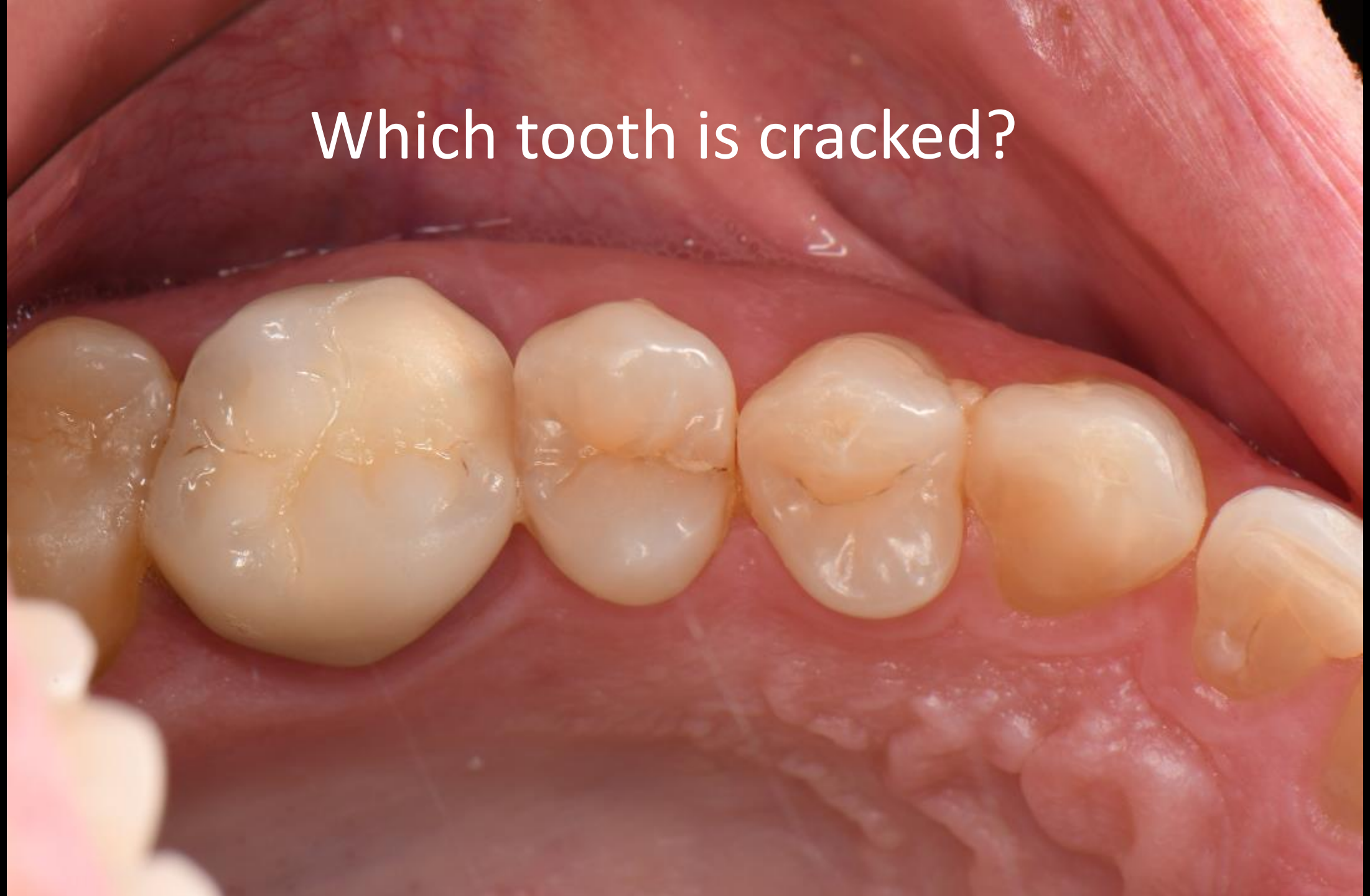
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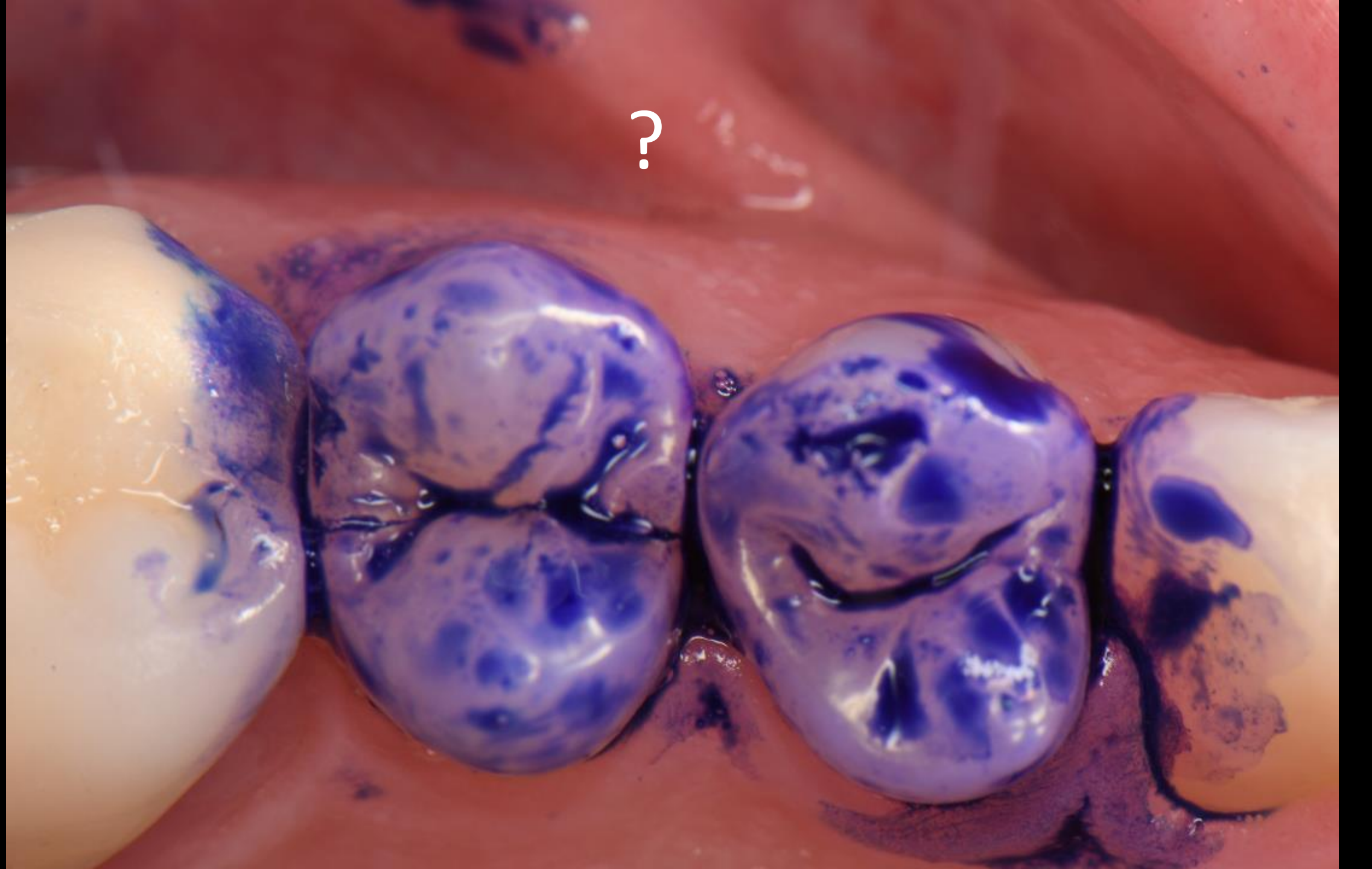
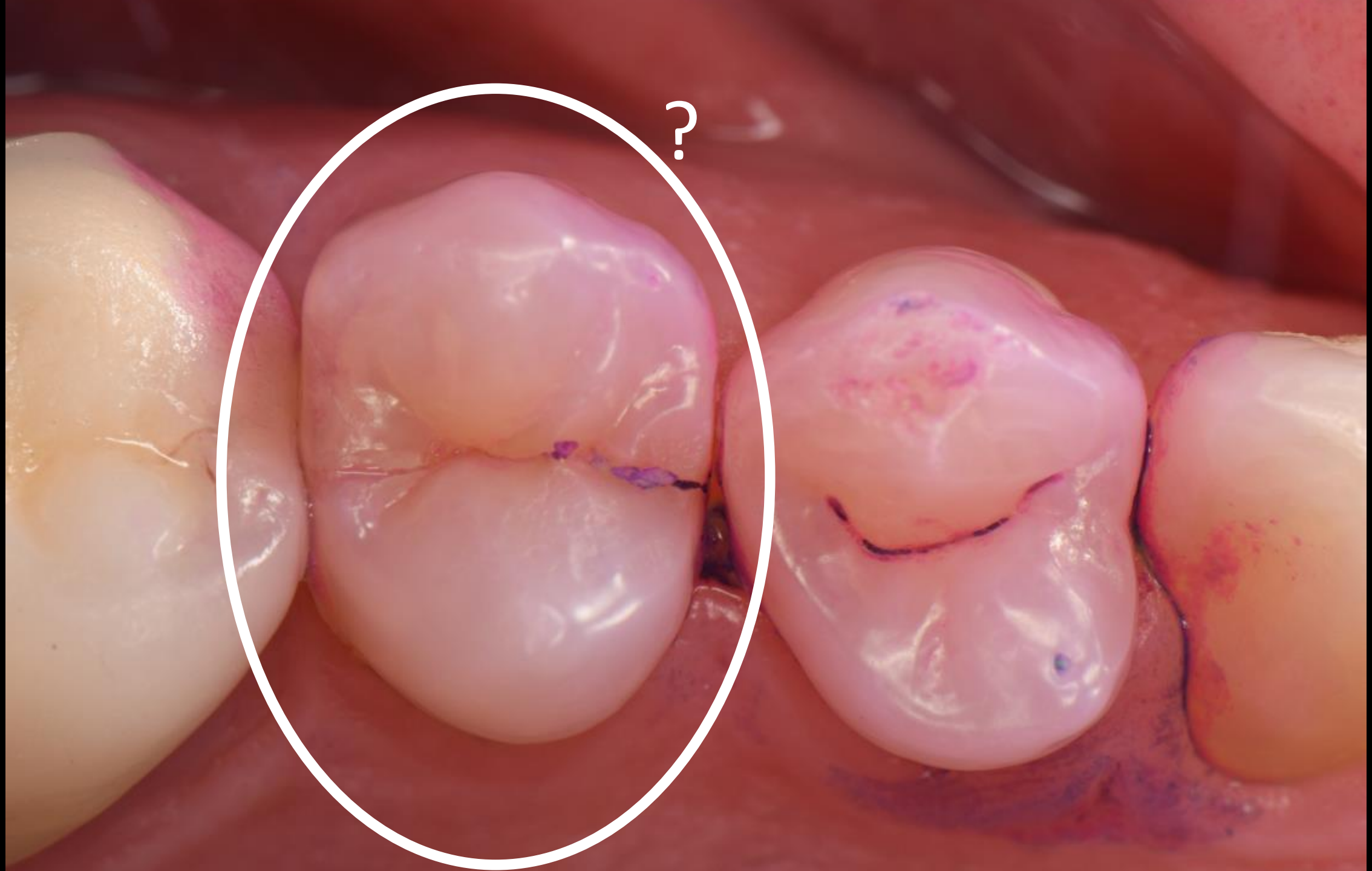
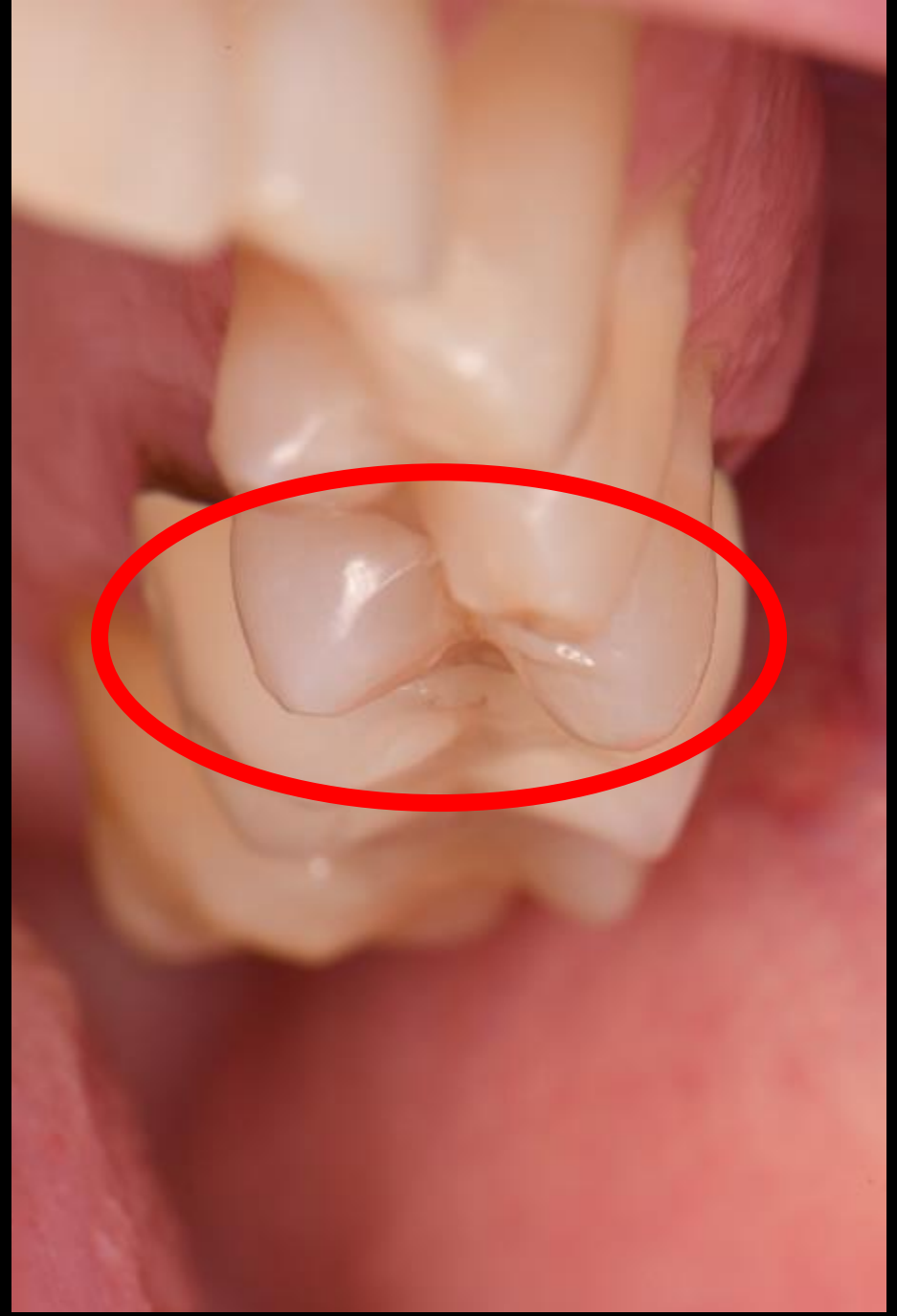
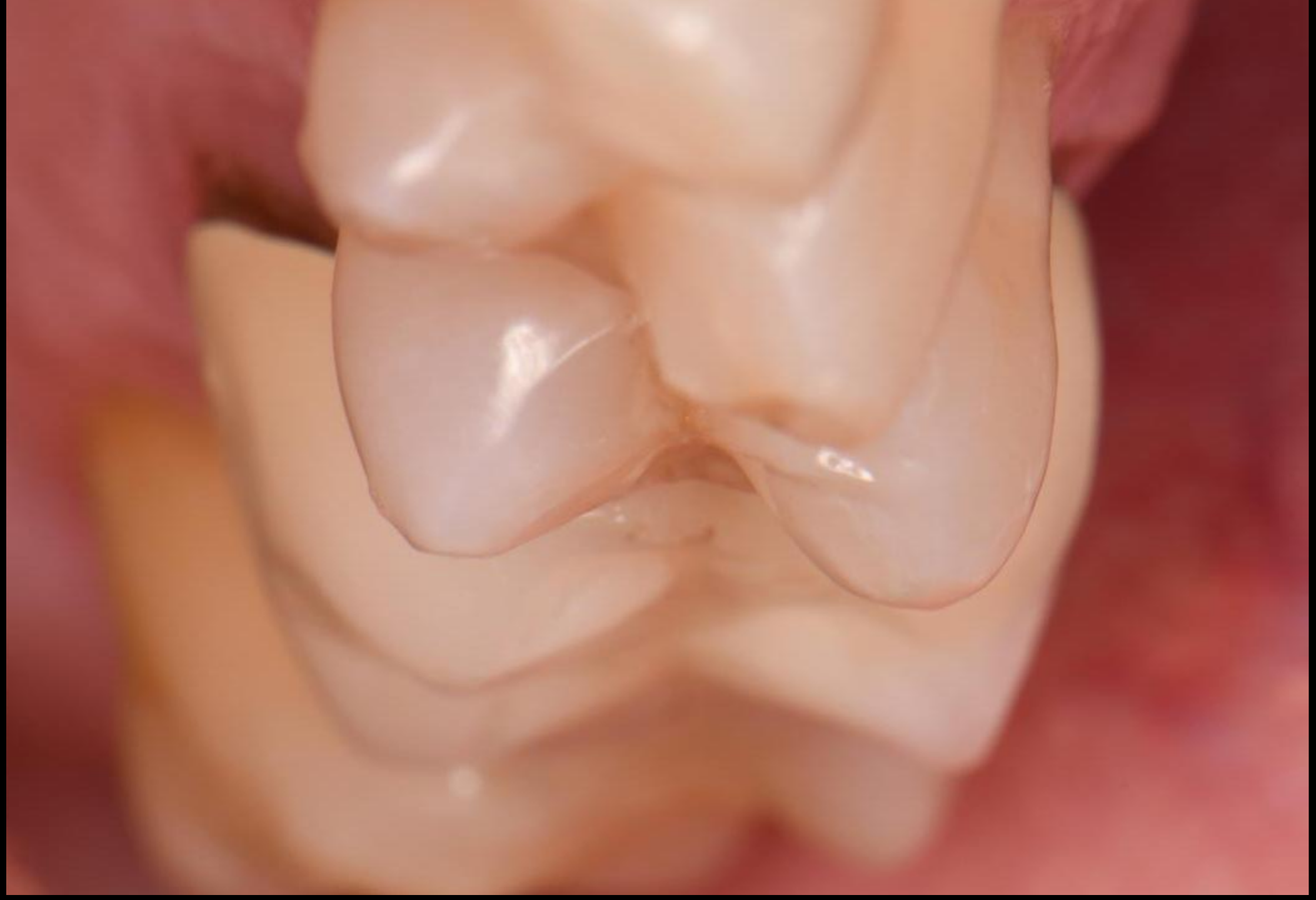
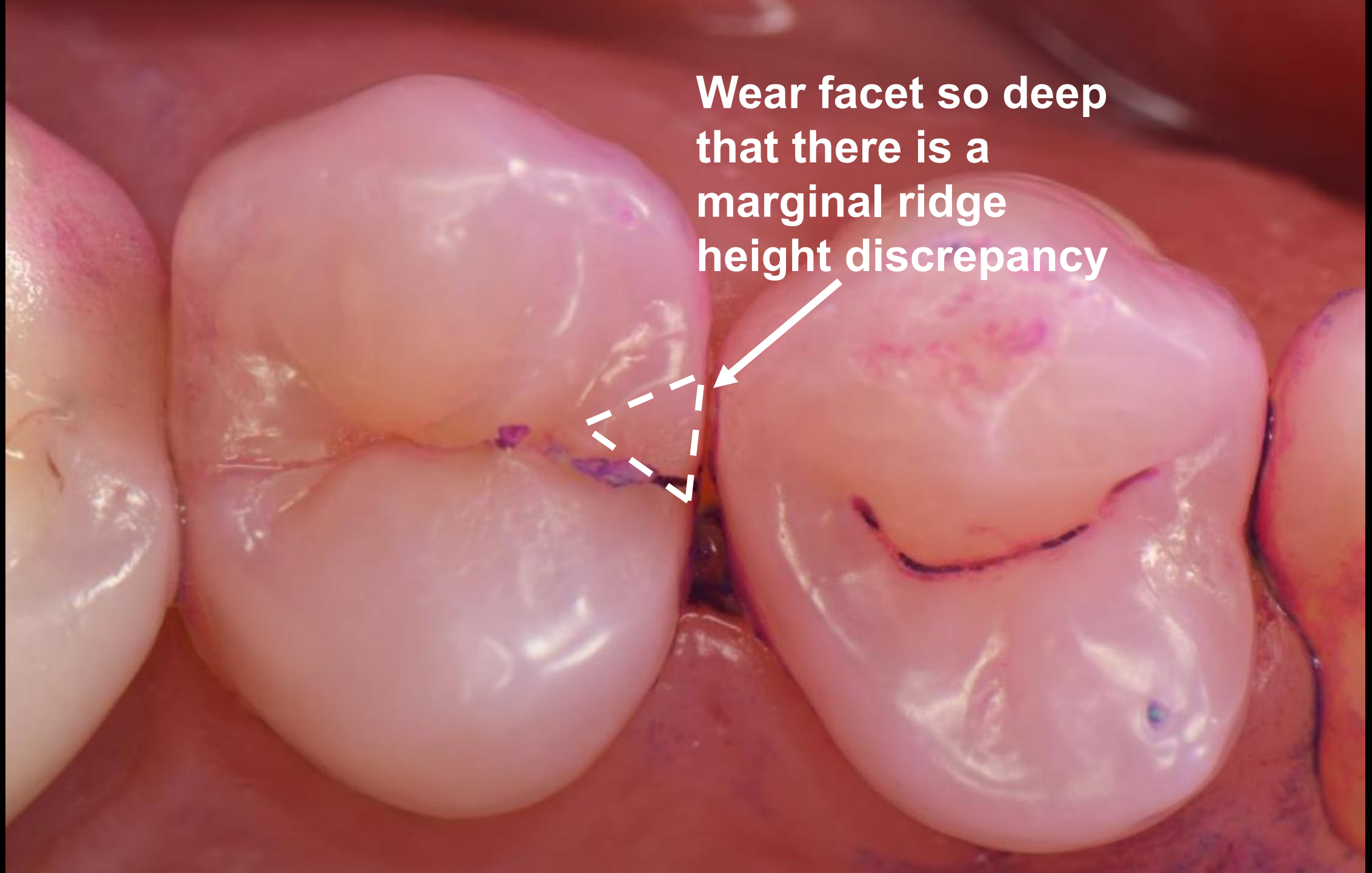
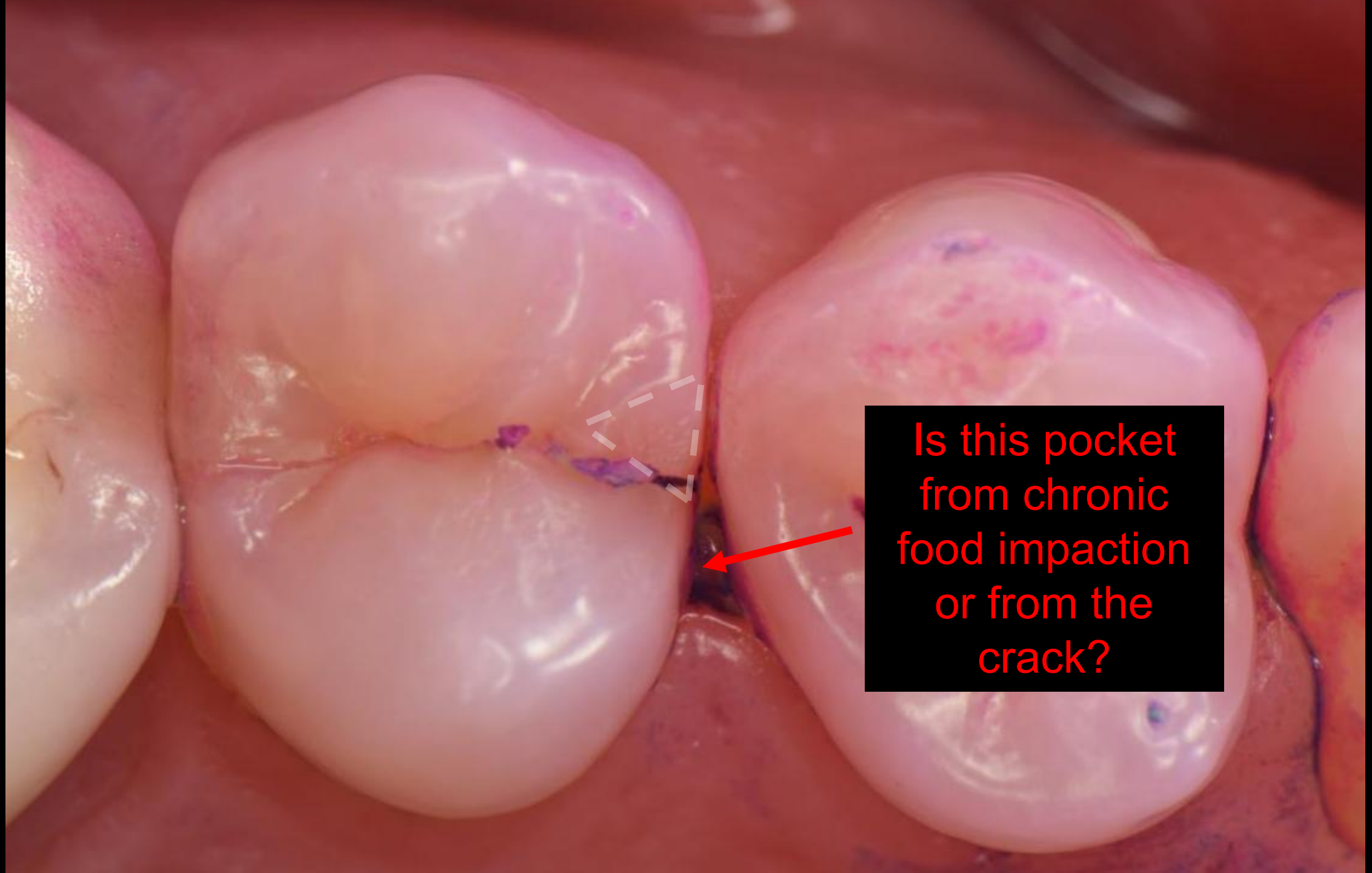


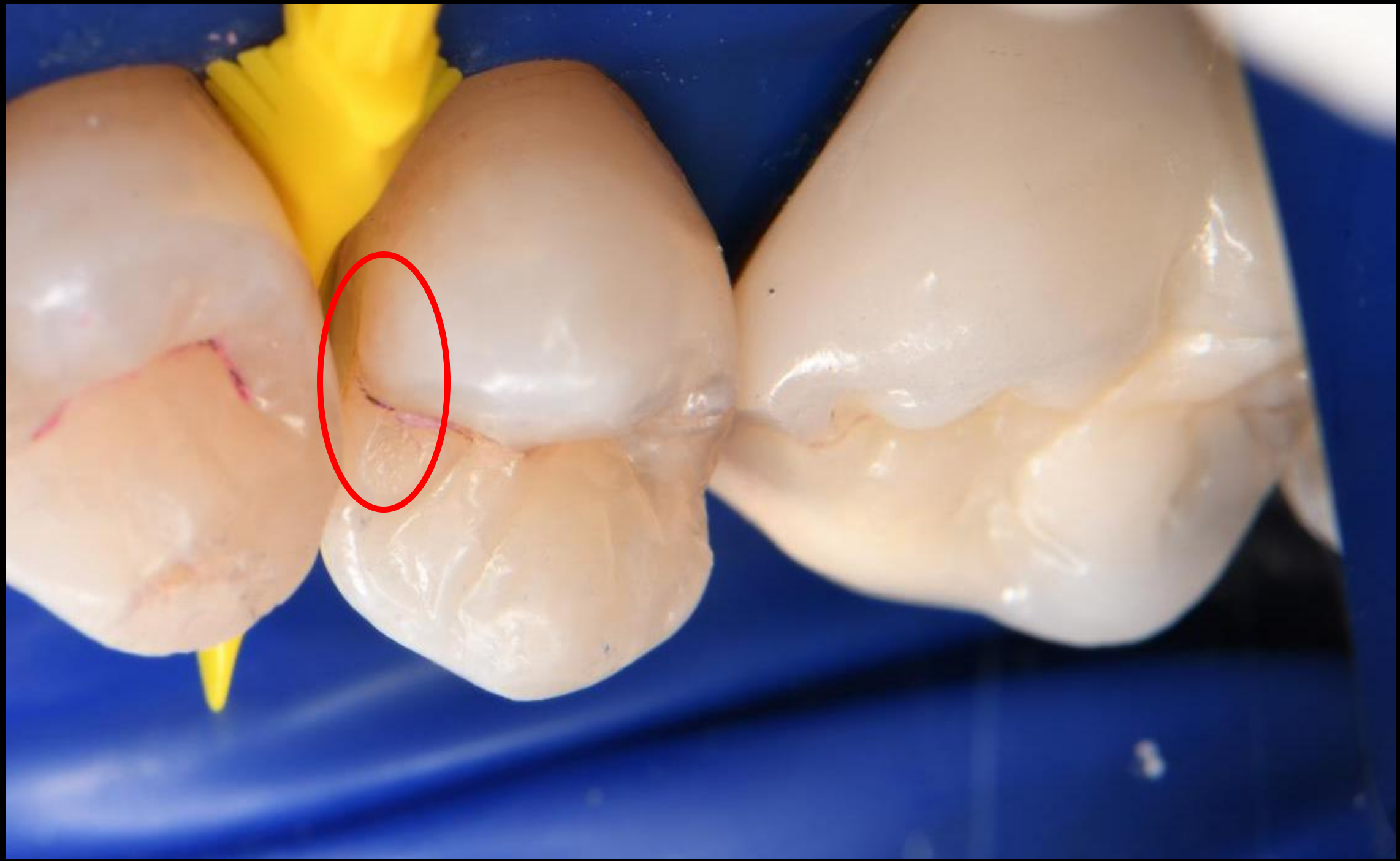


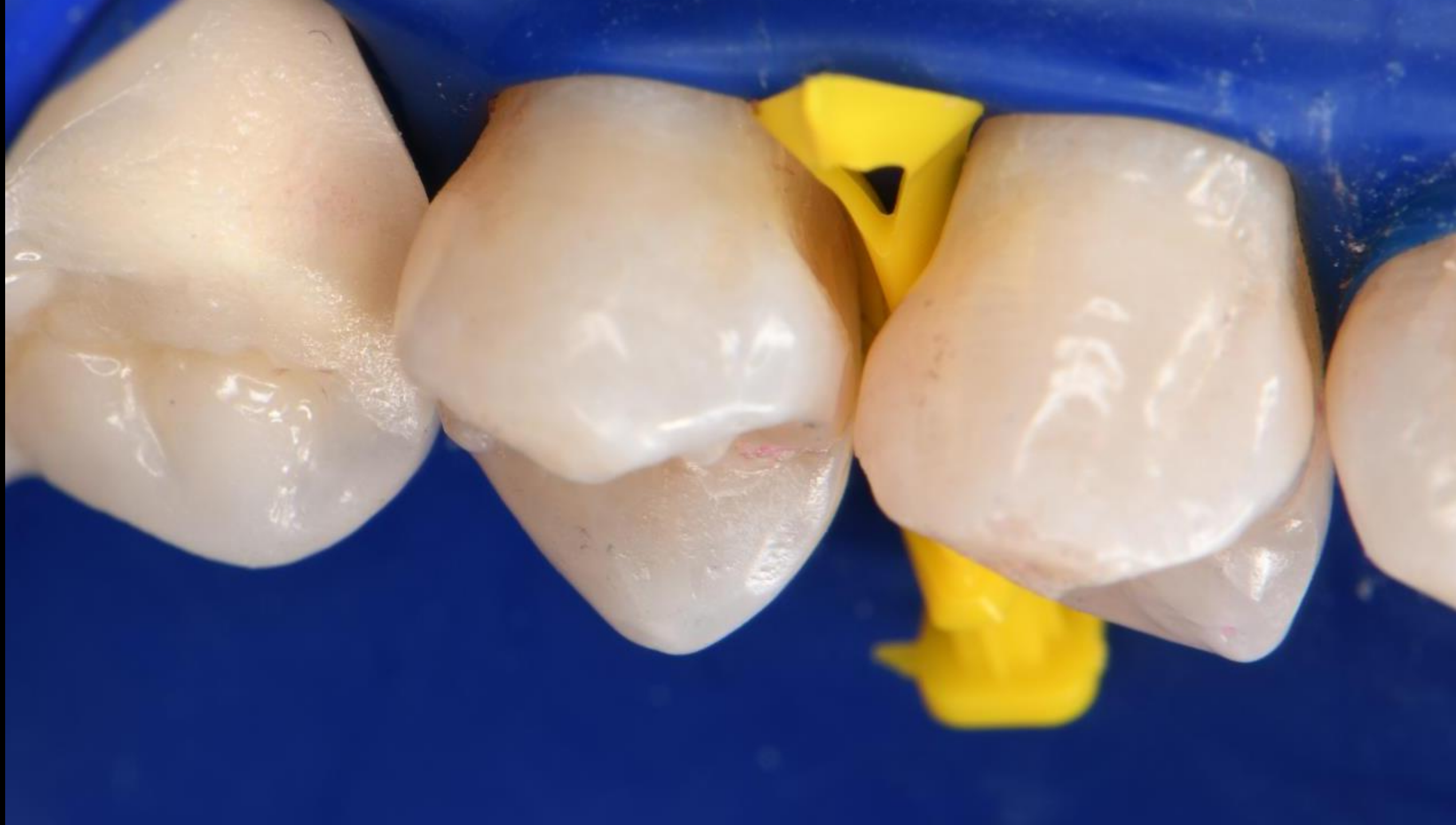


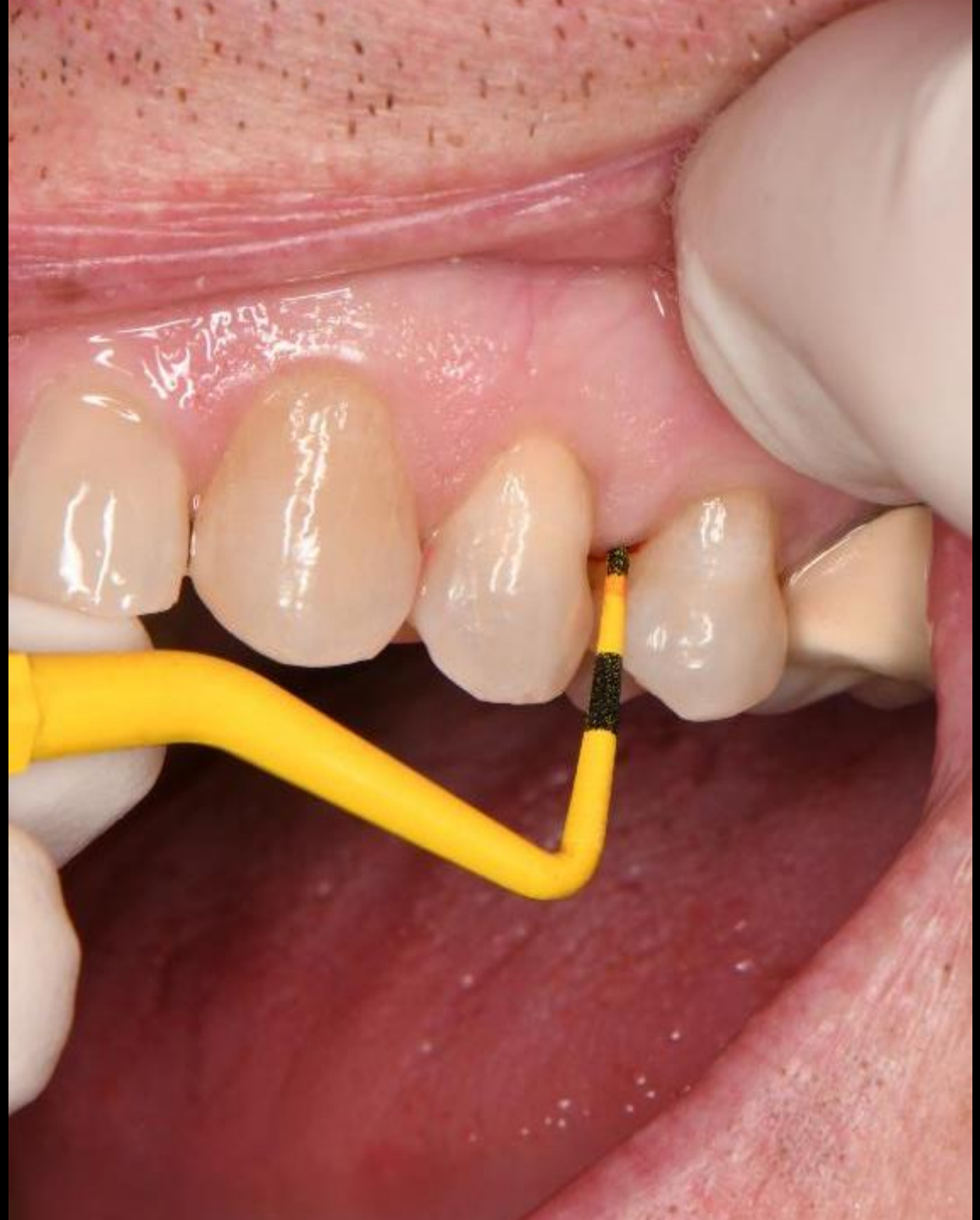


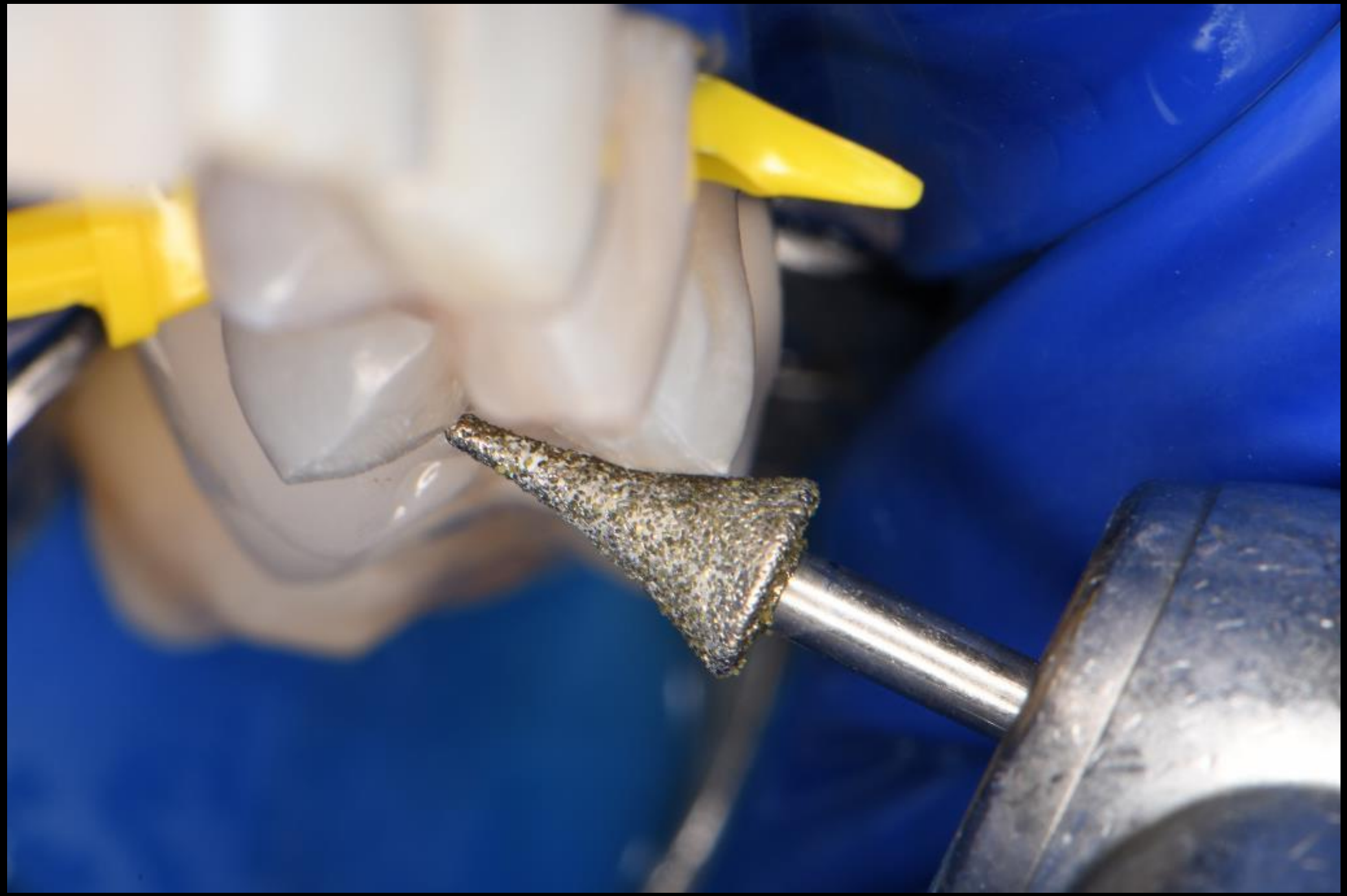

Wear facet so deep
that there is a
marginal ridge
height discrepancy

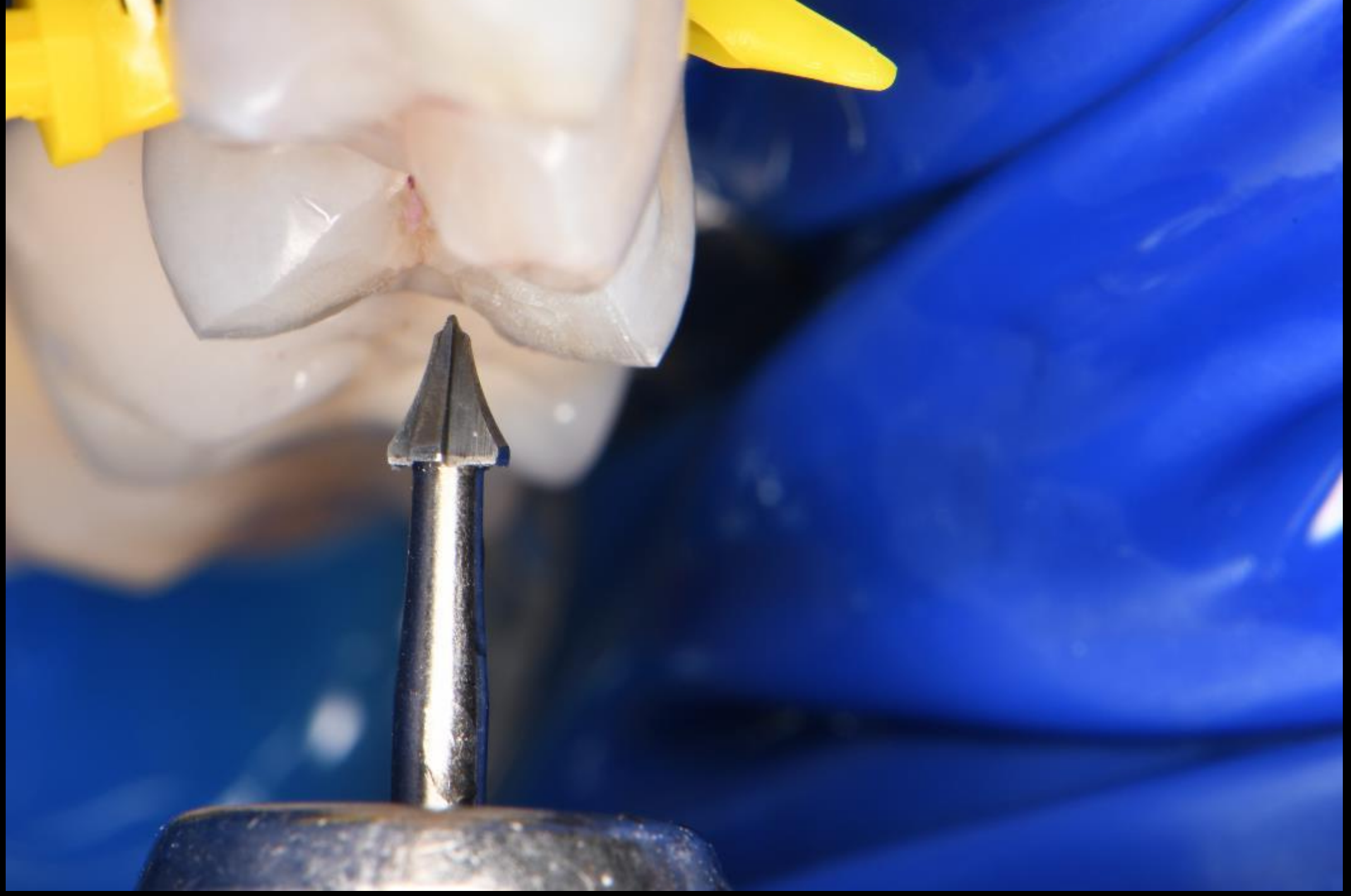

Is this pocket from chronic food impaction or from the crack?

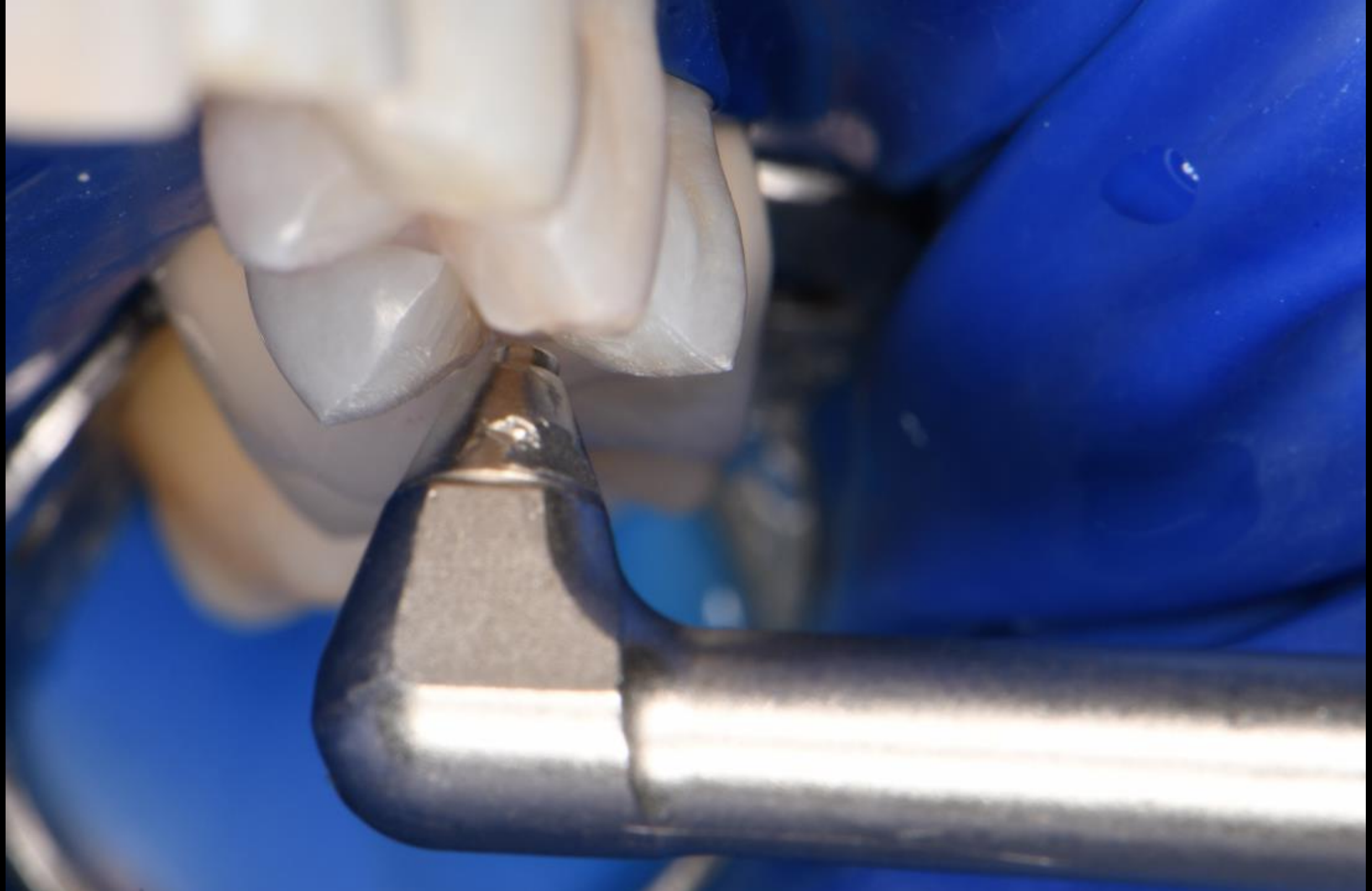


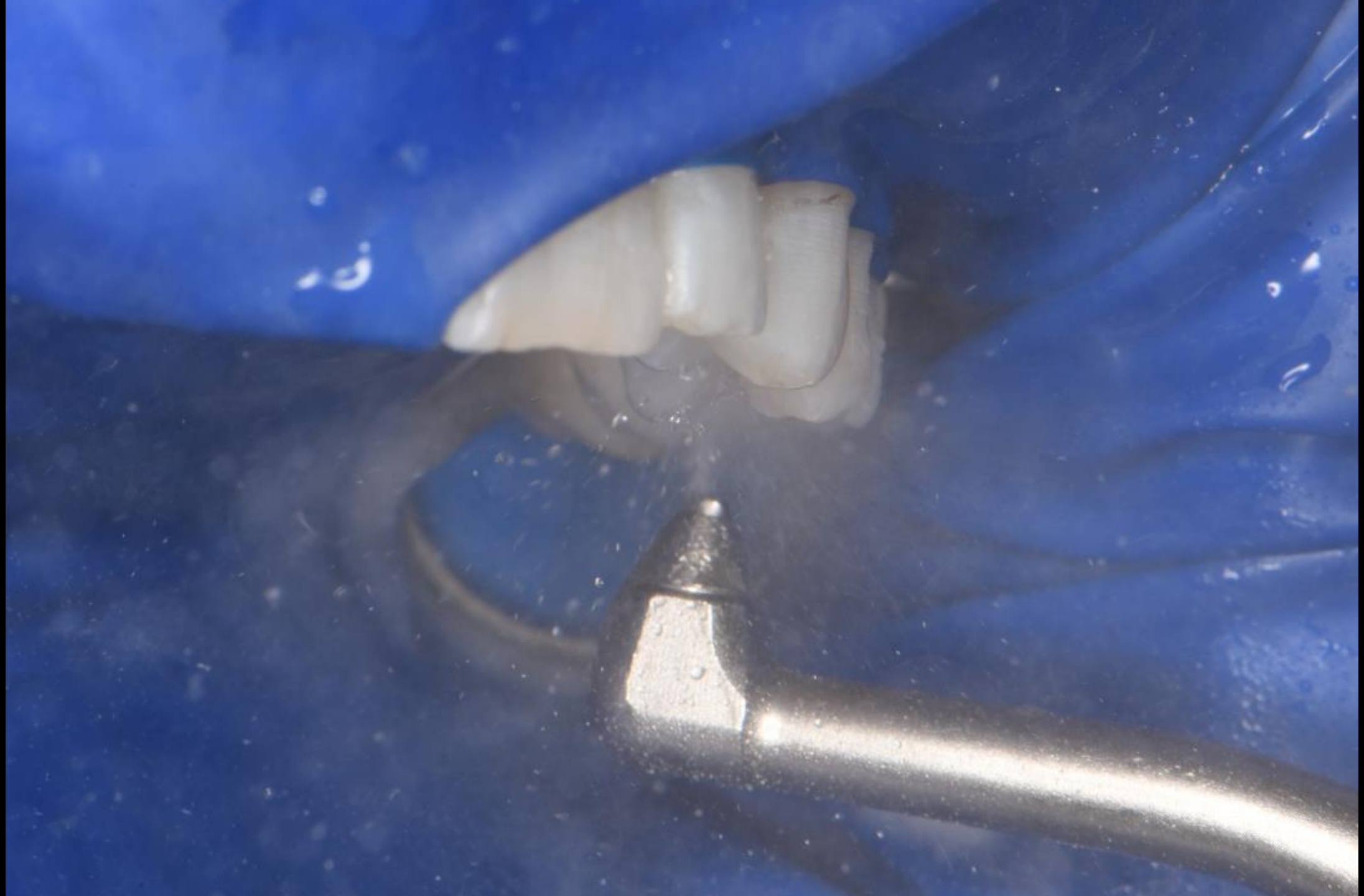


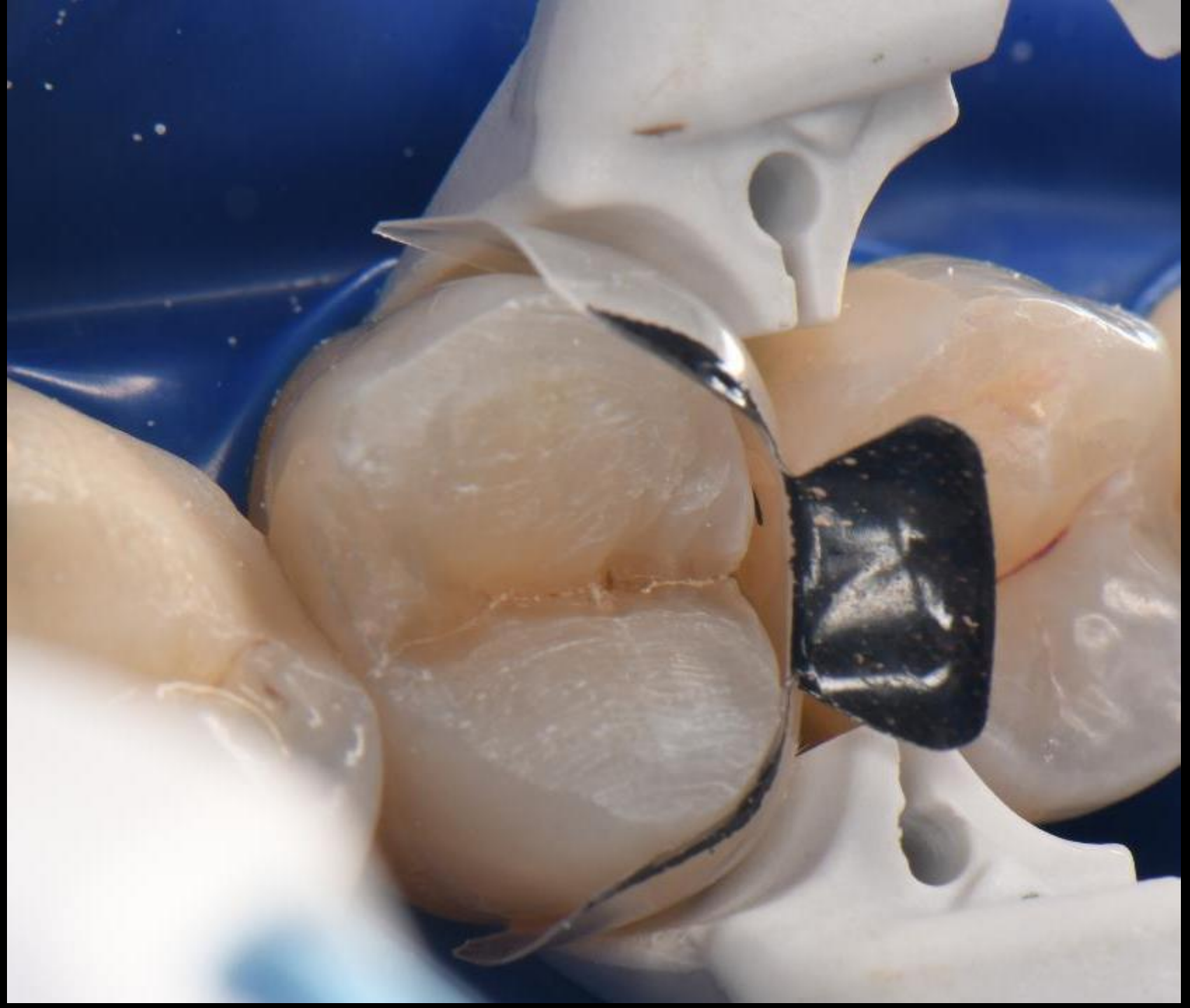


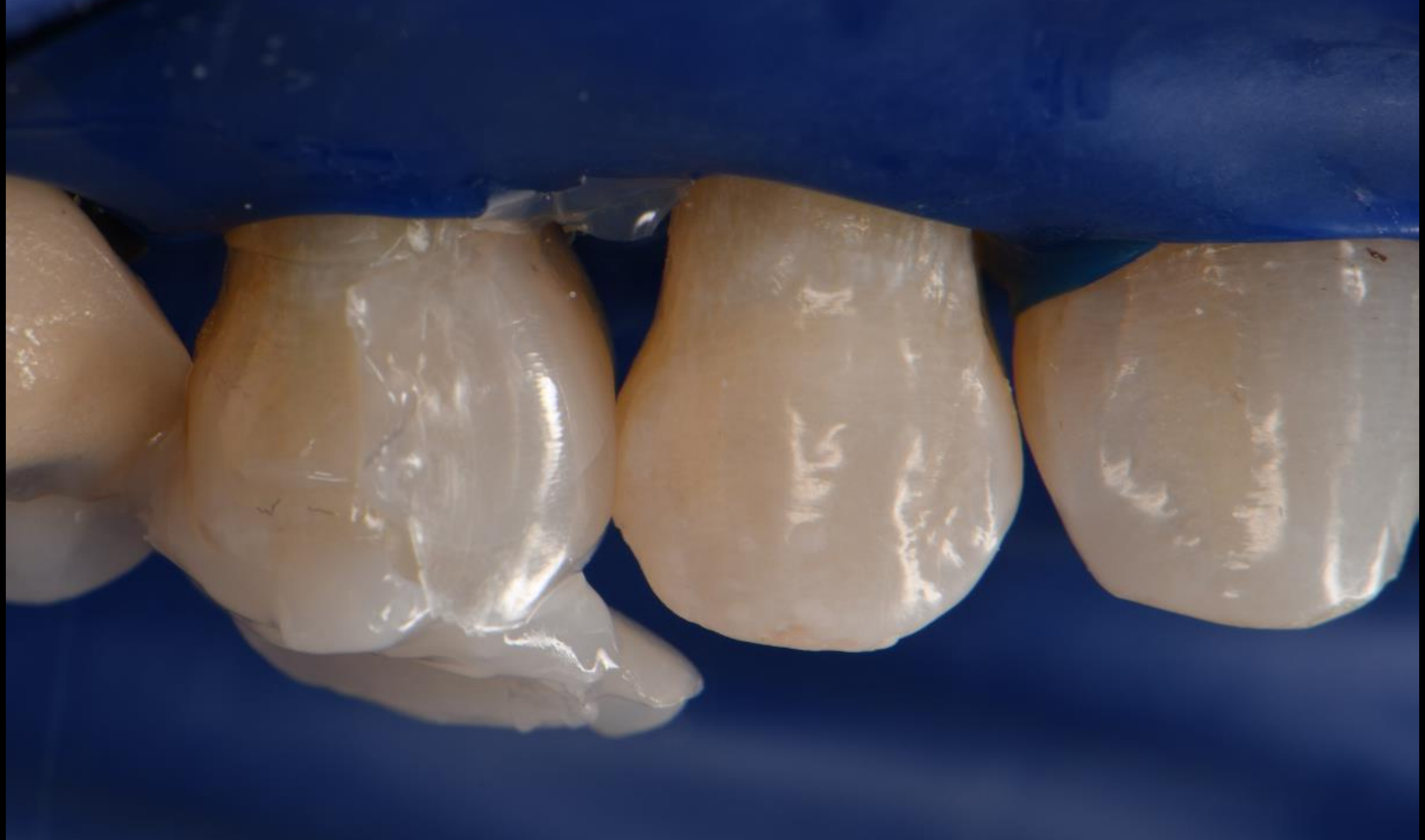


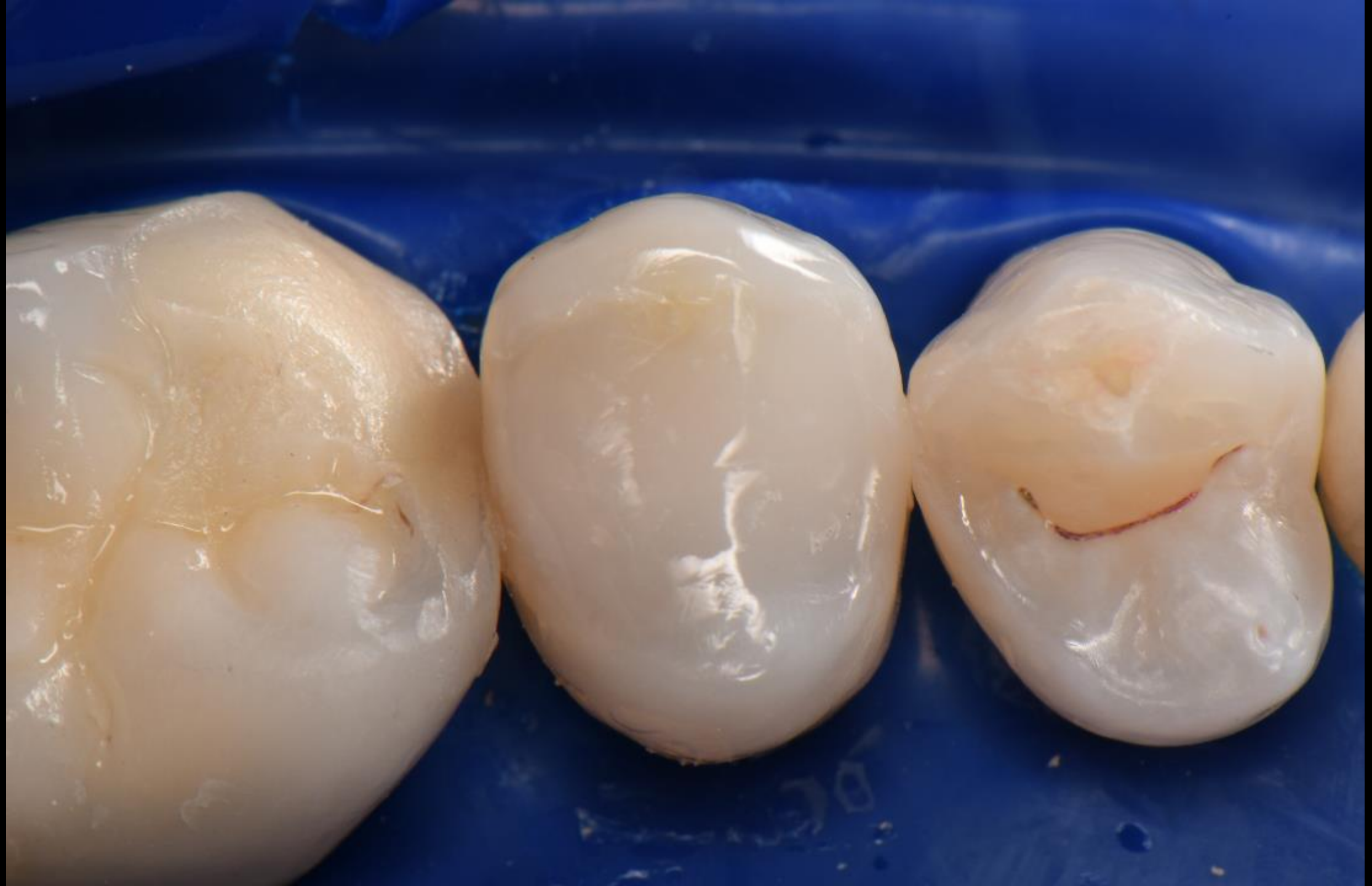


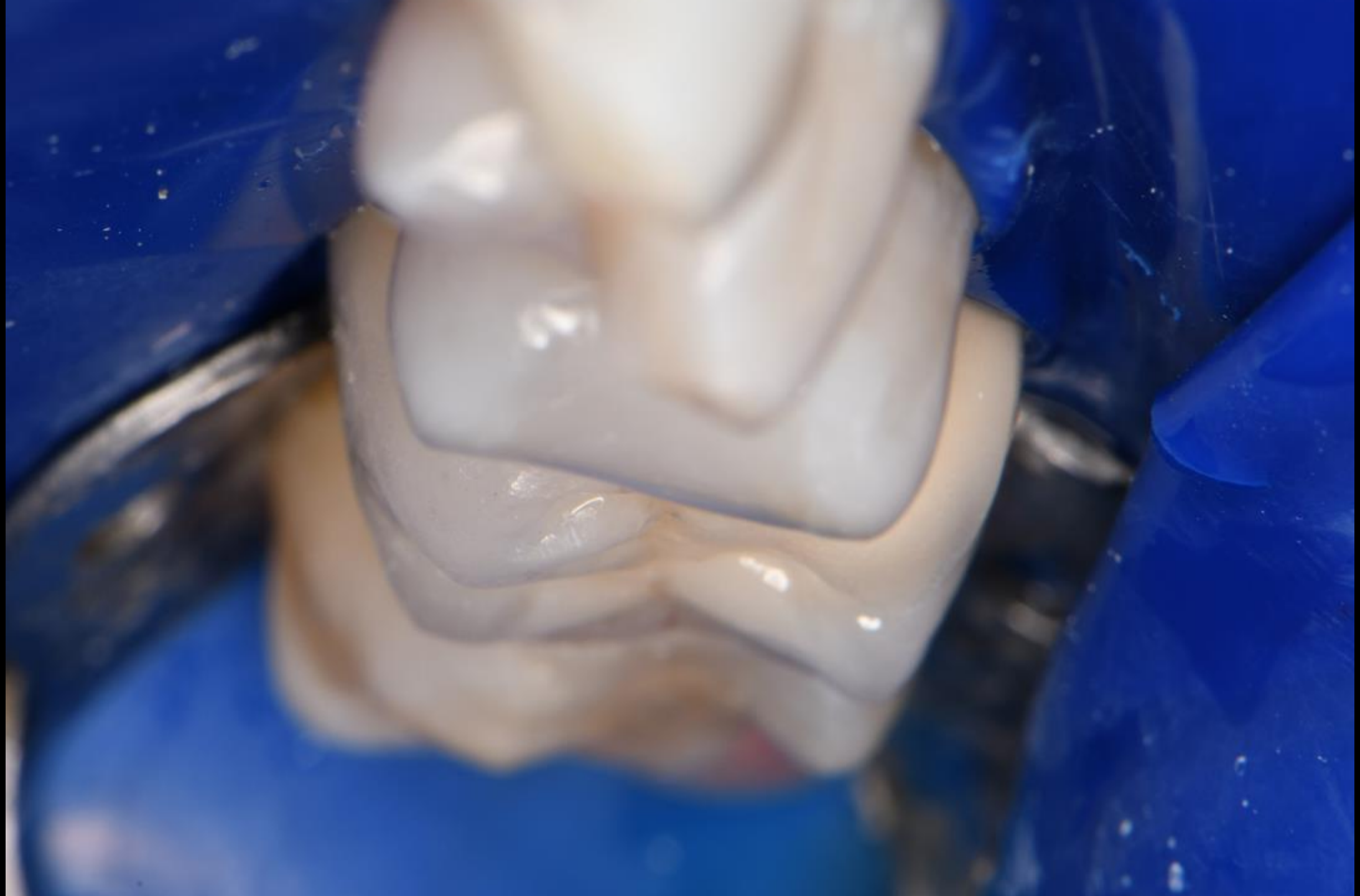


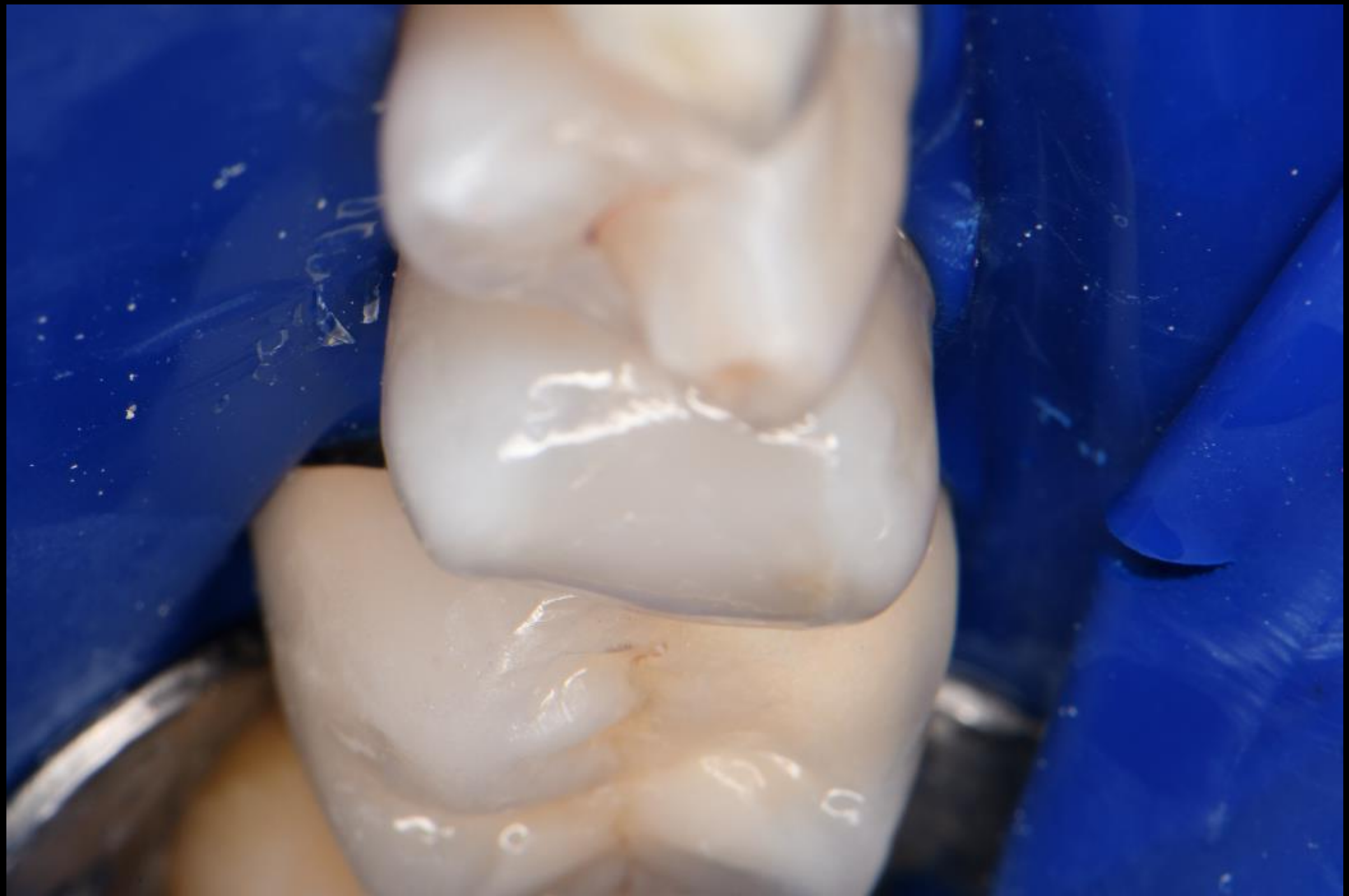


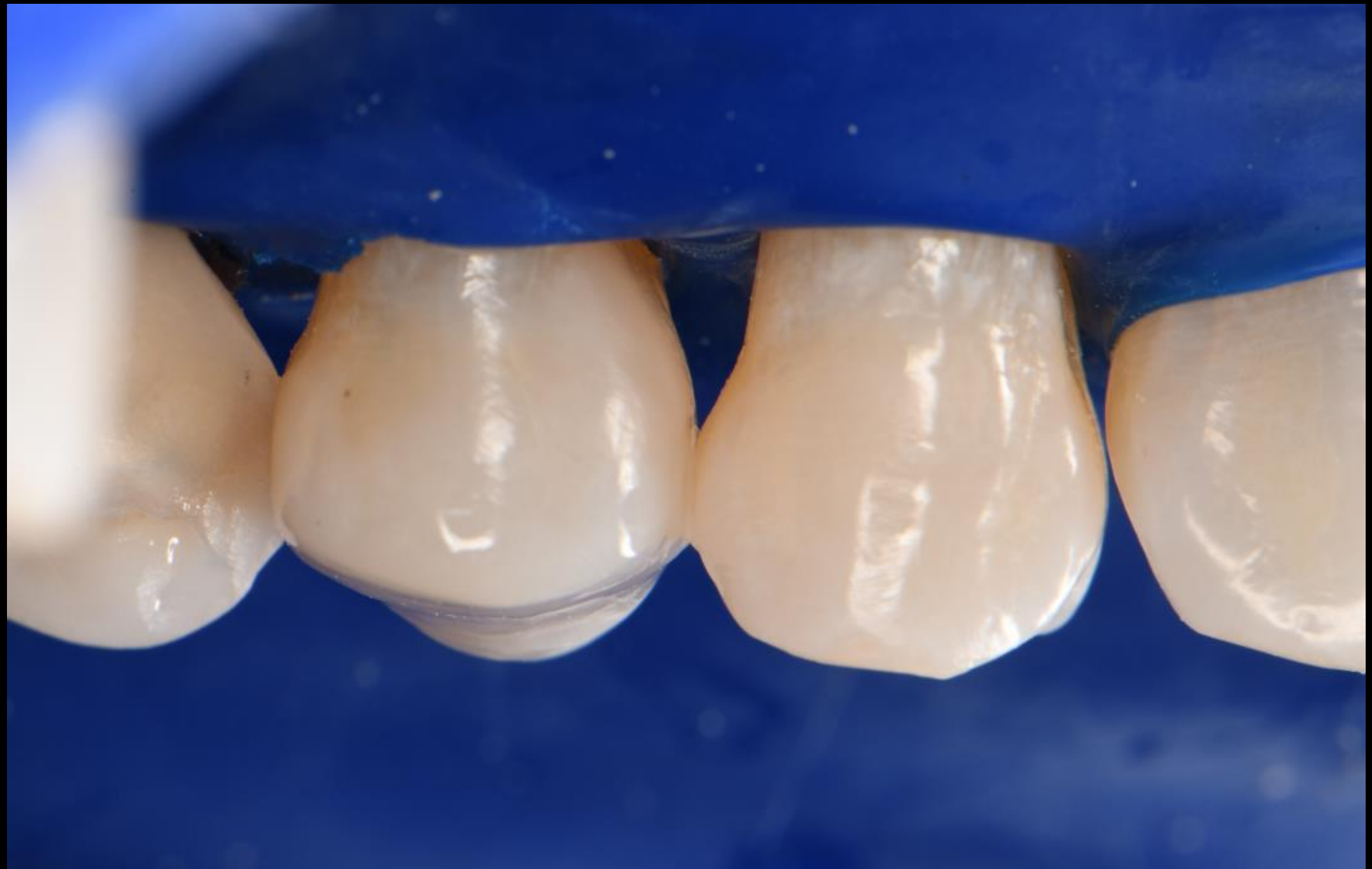


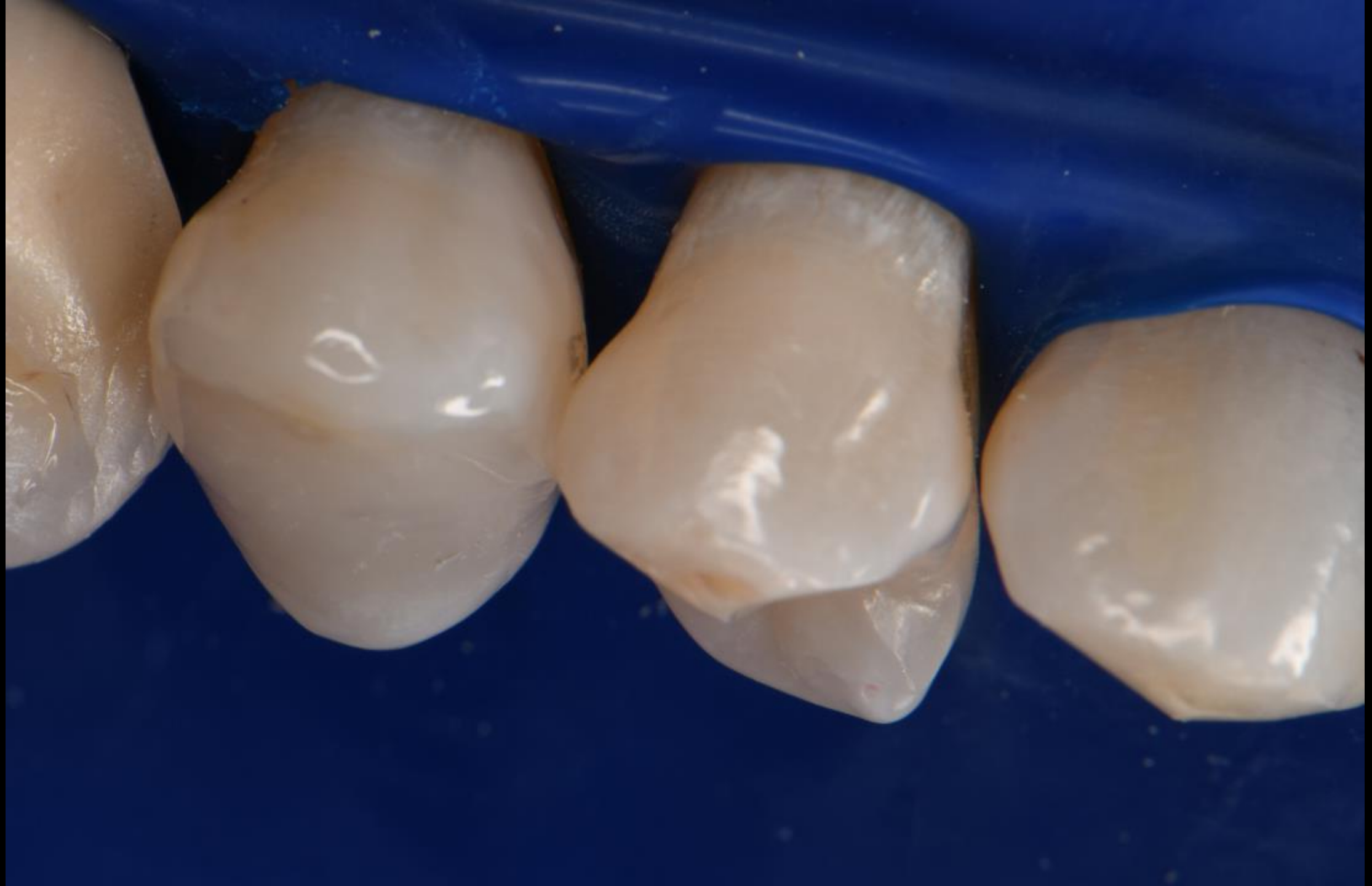


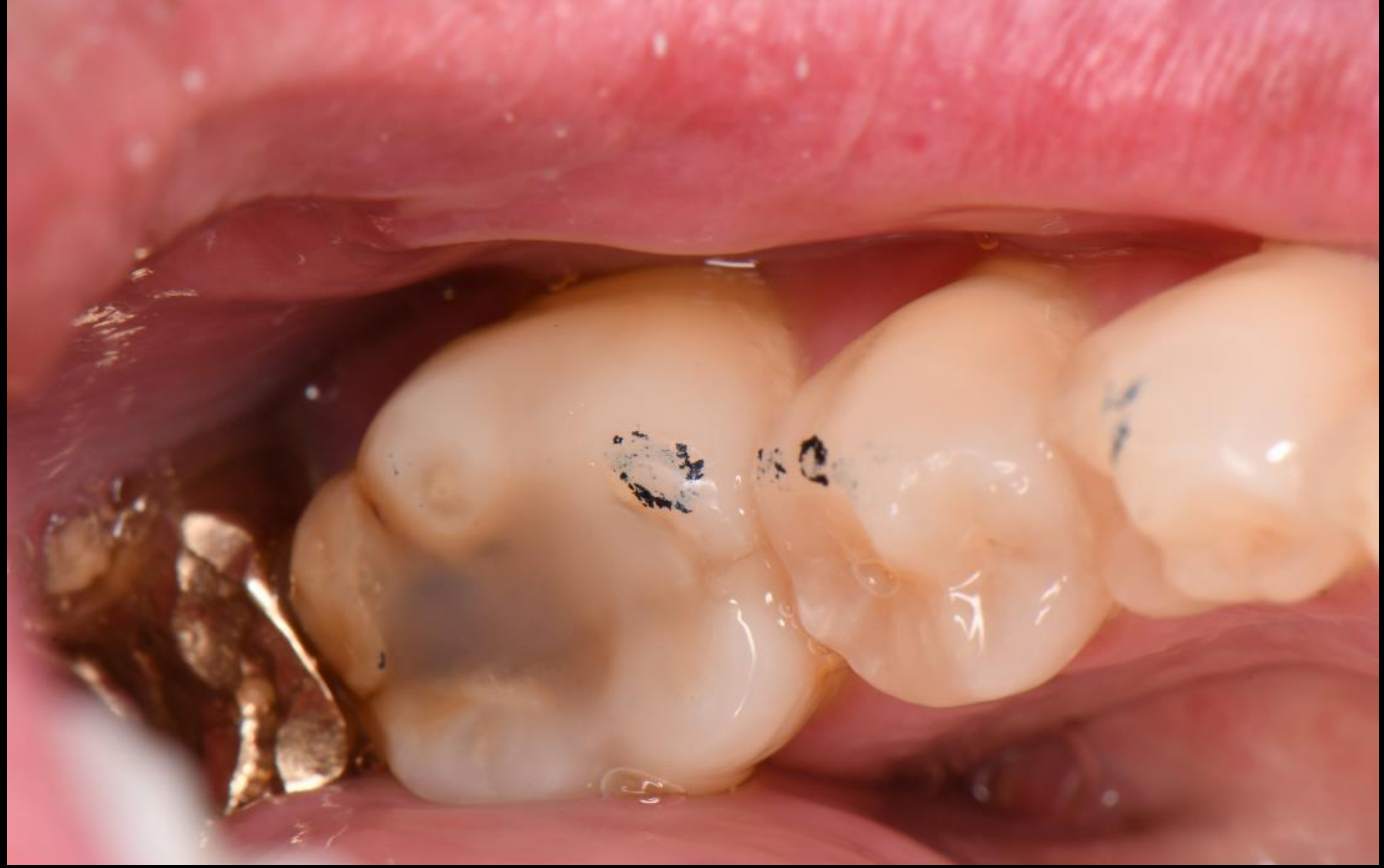






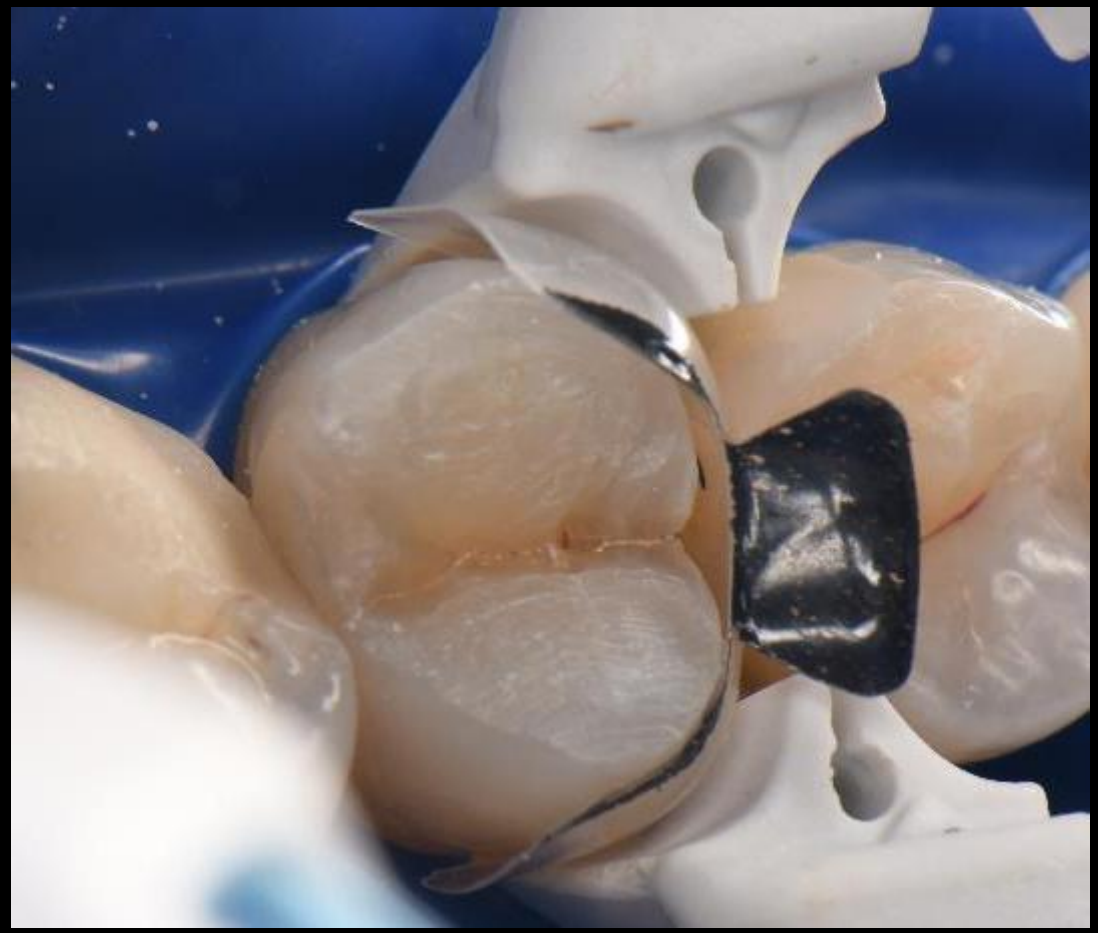




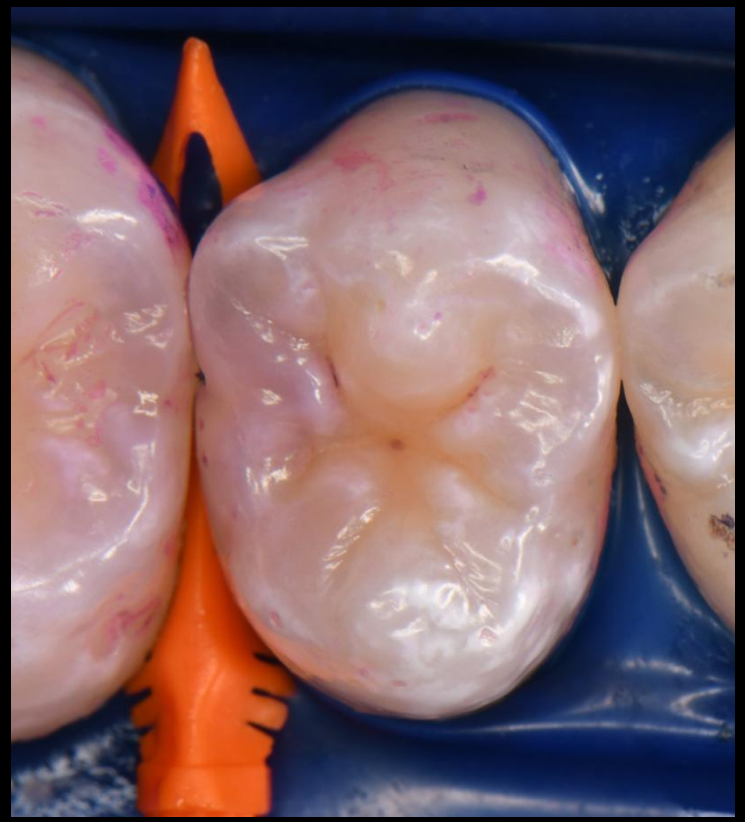


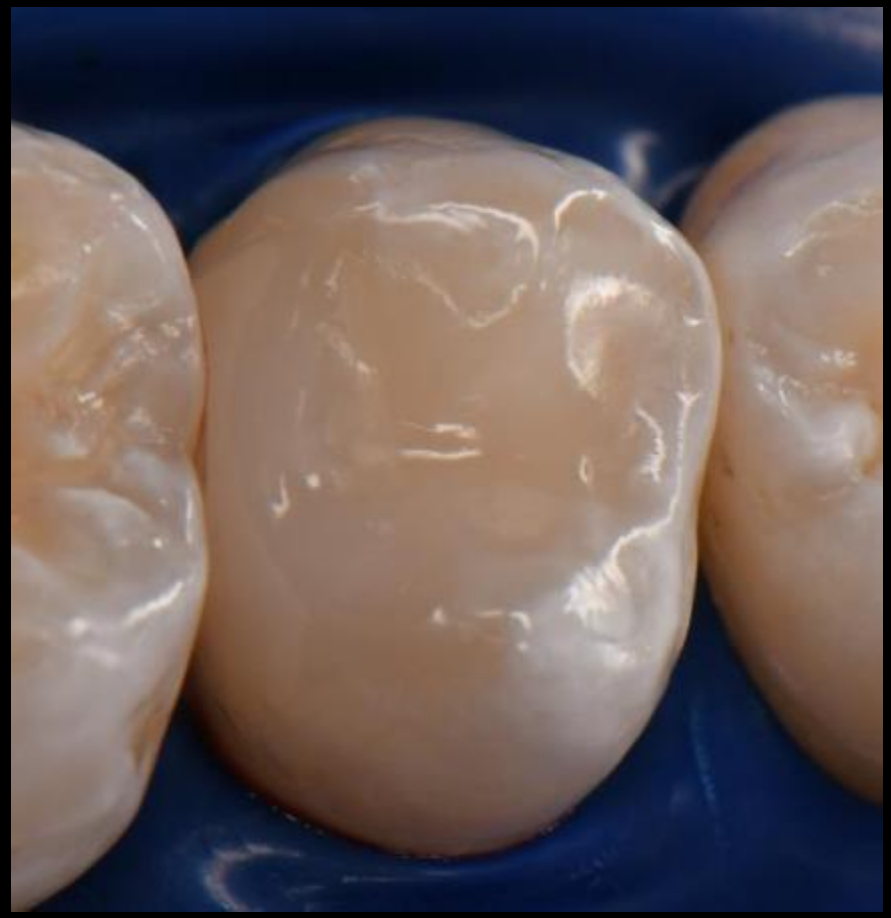
Learning Objectives from the Case:

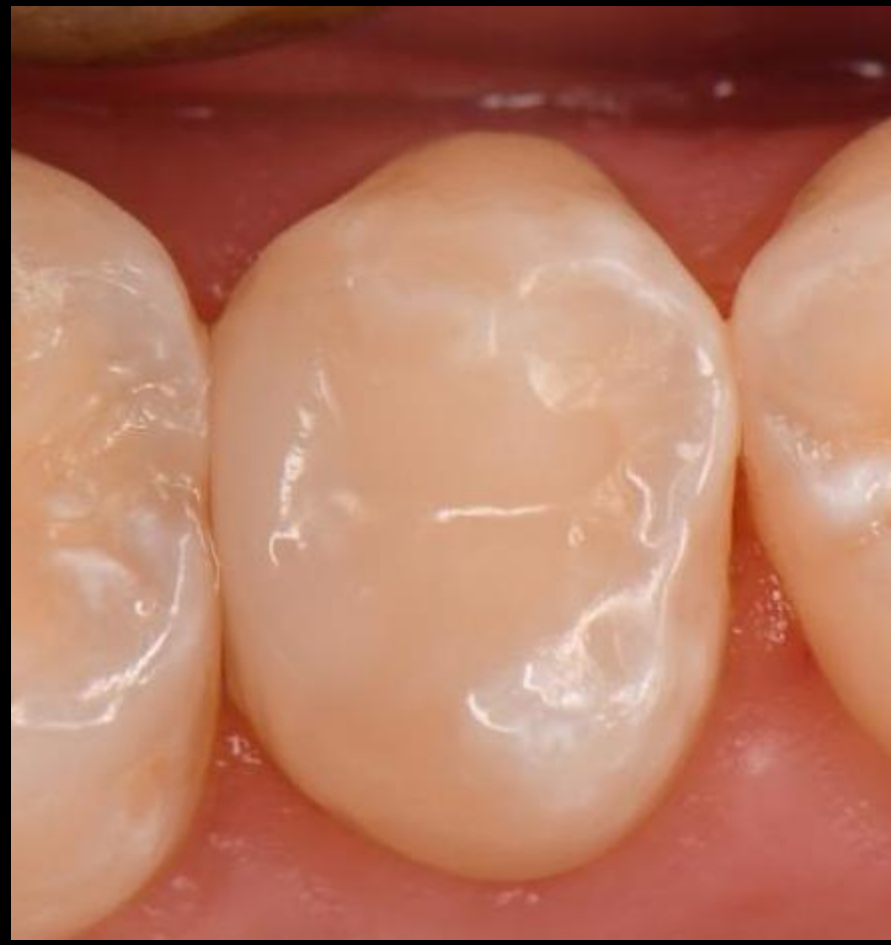
- Don’t sweep the contacts*
- 3 mm thickness over the crack
- Build a bridge from buccal to lingual
- The crack becomes dormant
- “Harmonize” the opposing w/ consent
- If food impaction continues, so will pain and pocketing
- Contact technique works for other problems**
- We need a powerful separator



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







Are all Separators Equal?

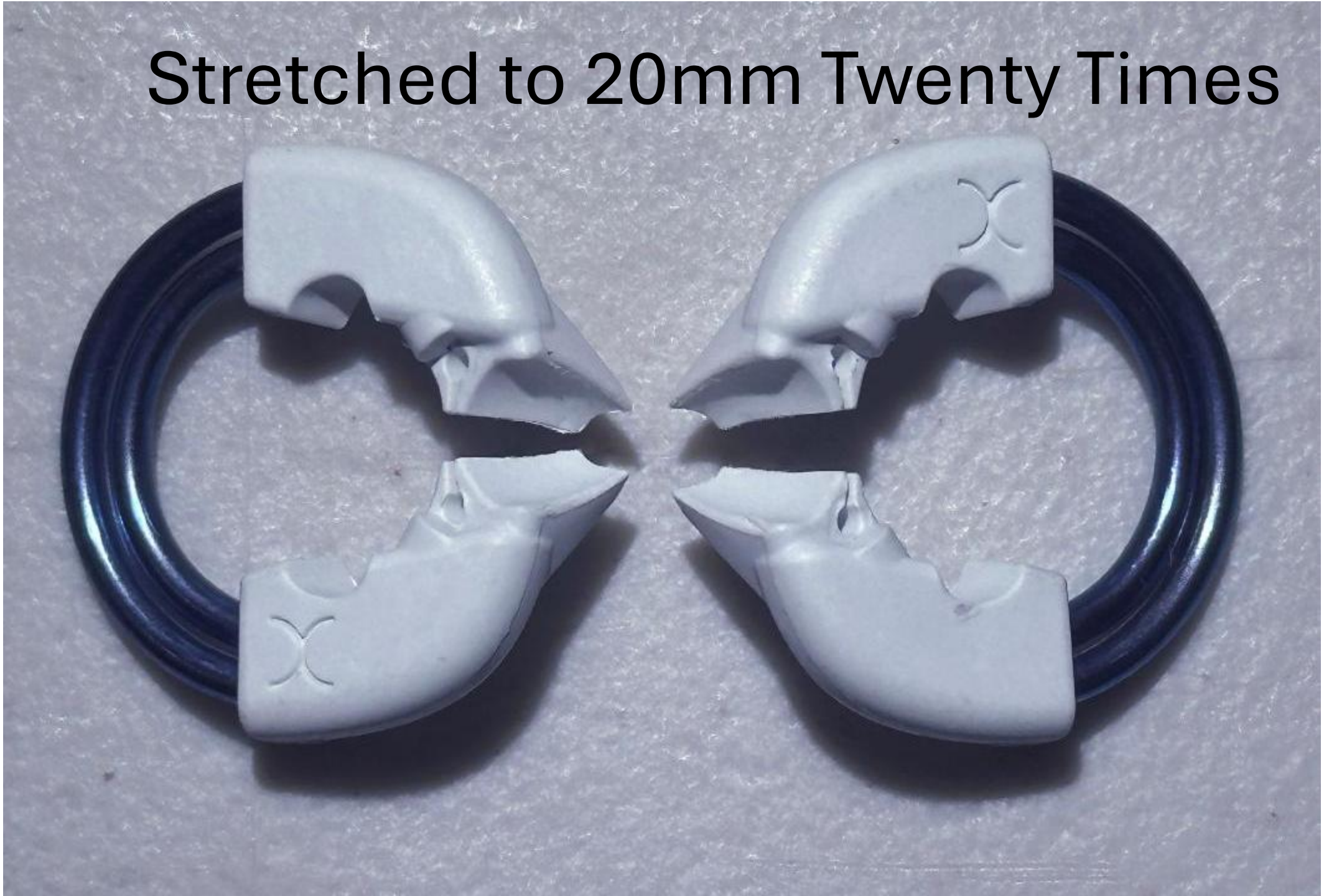
NO!

Stretched to 20mm ONCE!!!

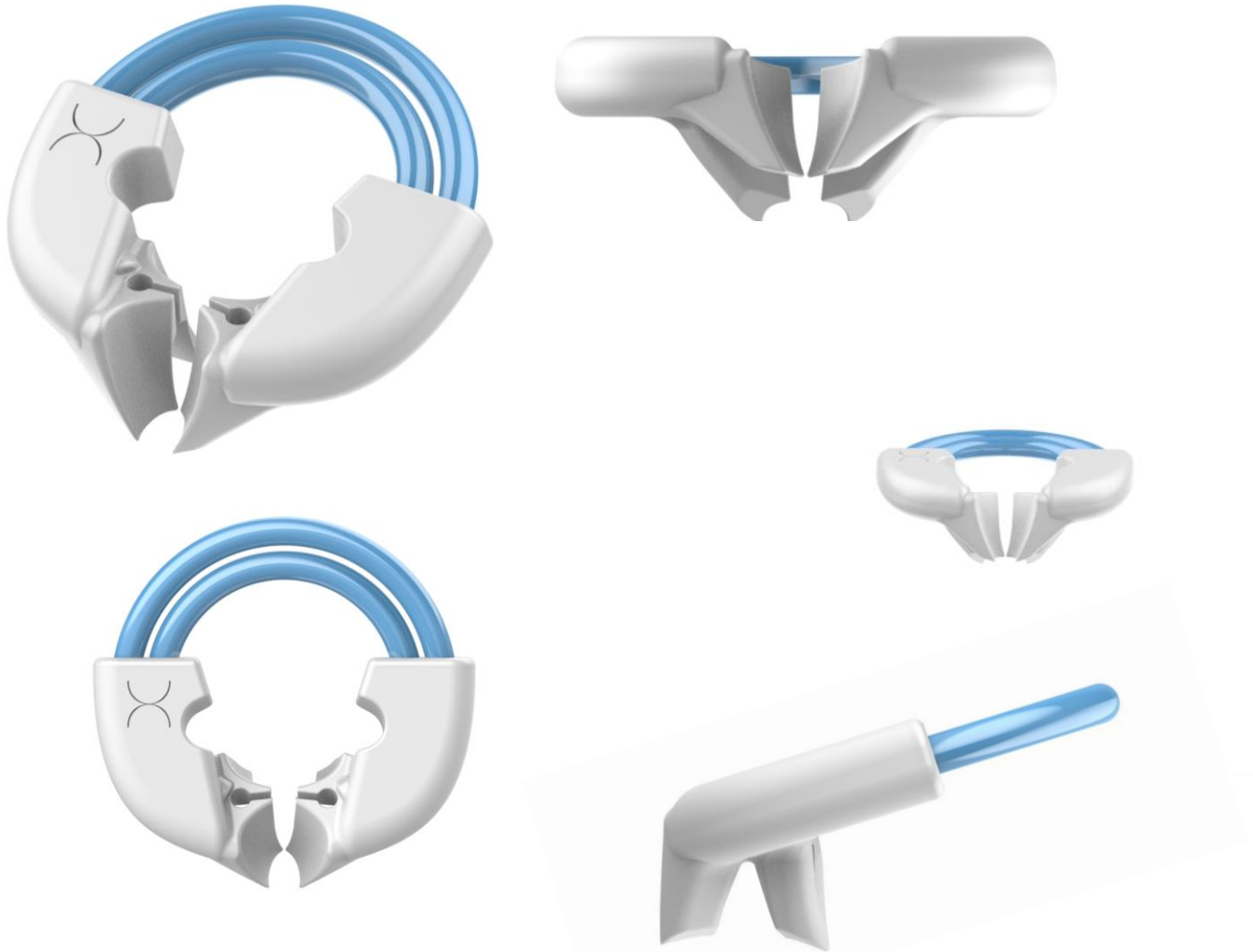
And now most of the power is permanently lost

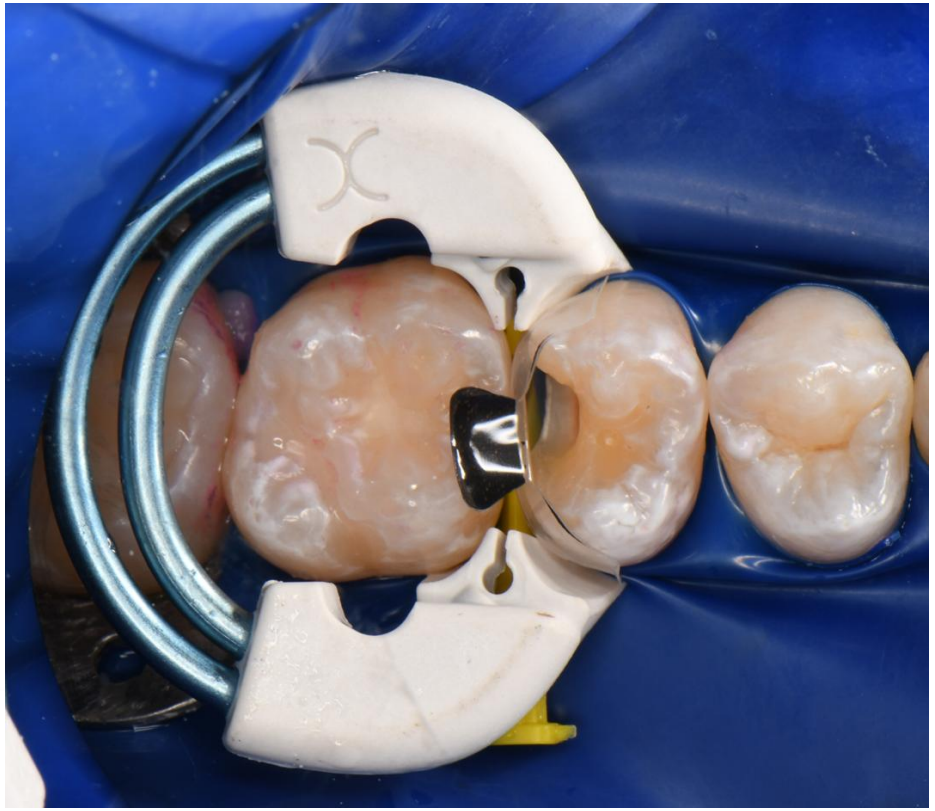
Once the yield of the metal/shape is reached, the metal undergoes plastic deformation

Stretched to 20mm Twenty Times


Stretched to 20mm Twenty Times

TwinRing Universal





TwinRing Universal

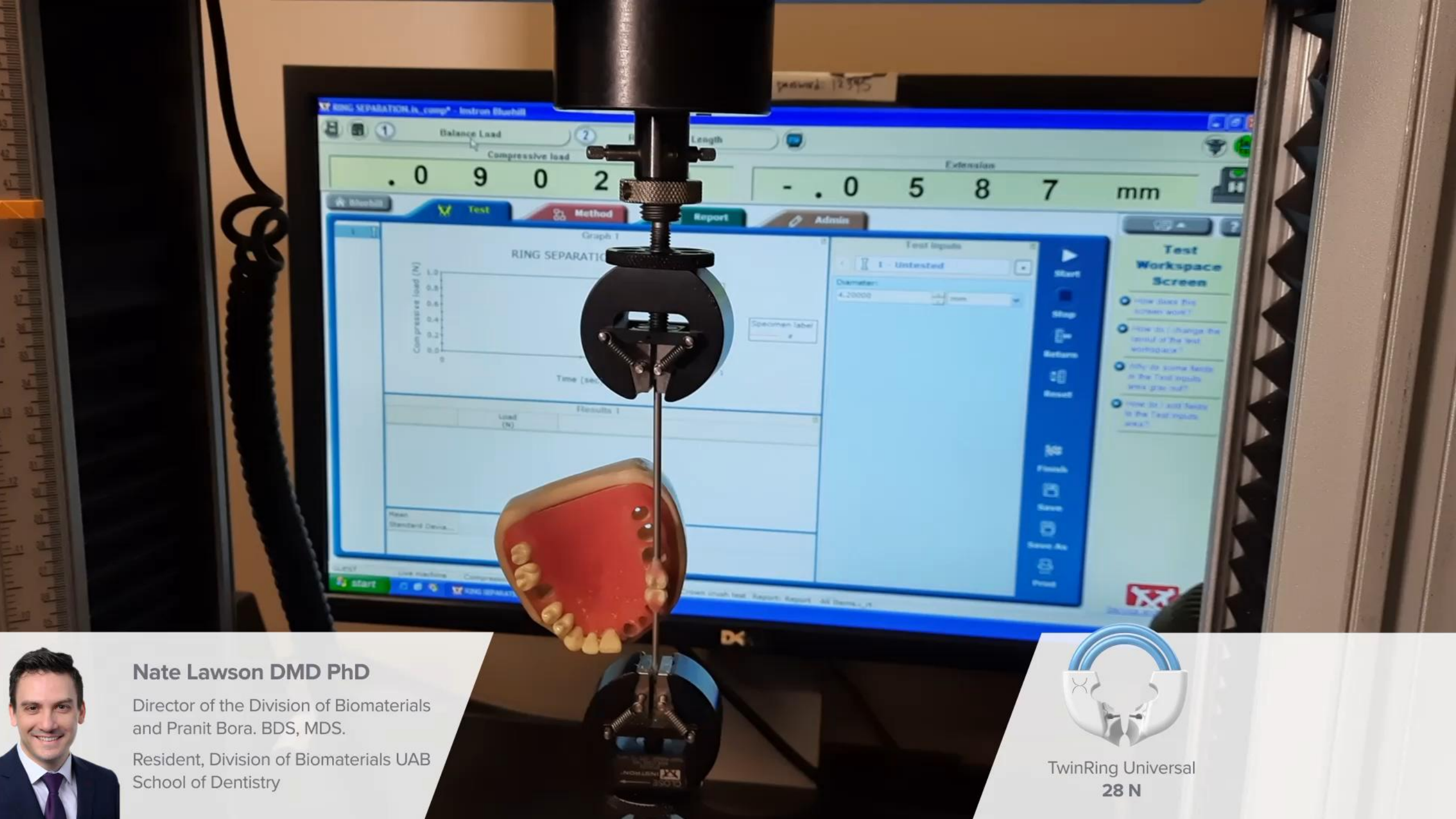
How do we win the ***Snug Contact Game?***

- Power
- Strategy
- Technique

TwinRing Universal

How do we win the *Snug Contact Game?*

- Power
- Strategy
- Technique



Nate Lawson DMD PhD

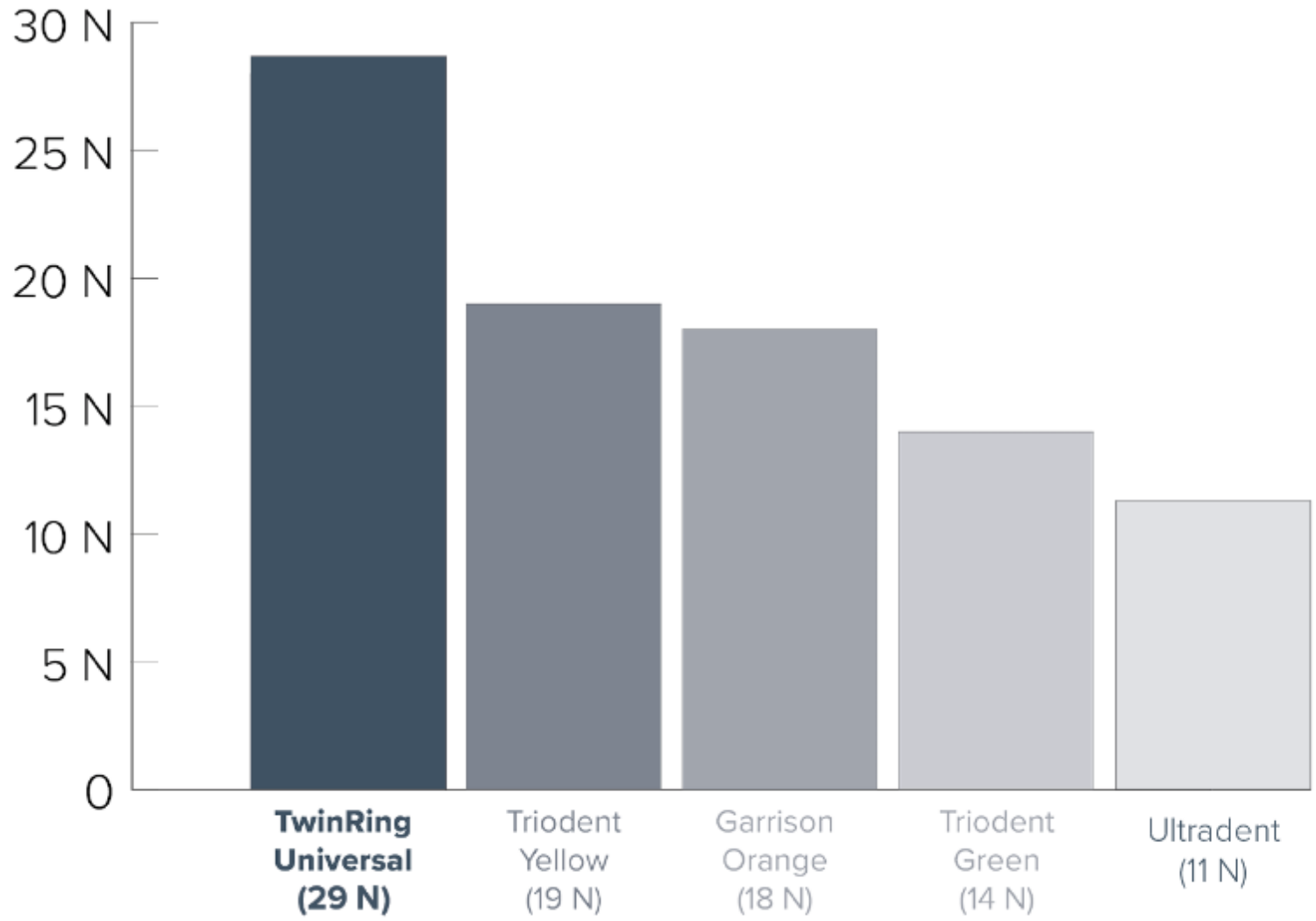
Director of the Division of Biomaterials and Pranit Bora. BDS, MDS.

Resident, Division of Biomaterials UAB School of Dentistry

TwinRing Universal
28 N

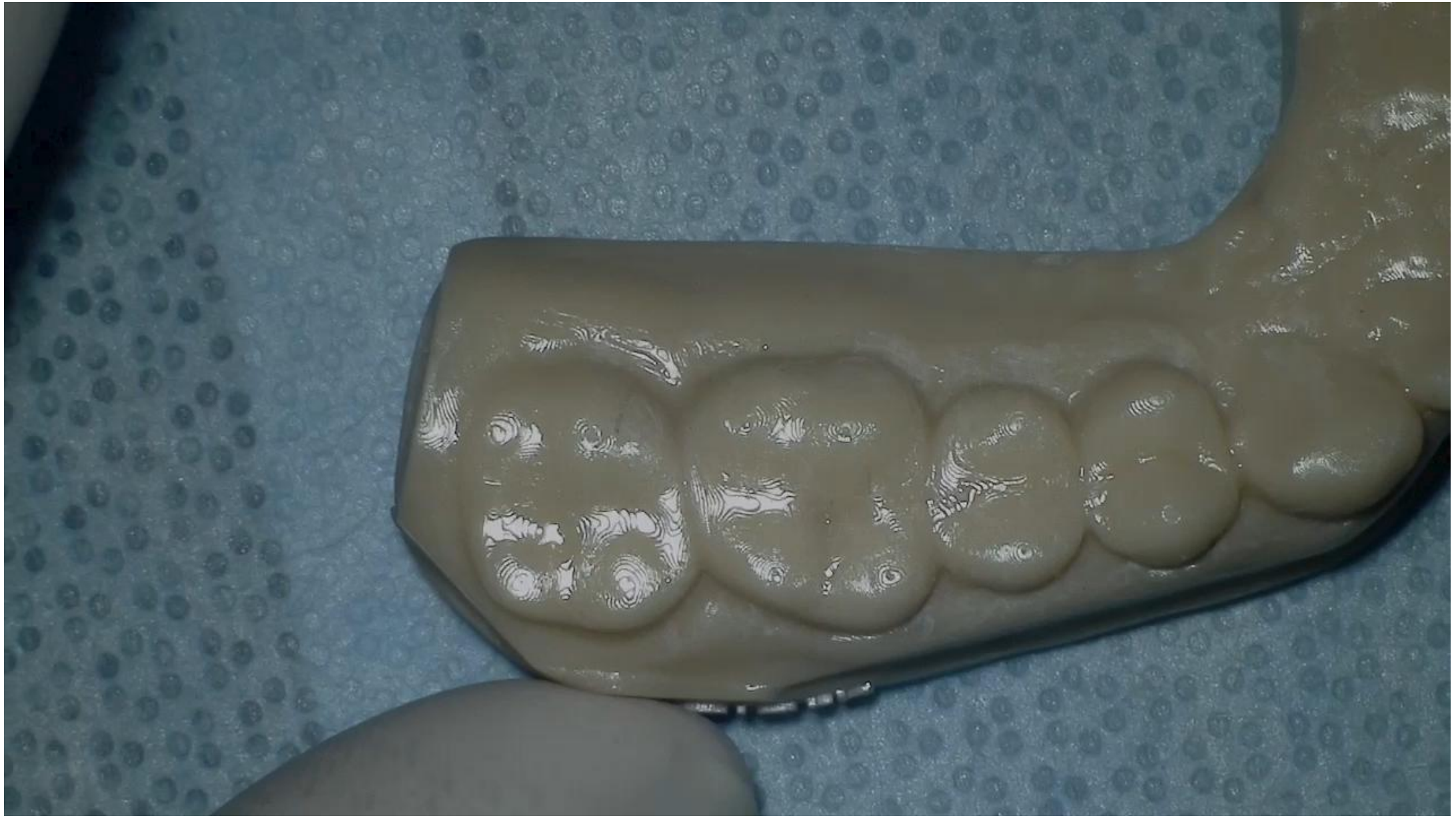
TwinRing Universal Instron Comparison

BIOCLEAR



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

BIOCLEAR

EVOLVE MATRIX

BIOCLEAR

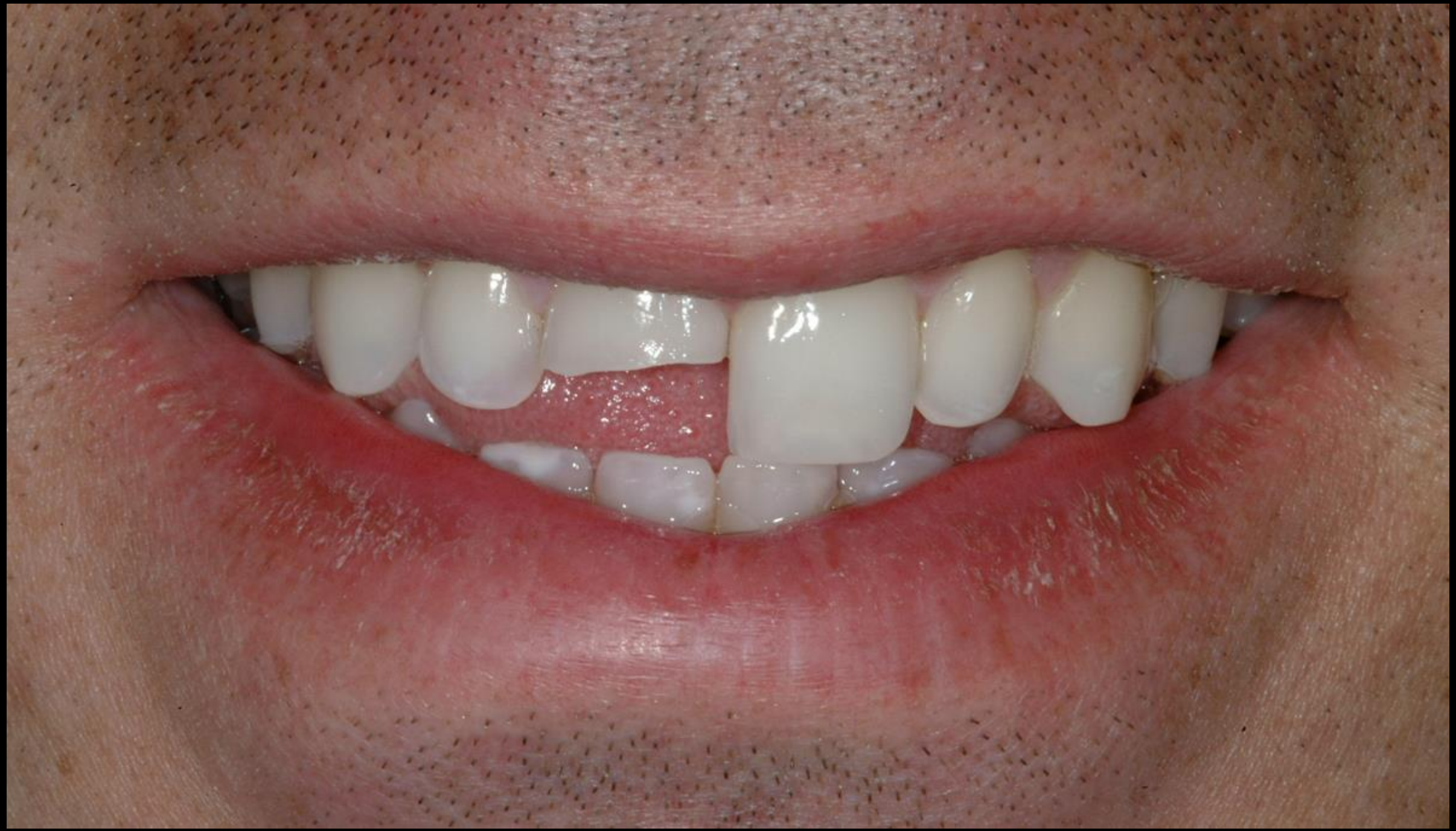
Premolar

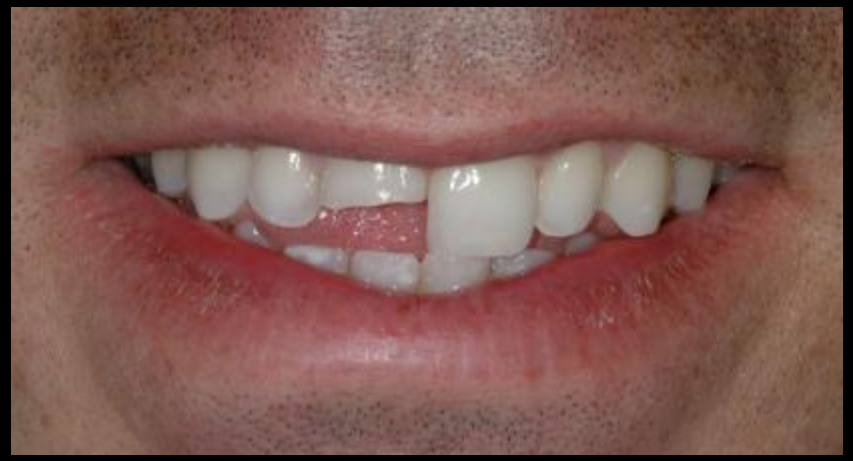
Molar

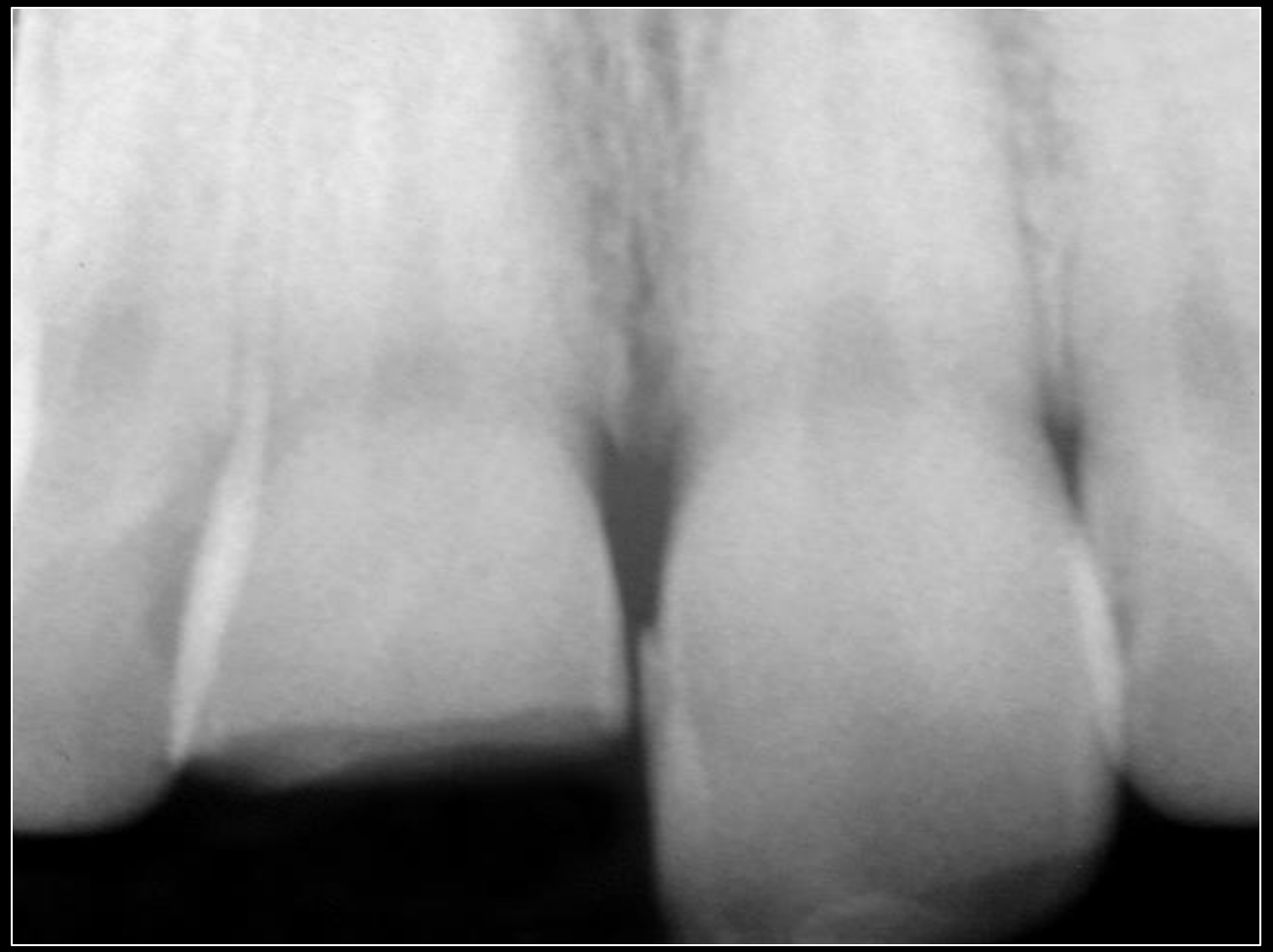
EVOLVE MATRIX

In this case based lecture today we explore:

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

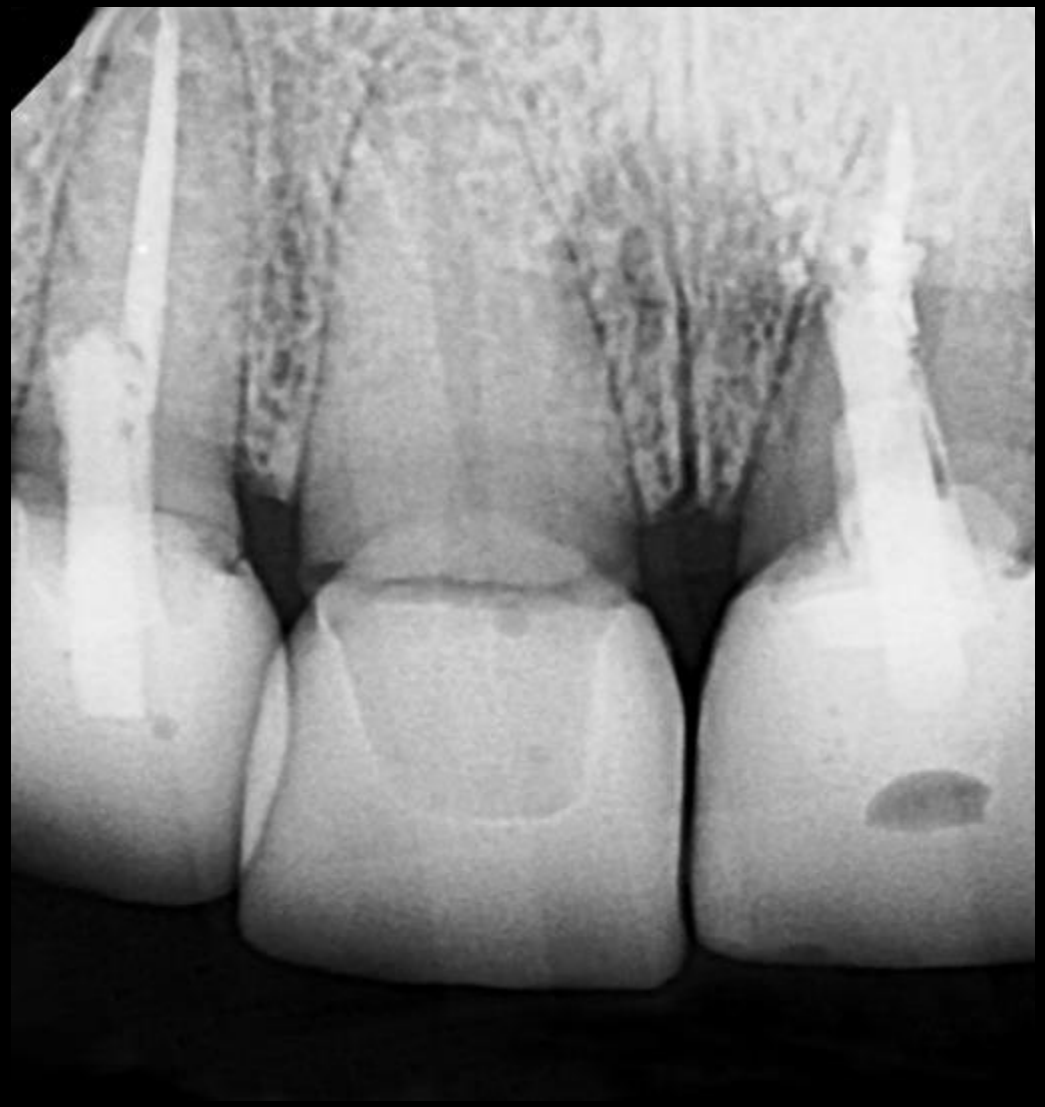


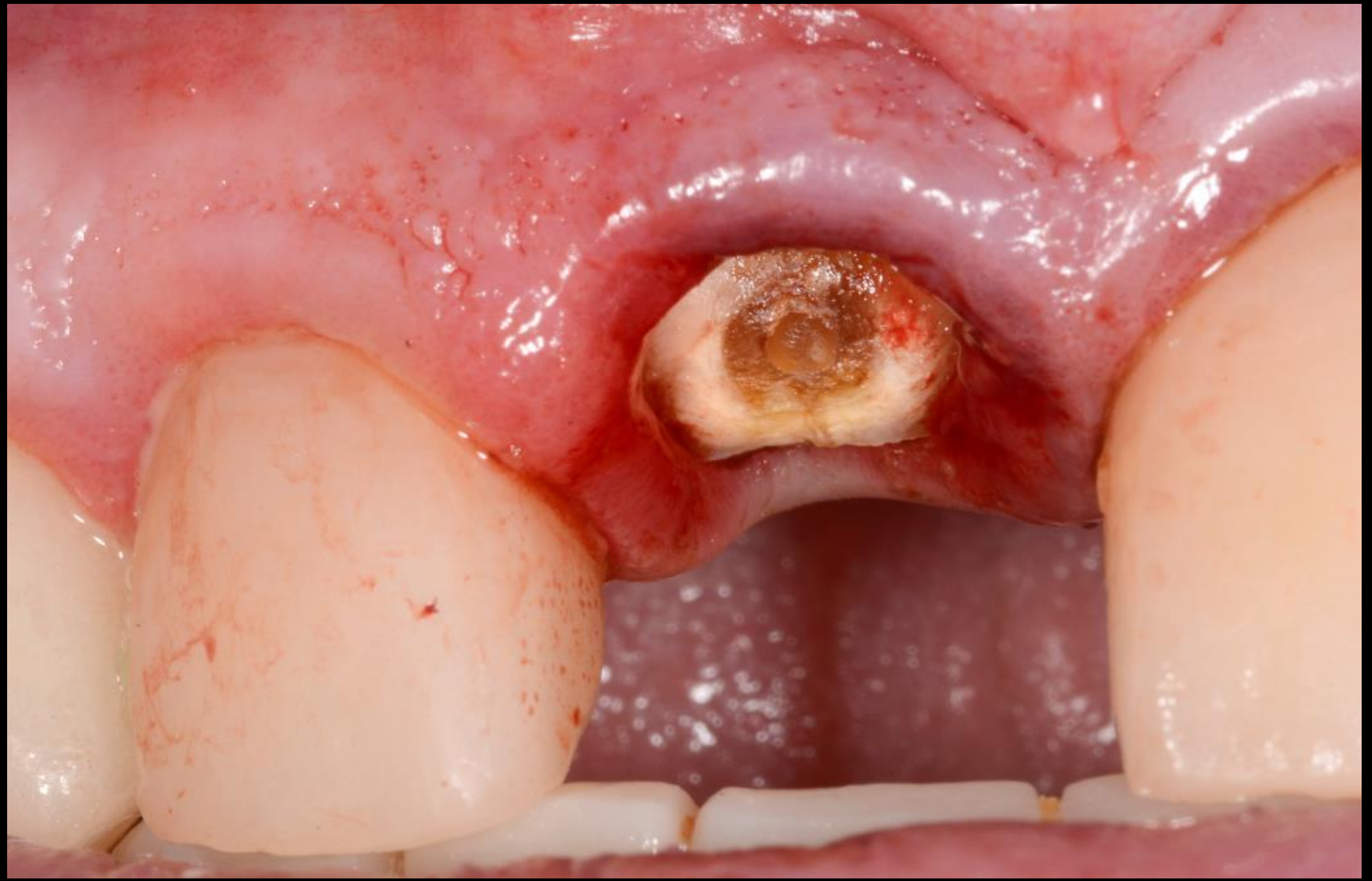


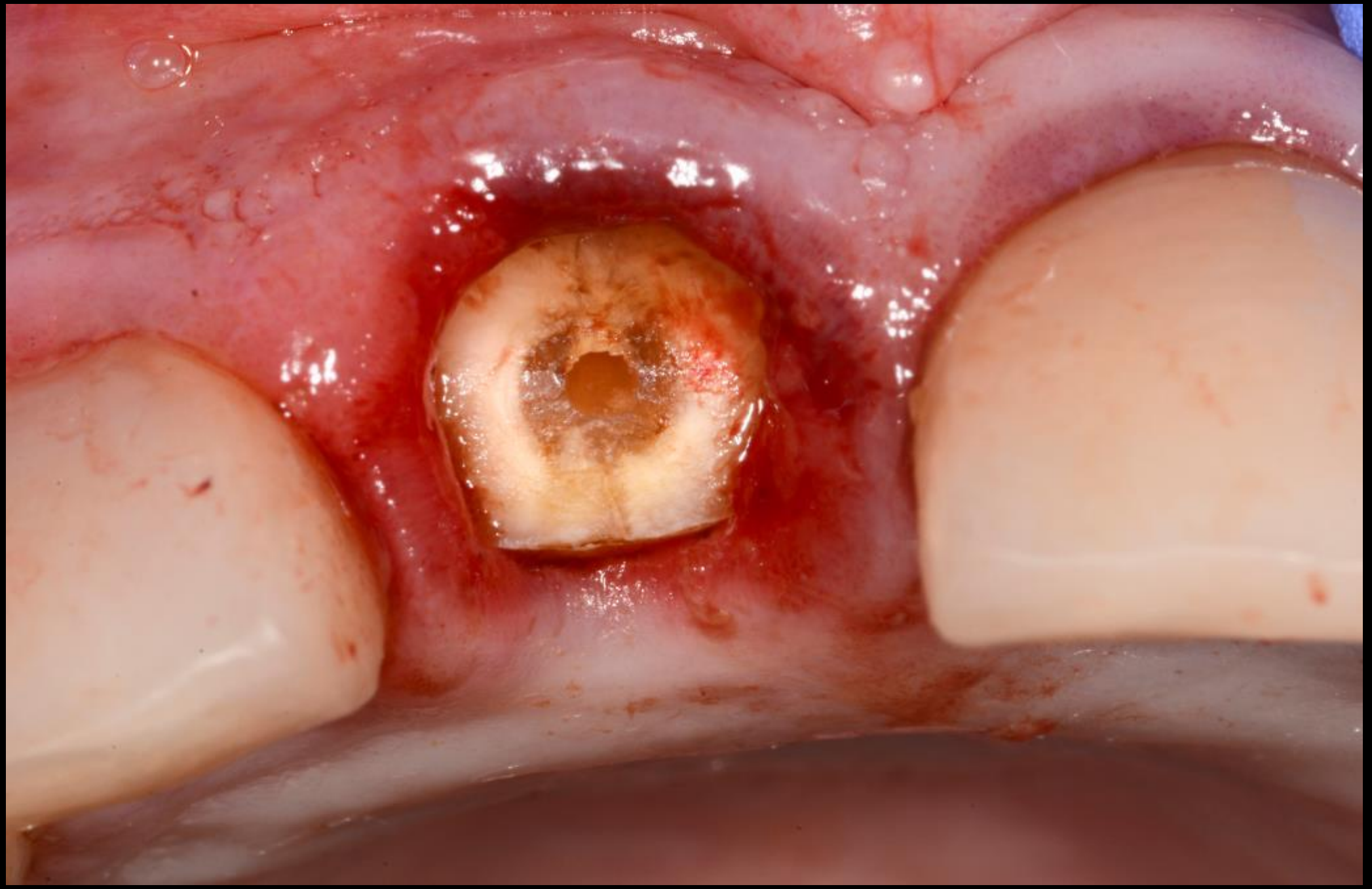


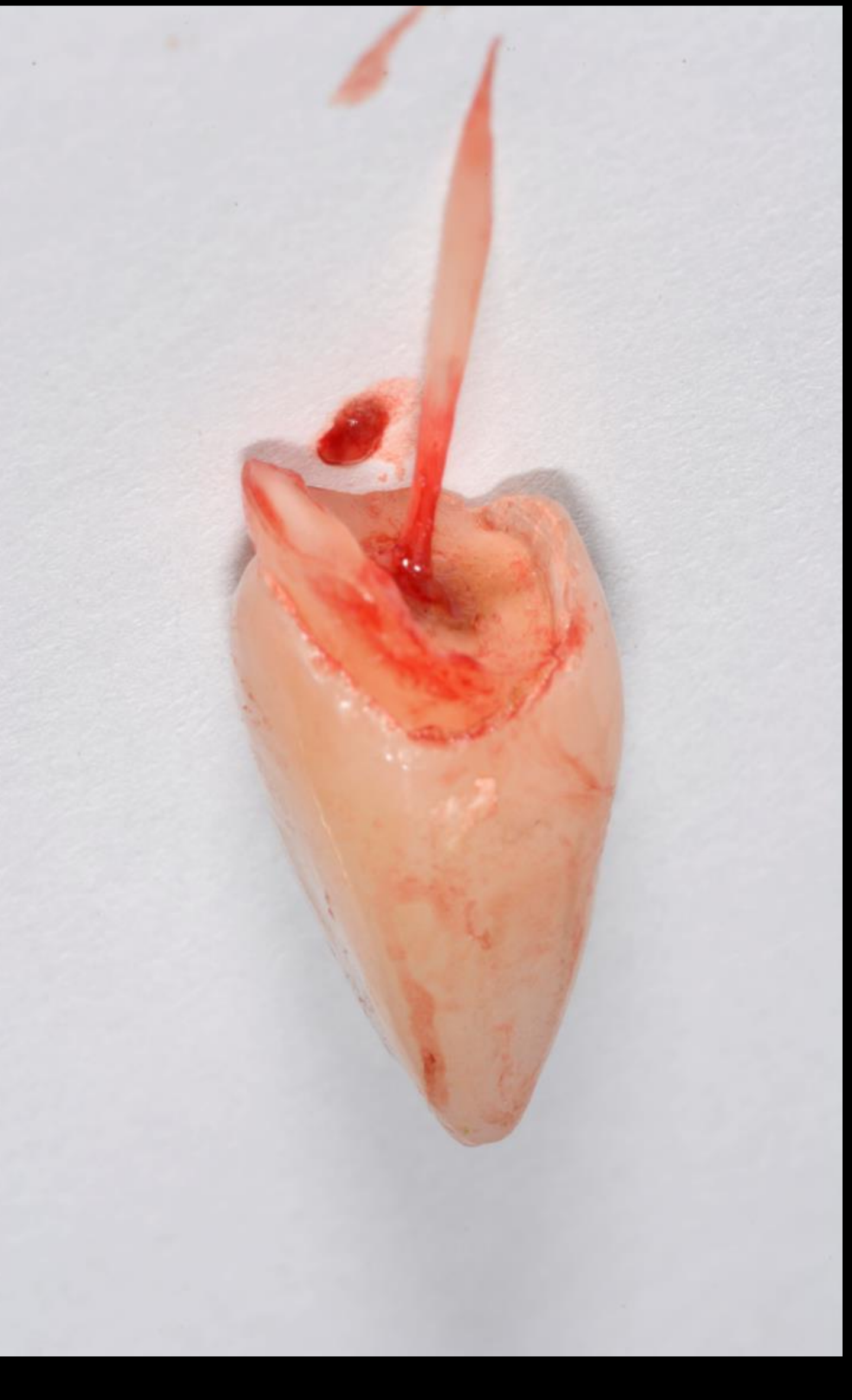
What Would You Do?

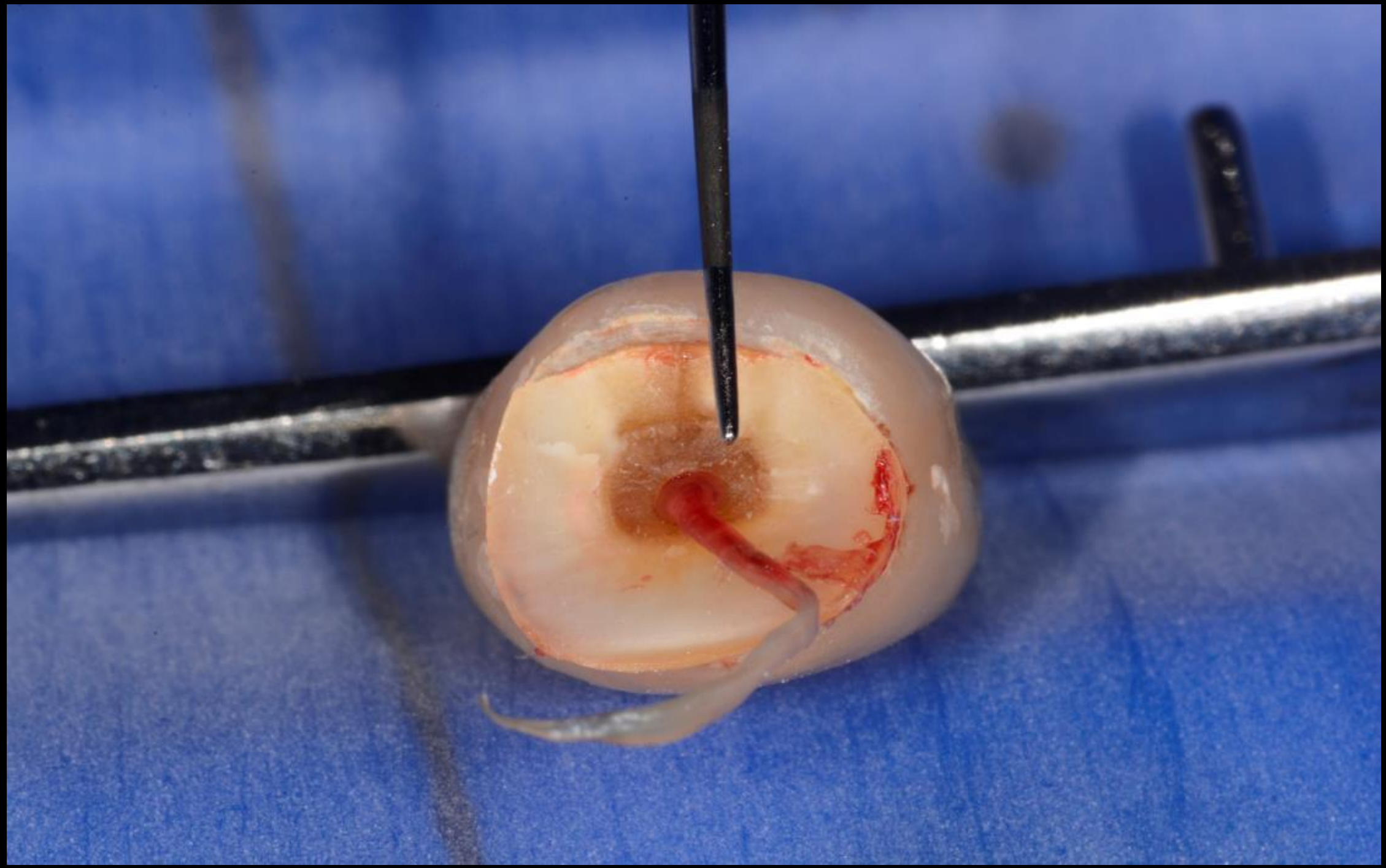
A different toothache patient we saw recently…

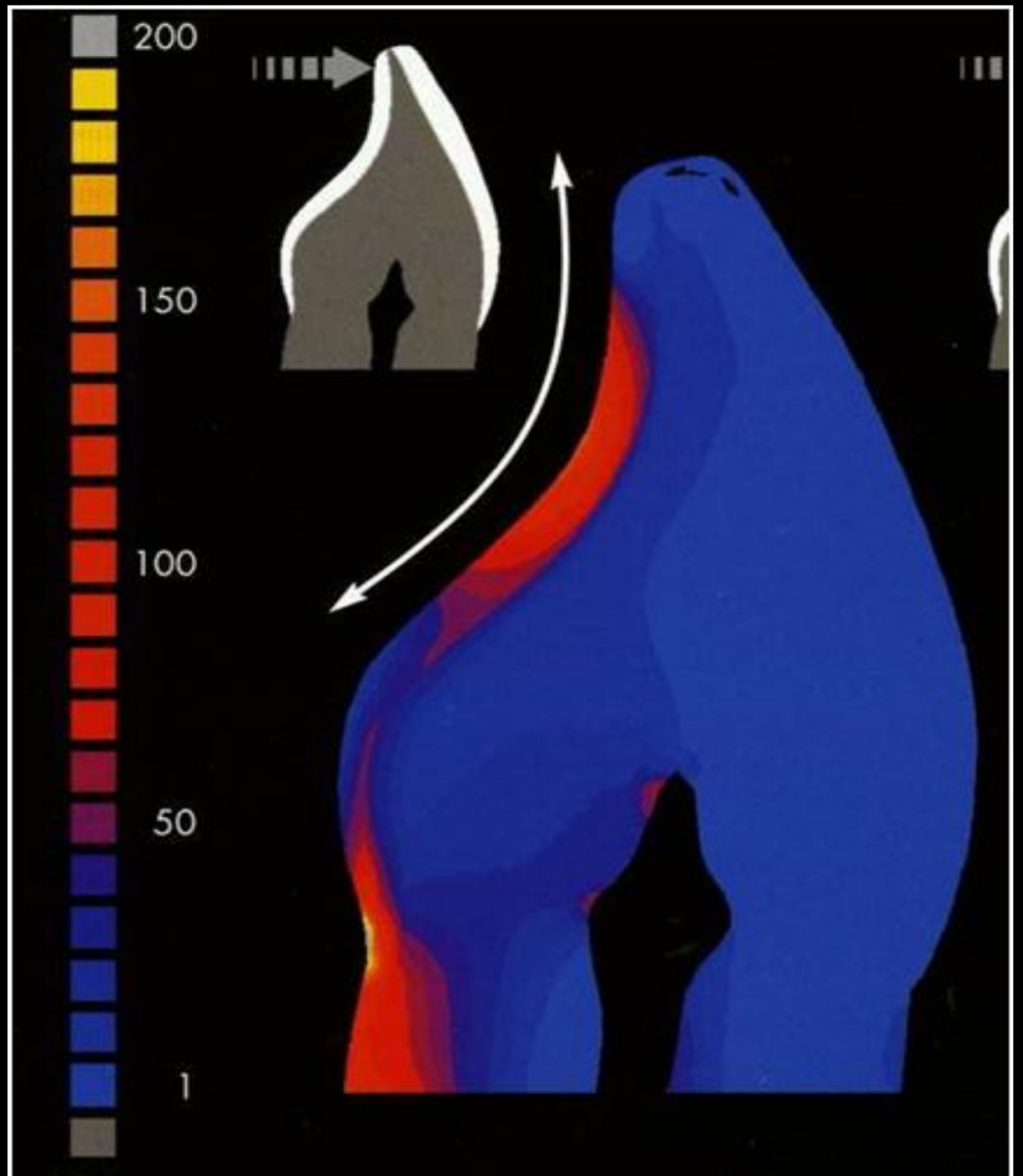


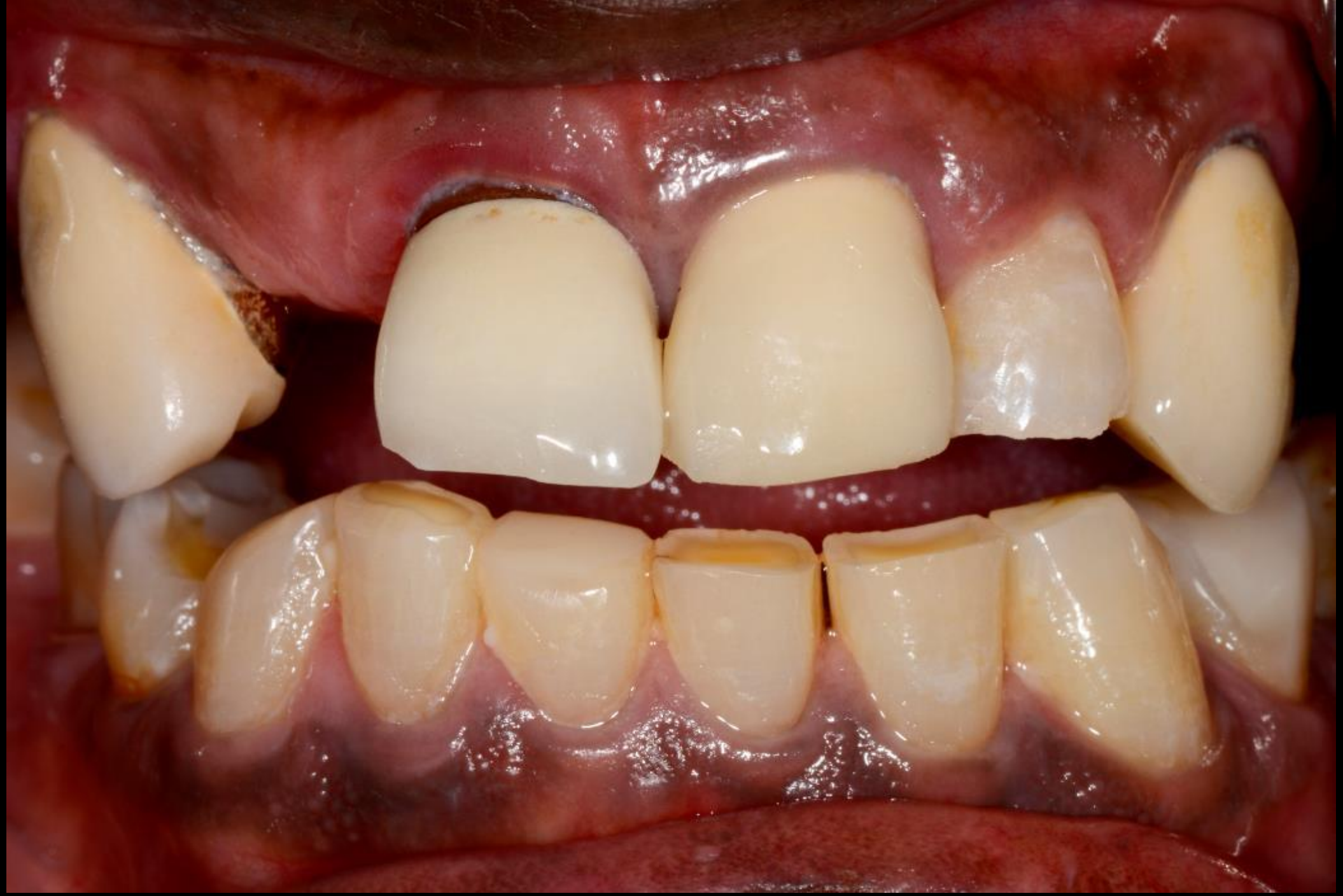


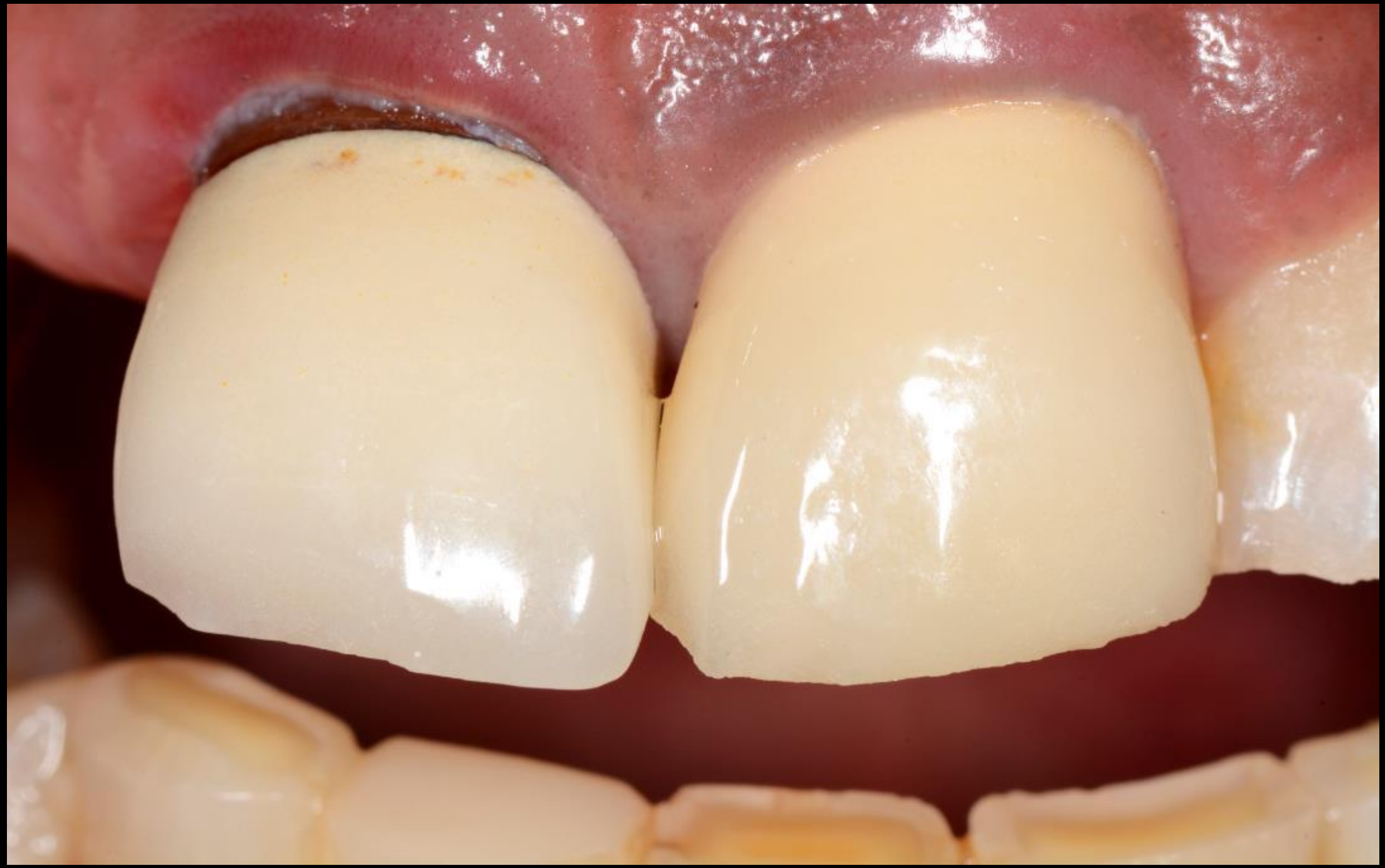


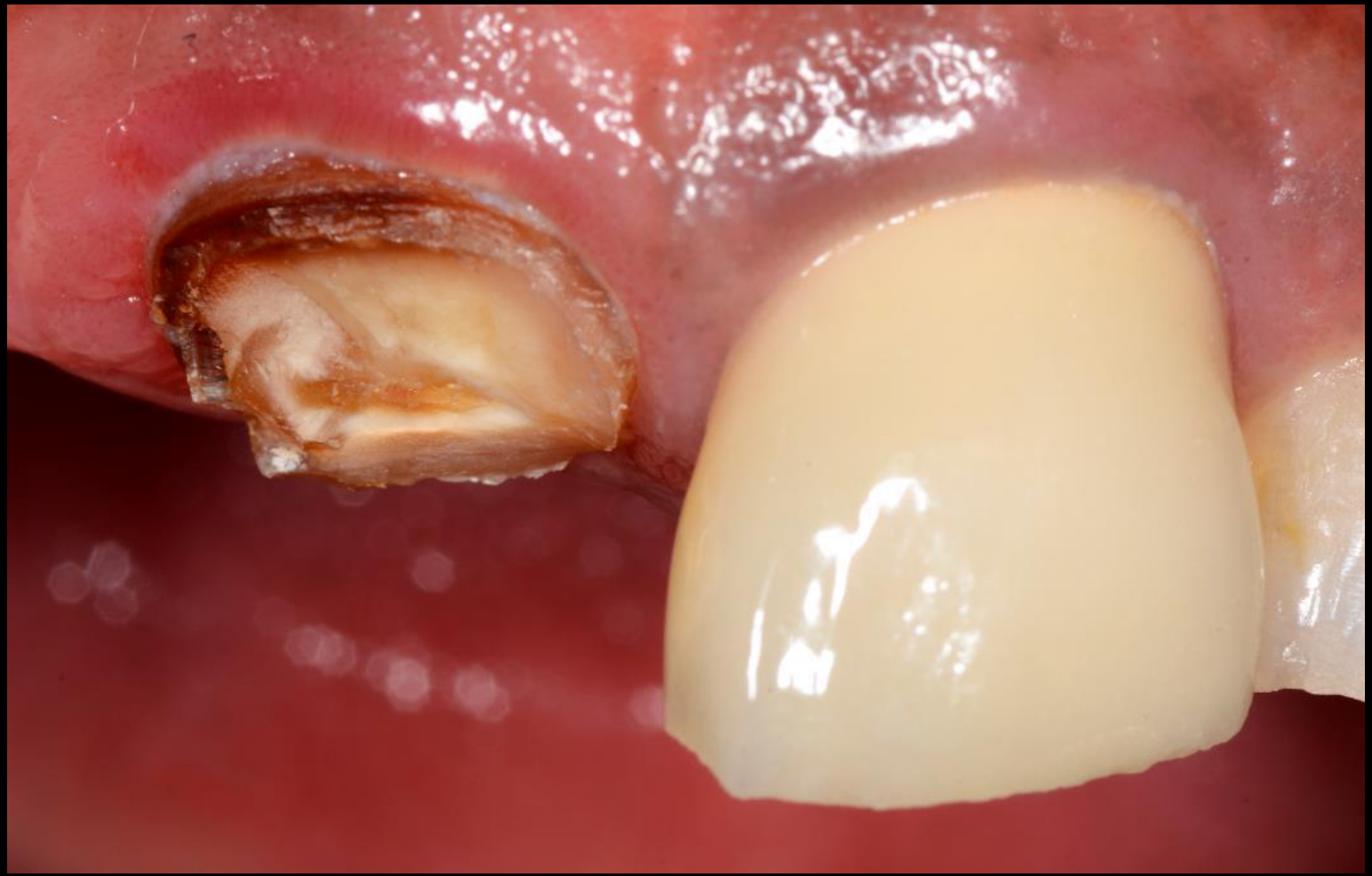


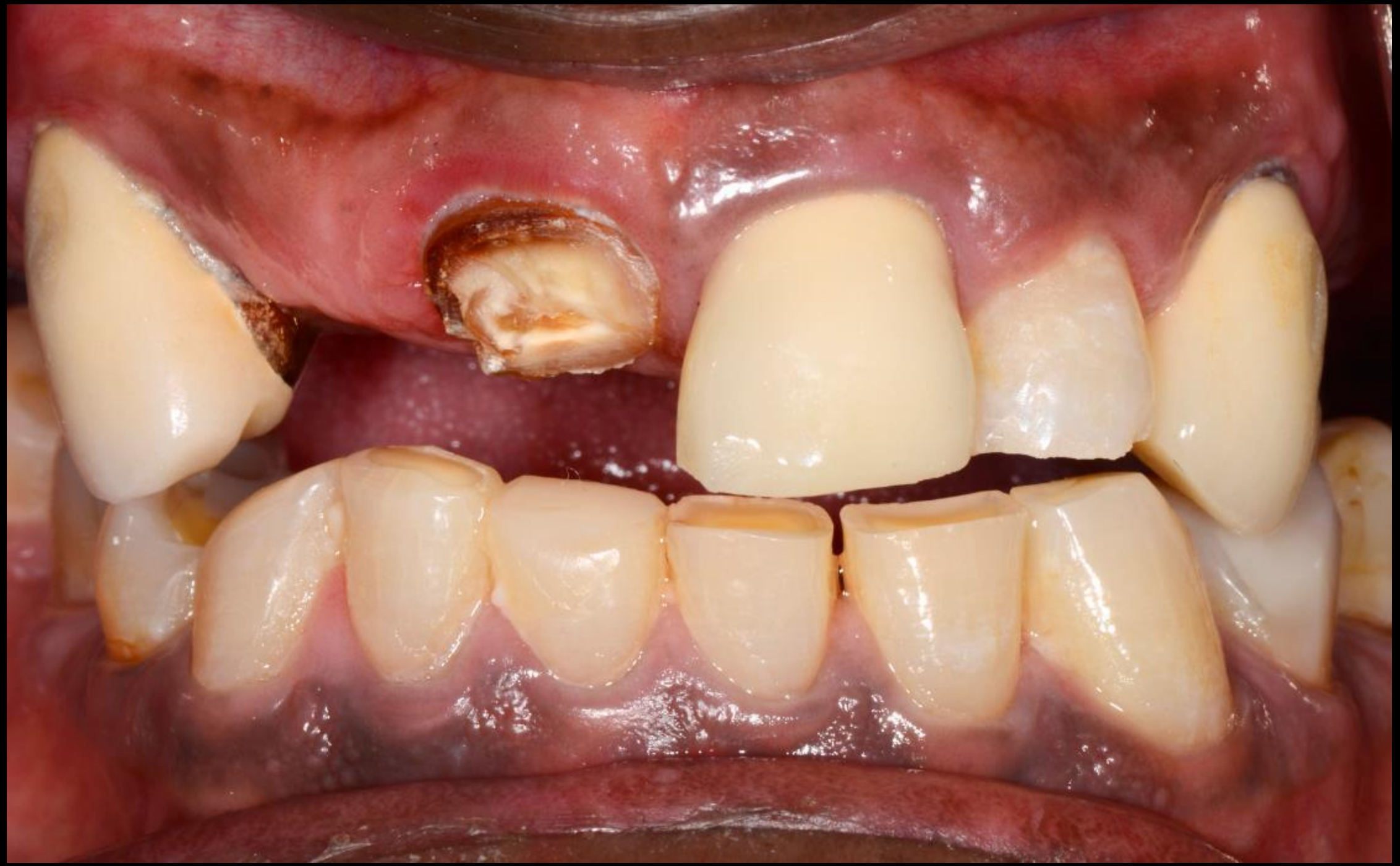



200
150
100
50
1

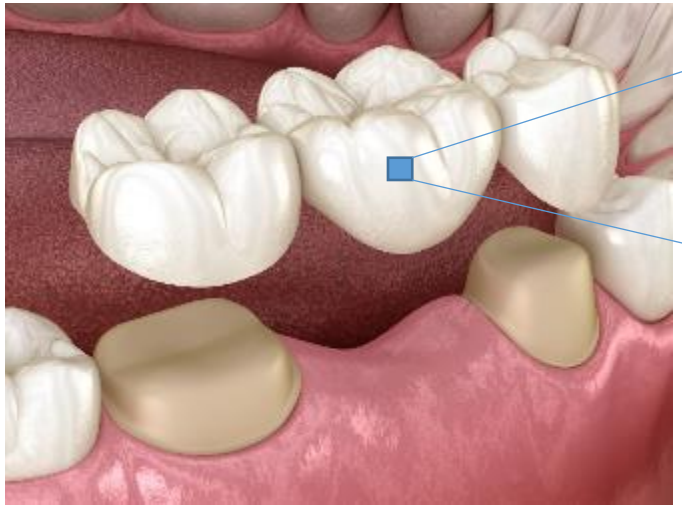




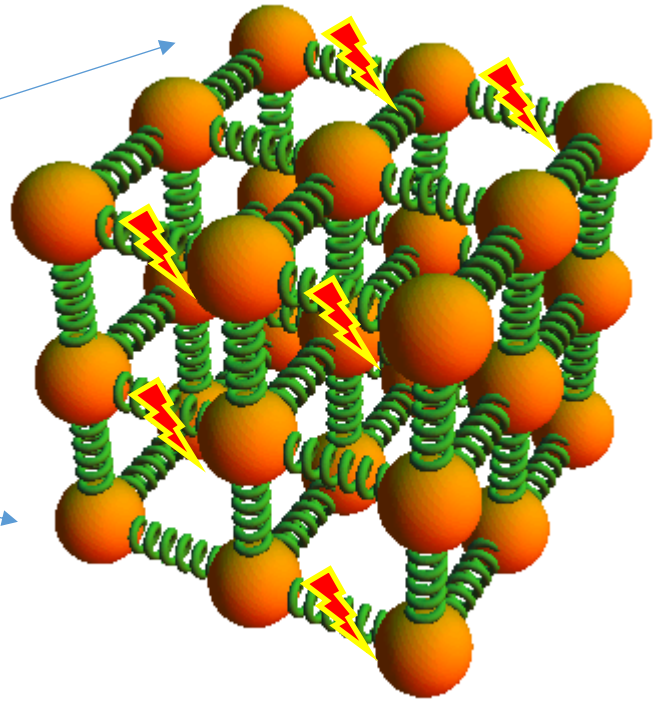




Basics of Solid Mechanics



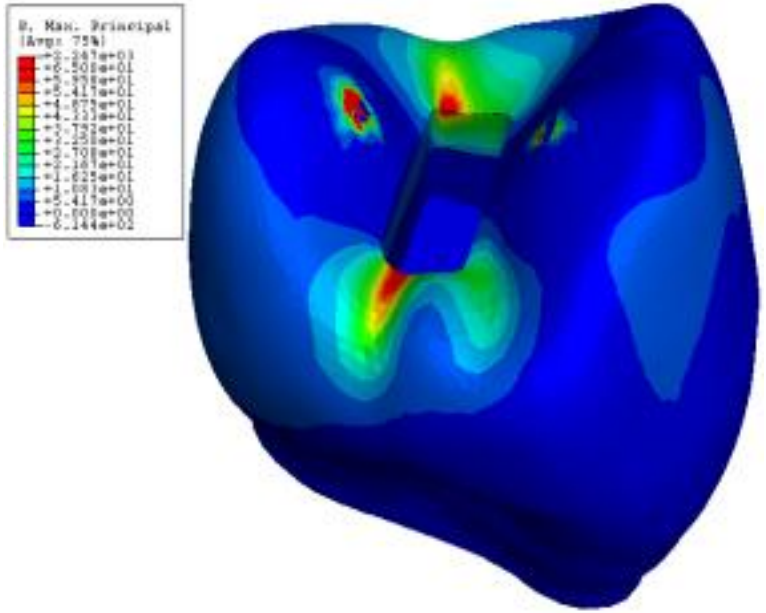
All solid structures can be considered as an assembly of many interconnected springs.

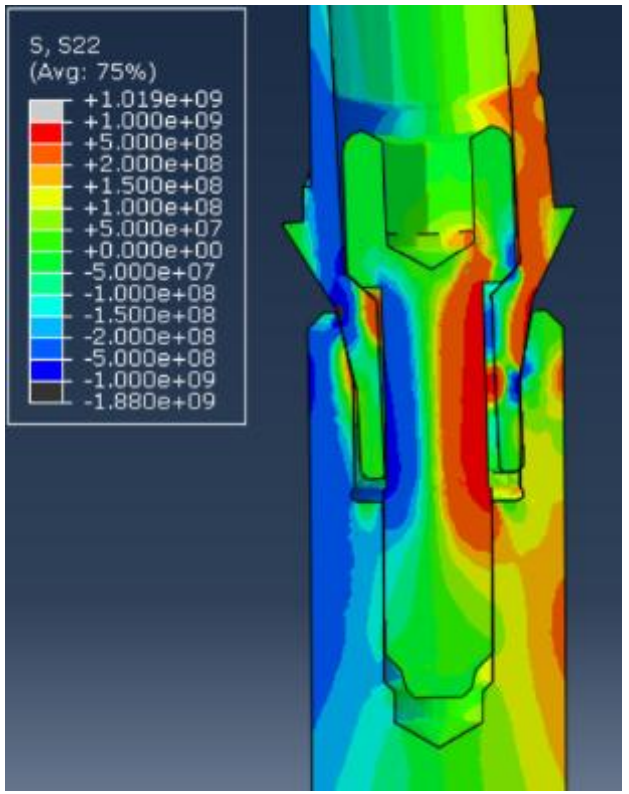


Stress/strain concentration

This occurs at

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

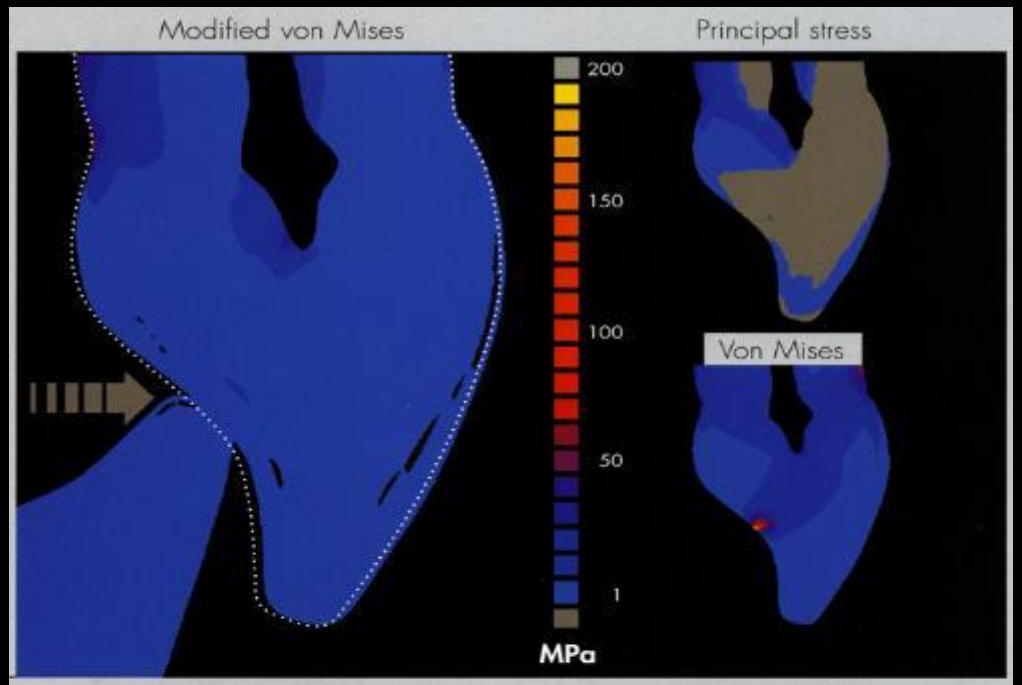


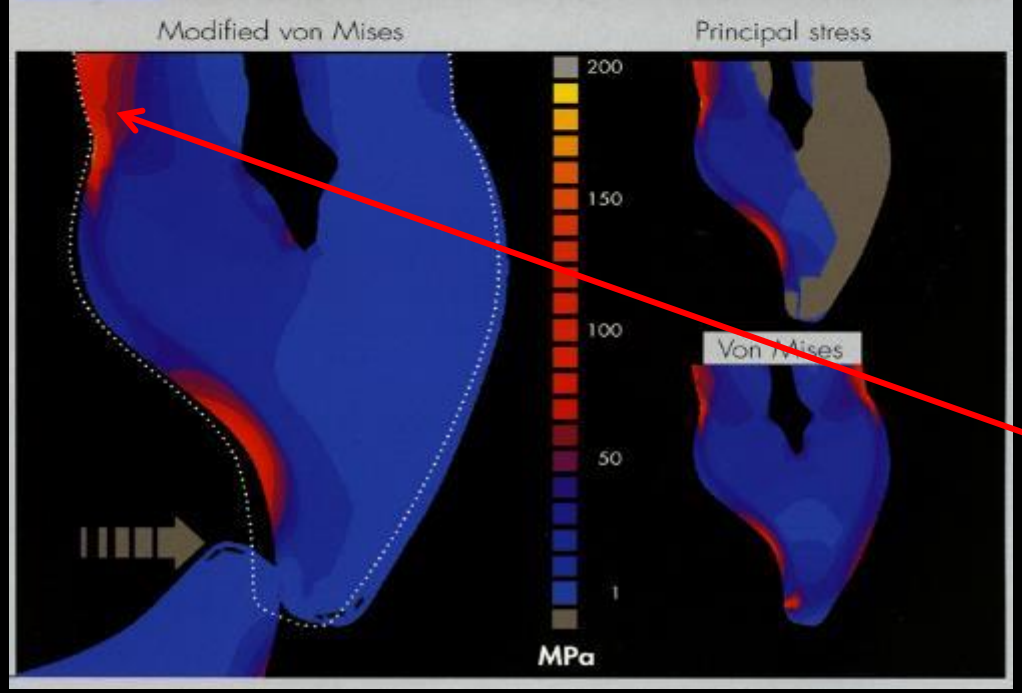


What is the percent of coronal volume removed in a conservative full porcelain crown preparation?

34 *

Edelhoff D, Sorensen JA.
ı 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

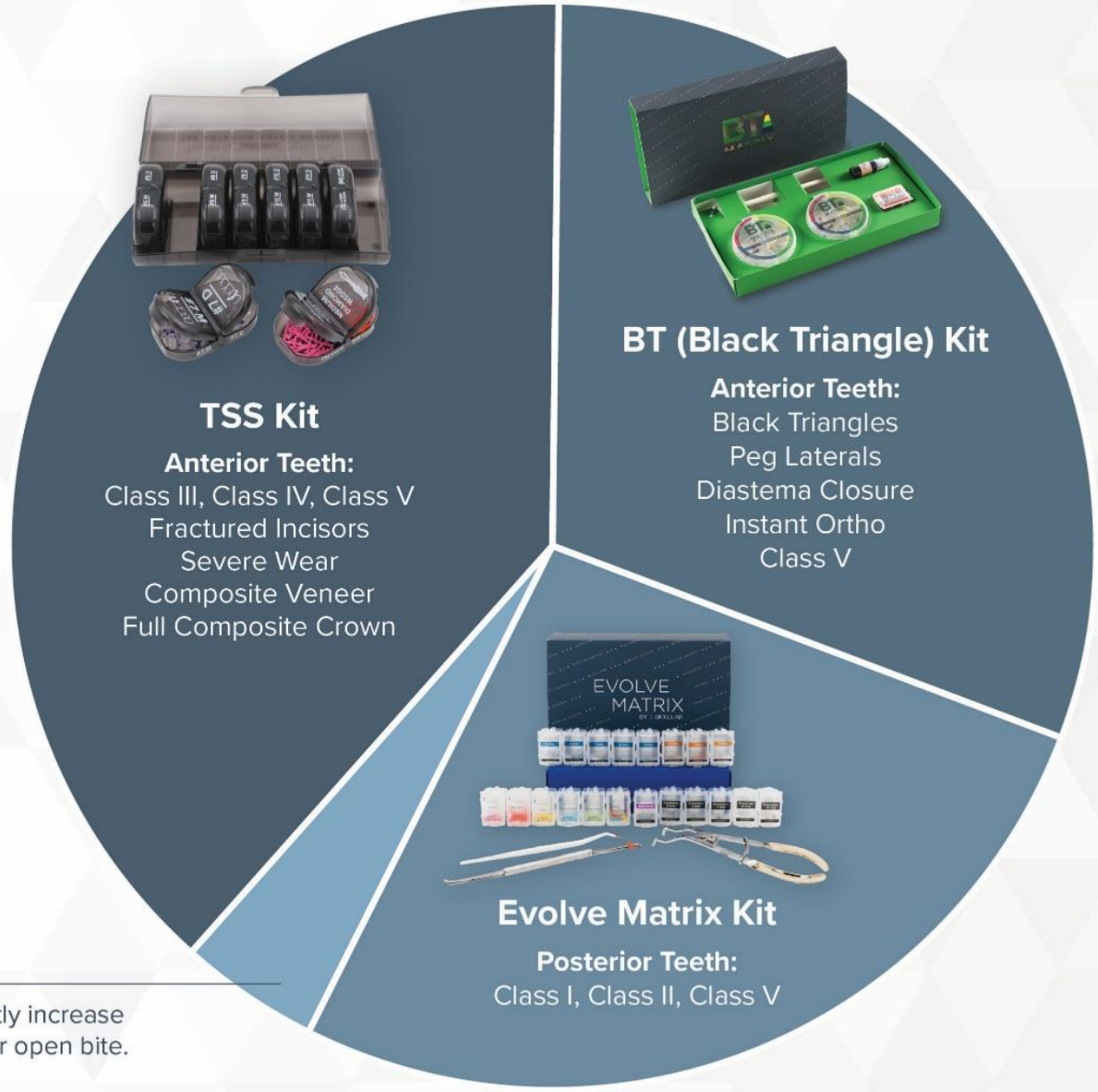
Is monolithic injection molded composite a viable alternative to full ceramic crowns in some cases?

You be the judge of that

BIOCLEAR

Recommended Bioclear Matrices by Indication

For more information contact us
Bioclear Matrix Systems
1-855-712-5327



TSS Kit

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

BT (Black Triangle) Kit

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

Evolve Matrix Kit

Posterior Teeth:
Class I, Class II, Class V

360 Veneer

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

TSS

TOOTH & SURFACE SPECIFIC
MATRIX SYSTEM
BY BIOCLEAR

140 Anterior Matrices
#6 through #11 in Mesial & Distal
Small & Medium Lower Incisor

75 Wedges
25 Small Wedges
50 Medium Wedges

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

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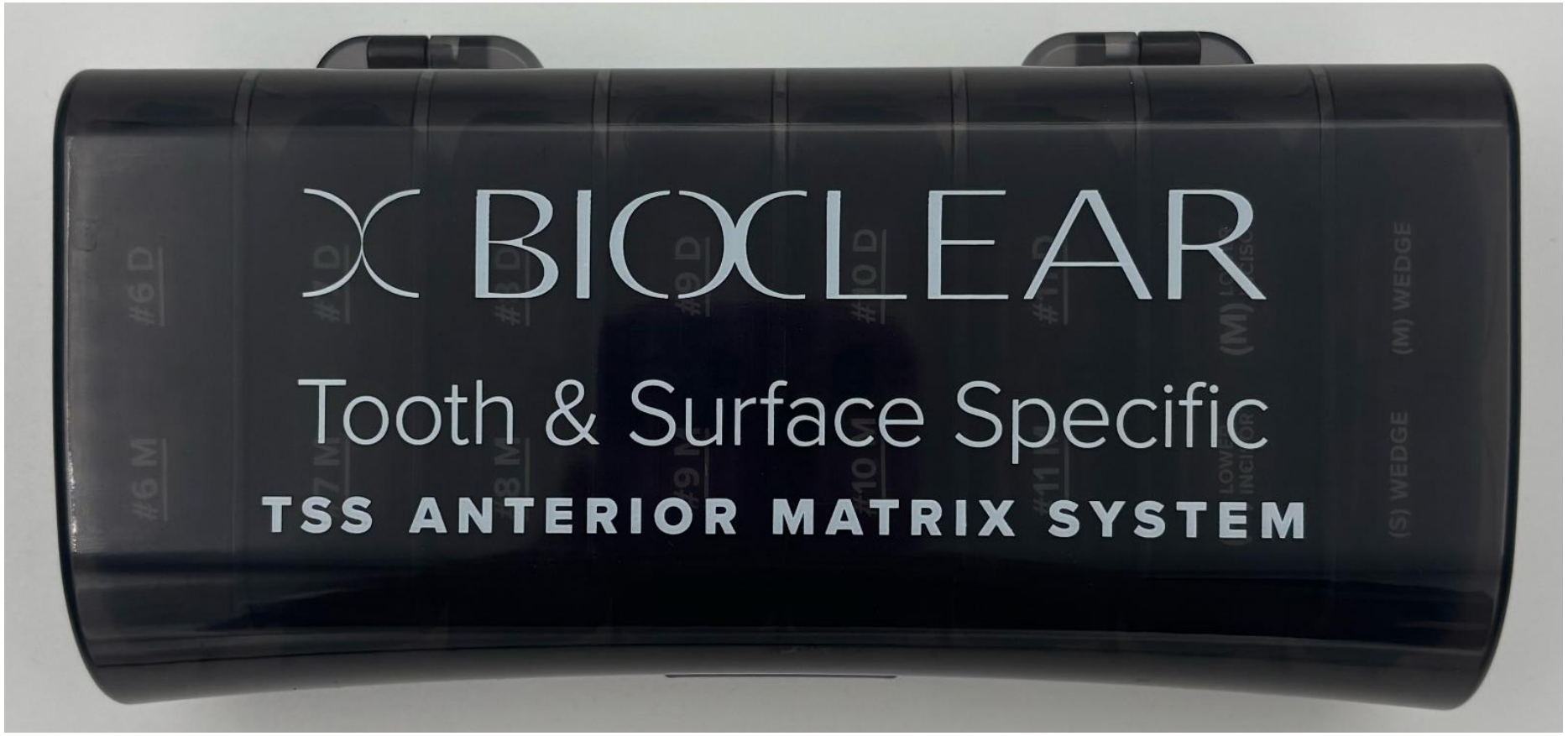
1.855.712.5327

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




#6 M
#6 D
#7 M
#7 D
#8 M
#8 D
#9 M
#9 D
#10 M
#10 D
#11 M
#11 D
(S) LOWER INCISOR
(M) LOWER INCISOR
(S) WEDGE
(M) WEDGE

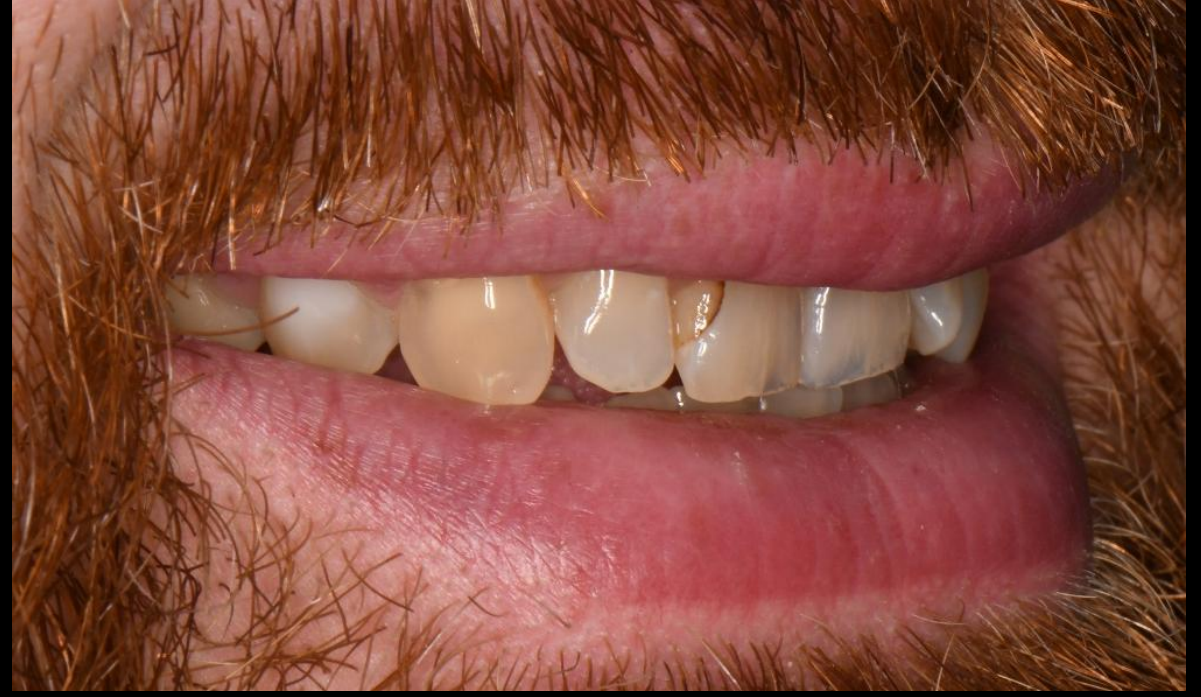

#6 M
#6 D
#7 M
#7 D
#9 M
#9 D
#10 M
#10 D
#11 M
#11 D
#8 D

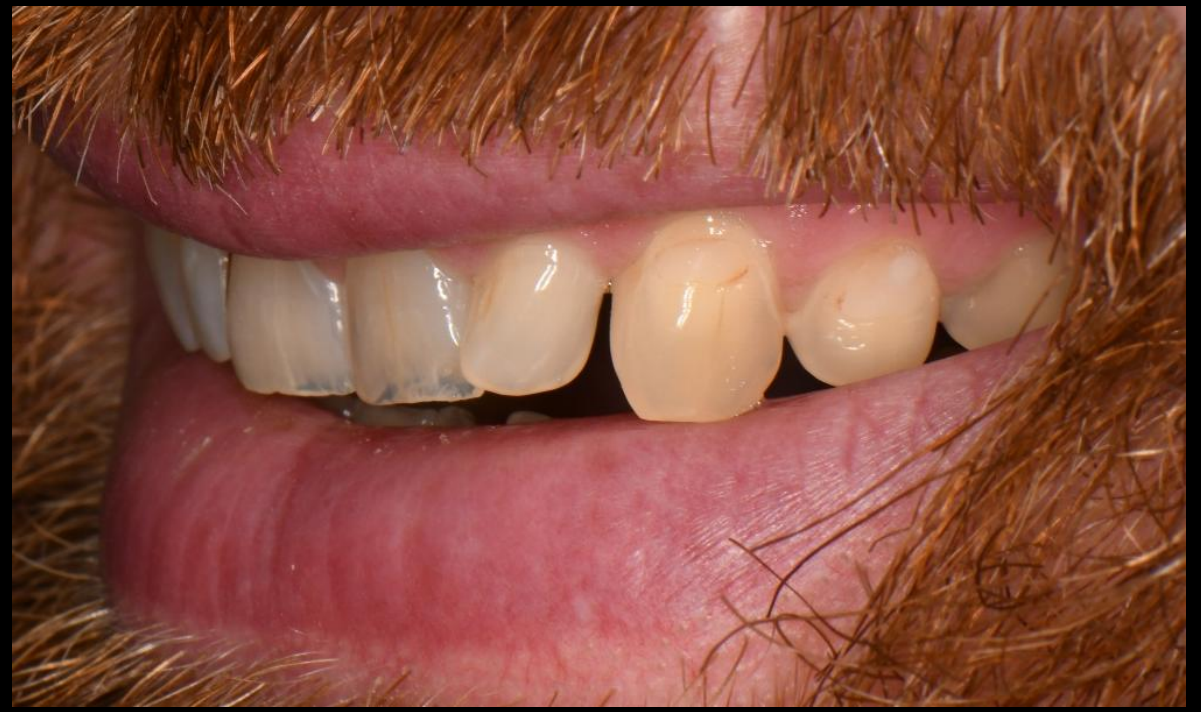

#8 M
#8 D


#8 M
#8 D
SMALL DIAMOND WEDGE
(S) WEDGE
(M) WEDGE

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.

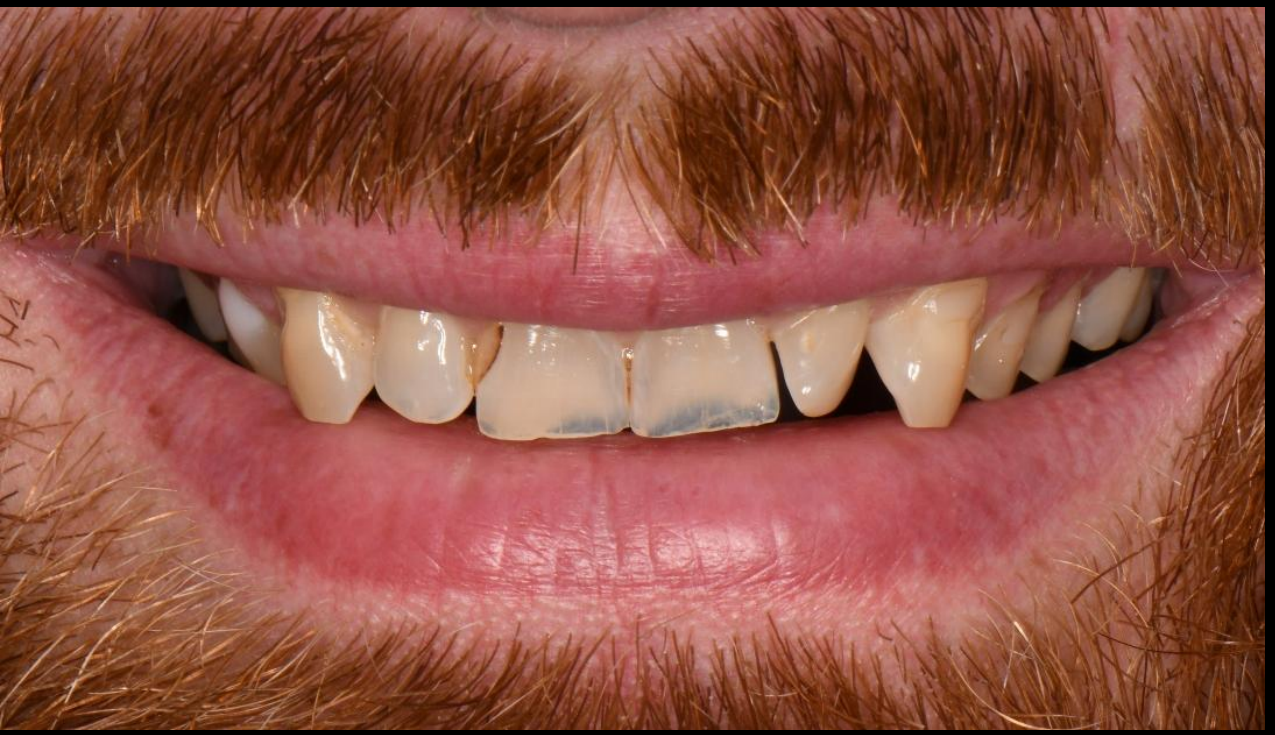
Phase one of the treatment plan was to restore the anterior six teeth, simultaneously opening the vertical dimension to reduce the need for aggressive tooth reduction for material thickness. In addition, because the patient needed to have the teeth lengthened by 2 mm, opening the vertical dimension by 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.

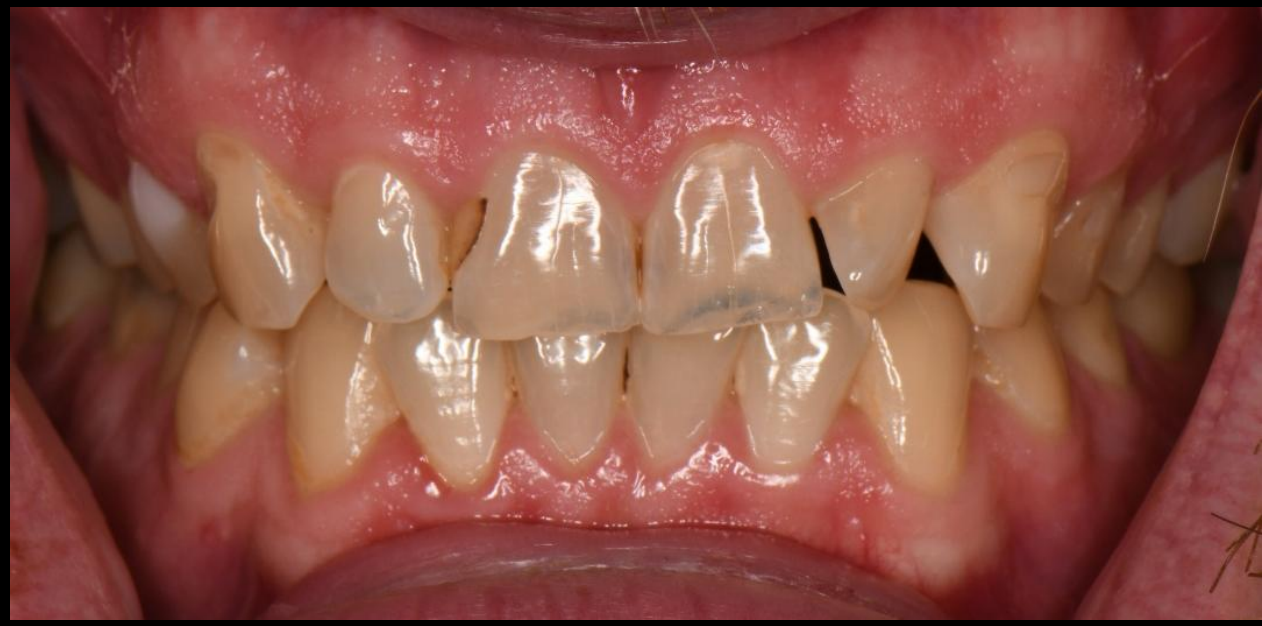
Phase two will be to restore the remaining teeth with Bioclear when the patient has his finances ready.

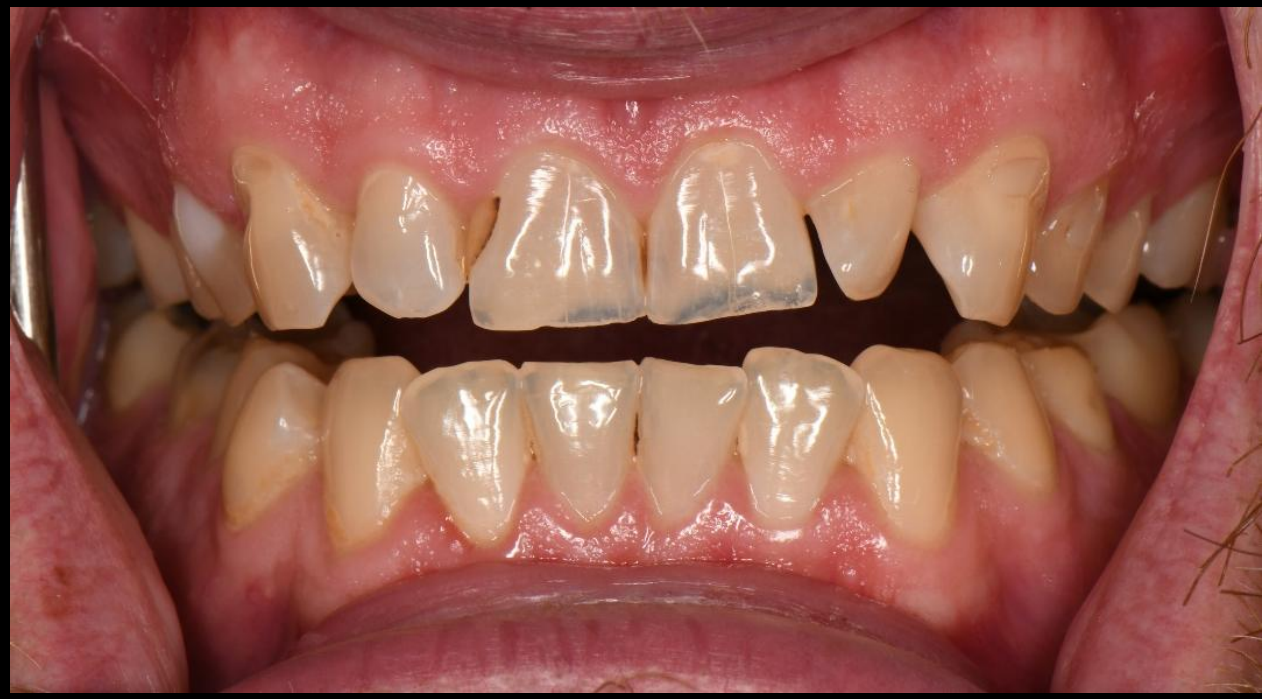
Treatment Summary Short Version:

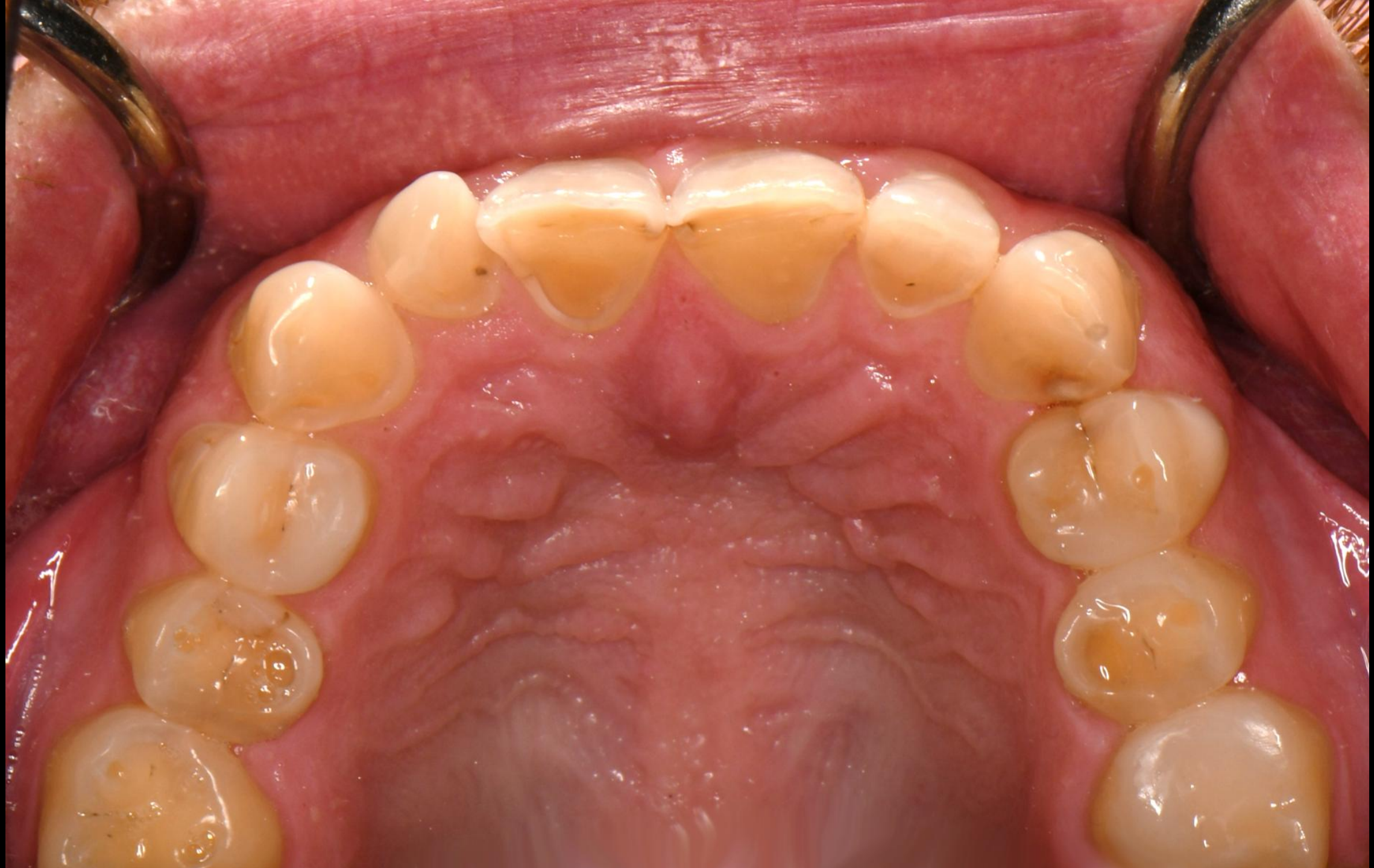
Treatment was finished in a single 4-hour session. (Less experienced clinicians should plan to give one hour per tooth). Bioclear TSS Matrices were utilized on all the teeth except tooth #10. #10 required the Bioclear BT matrix system to create “instant ortho” and because a diastema was present there. 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.

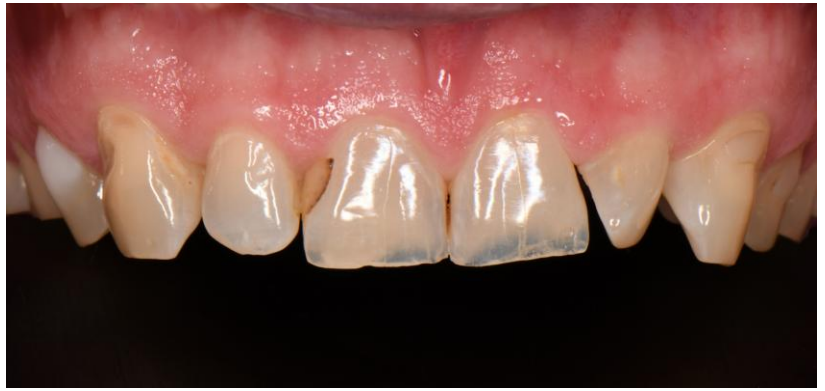


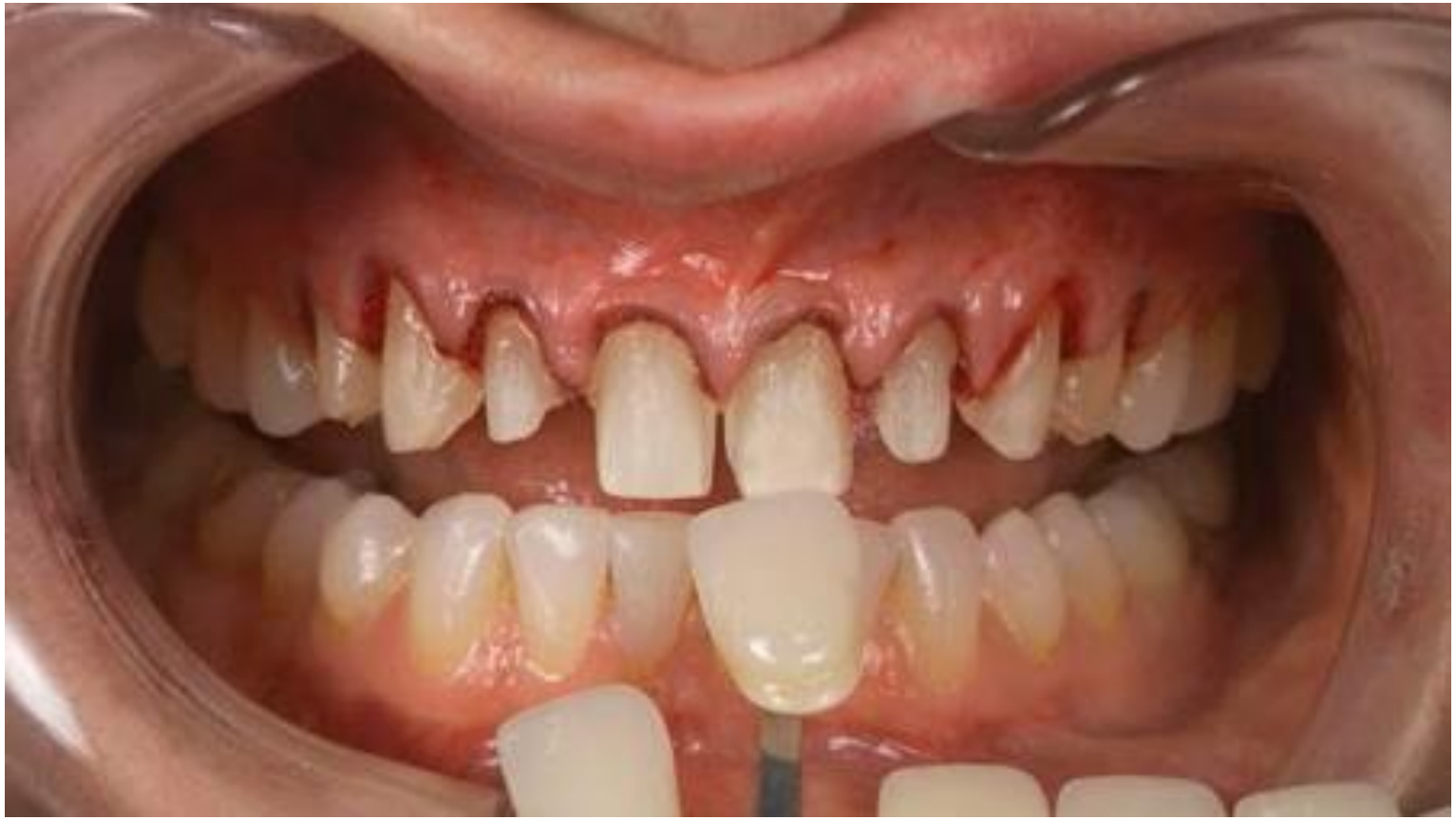






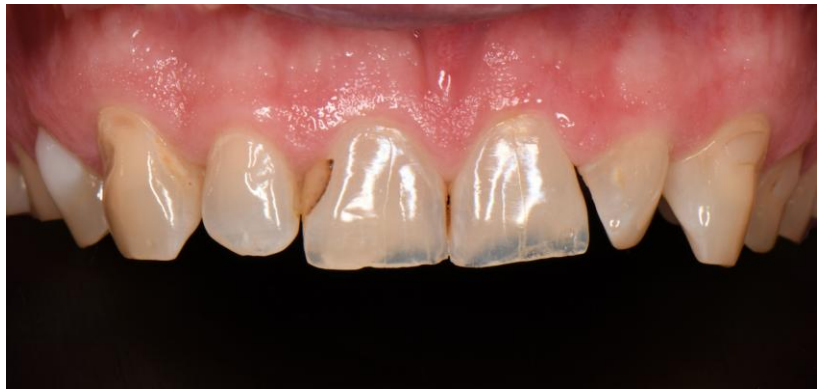
What percentage of the tooth is removed for a conservative crown prep?



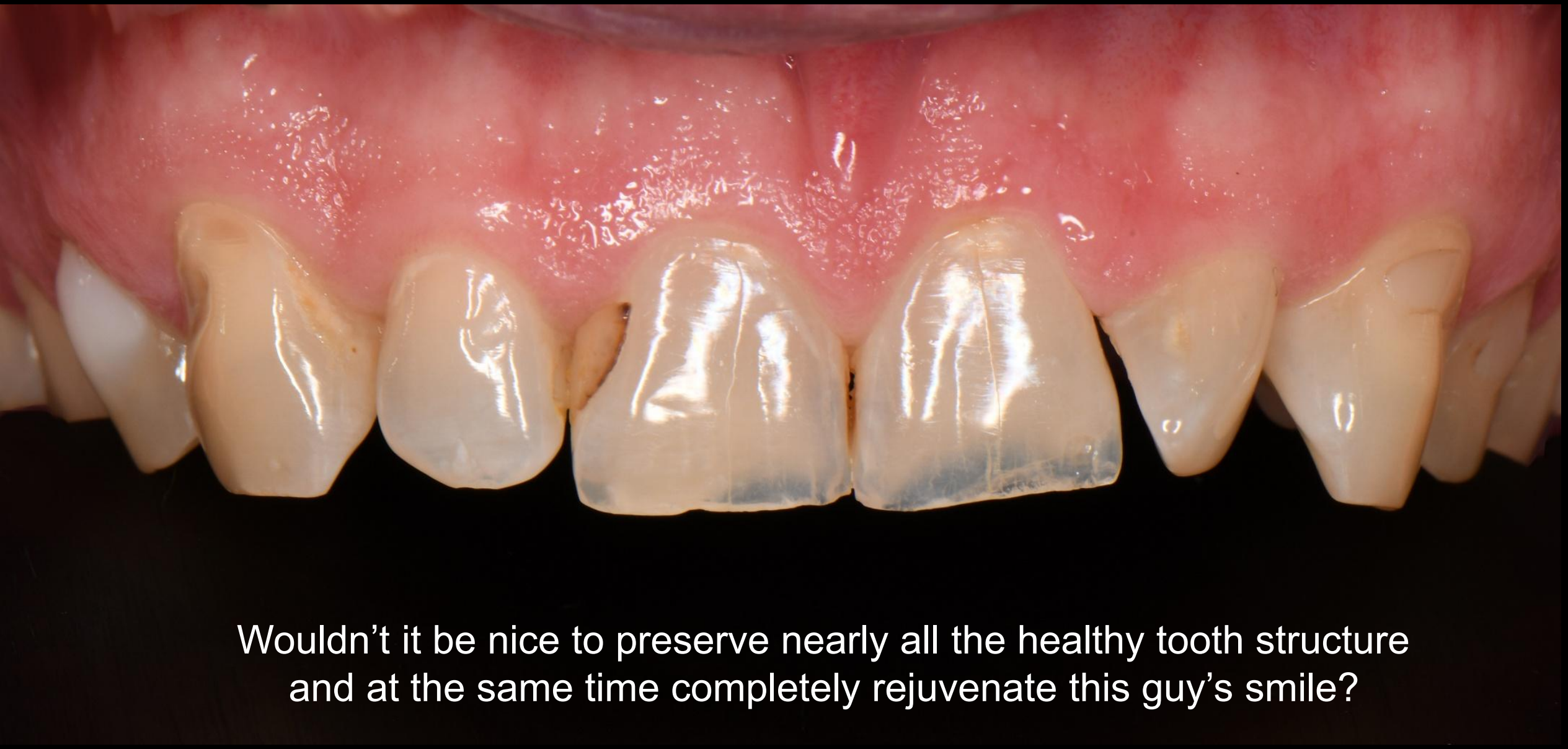


Source: Google Images

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



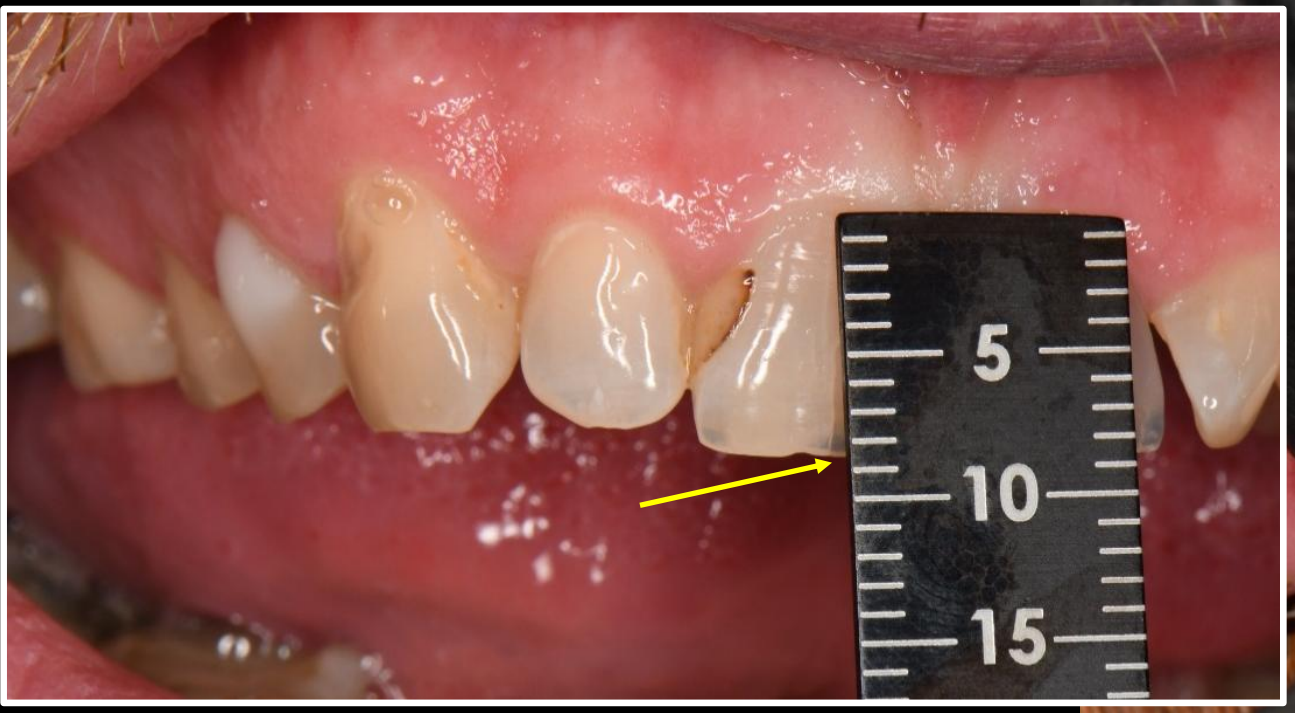
Source: Google Images



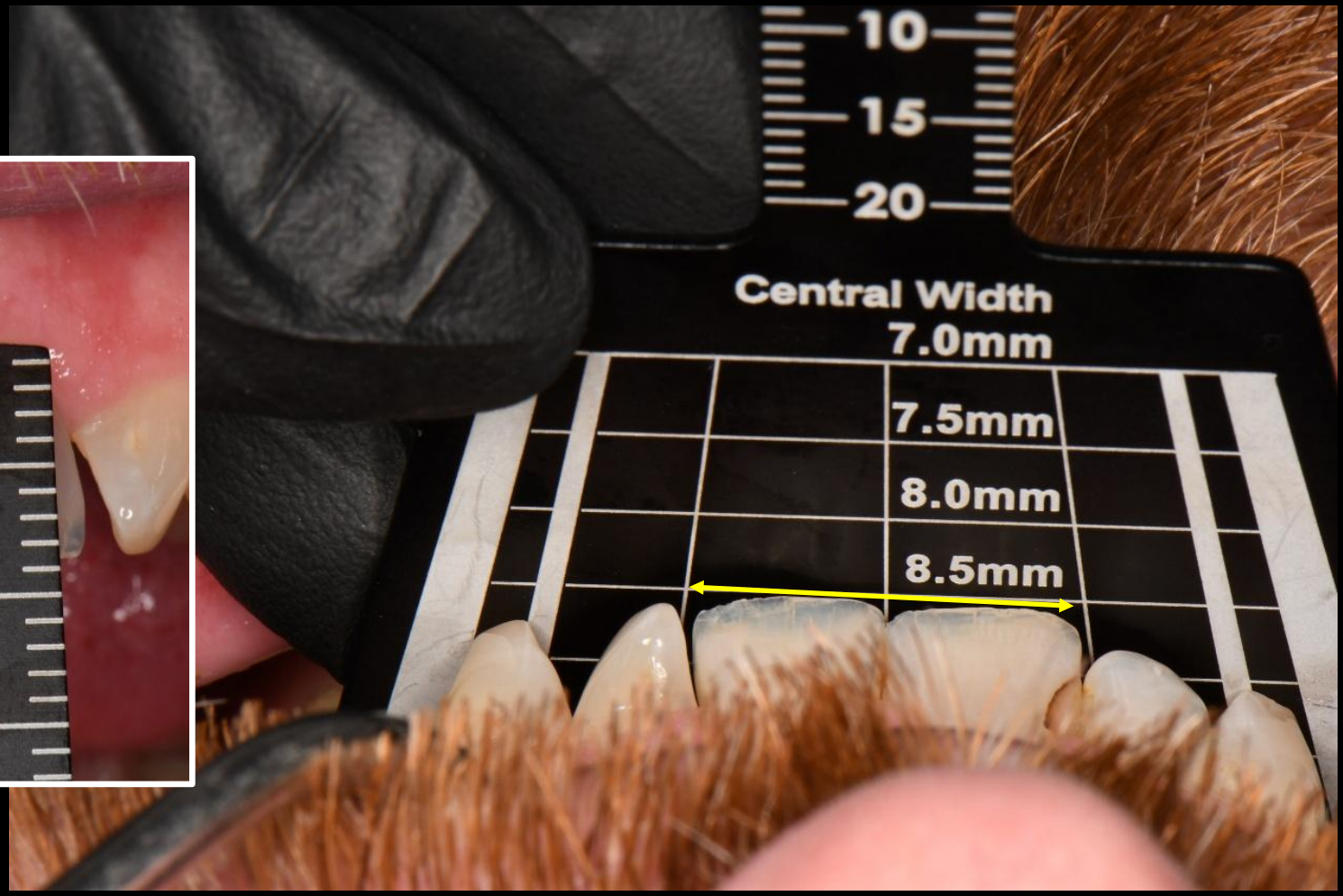
Wouldn’t it be nice to preserve nearly all the healthy tooth structure
and at the same time completely rejuvenate this guy’s smile?

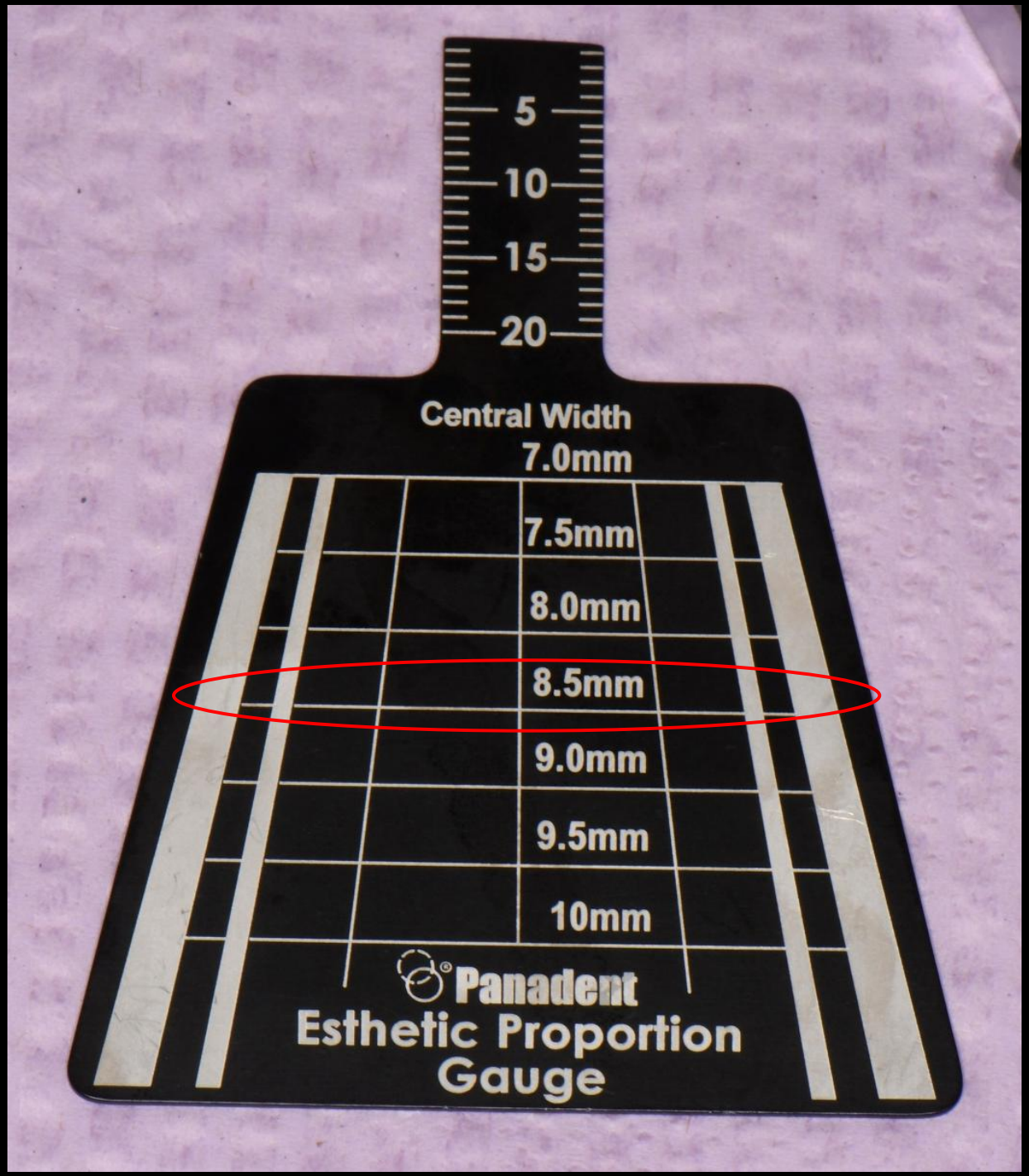

Simplified Smile Design!

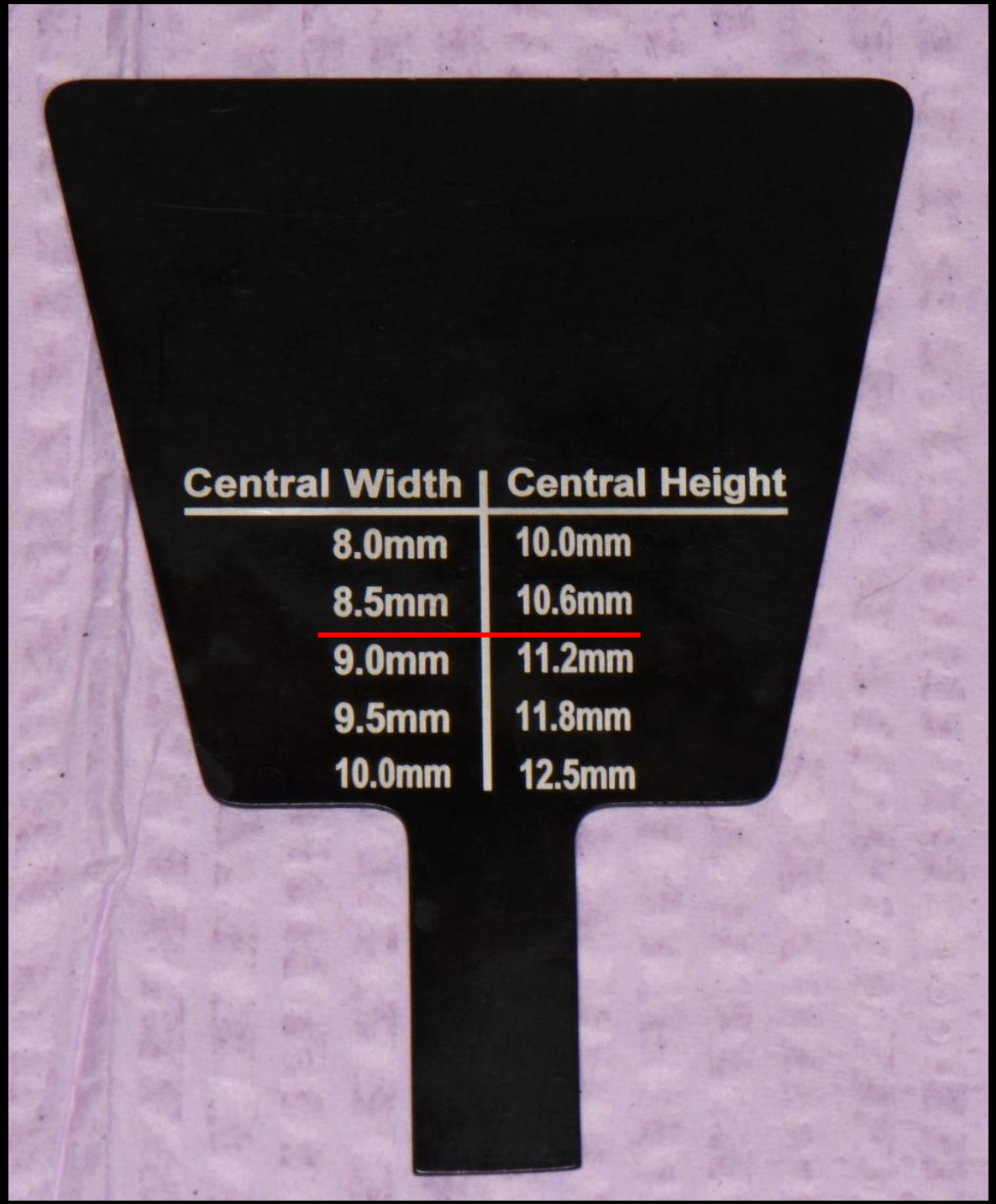
How long are his centrals currently? 8.5 mm



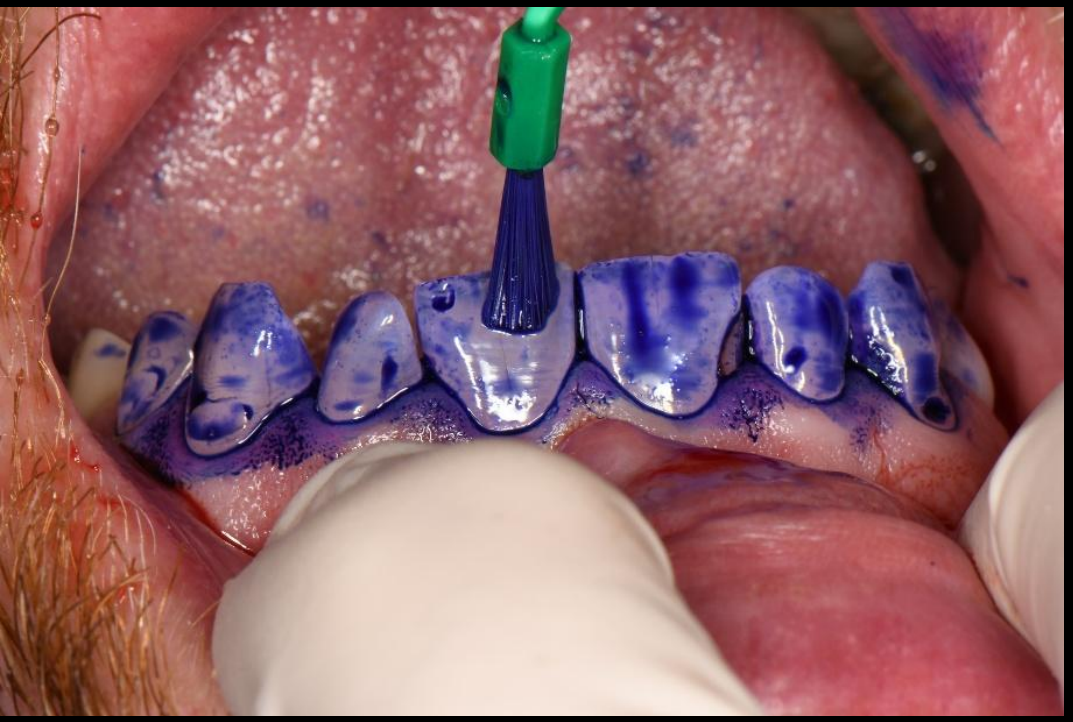
How wide are his centrals? 8.5 mm

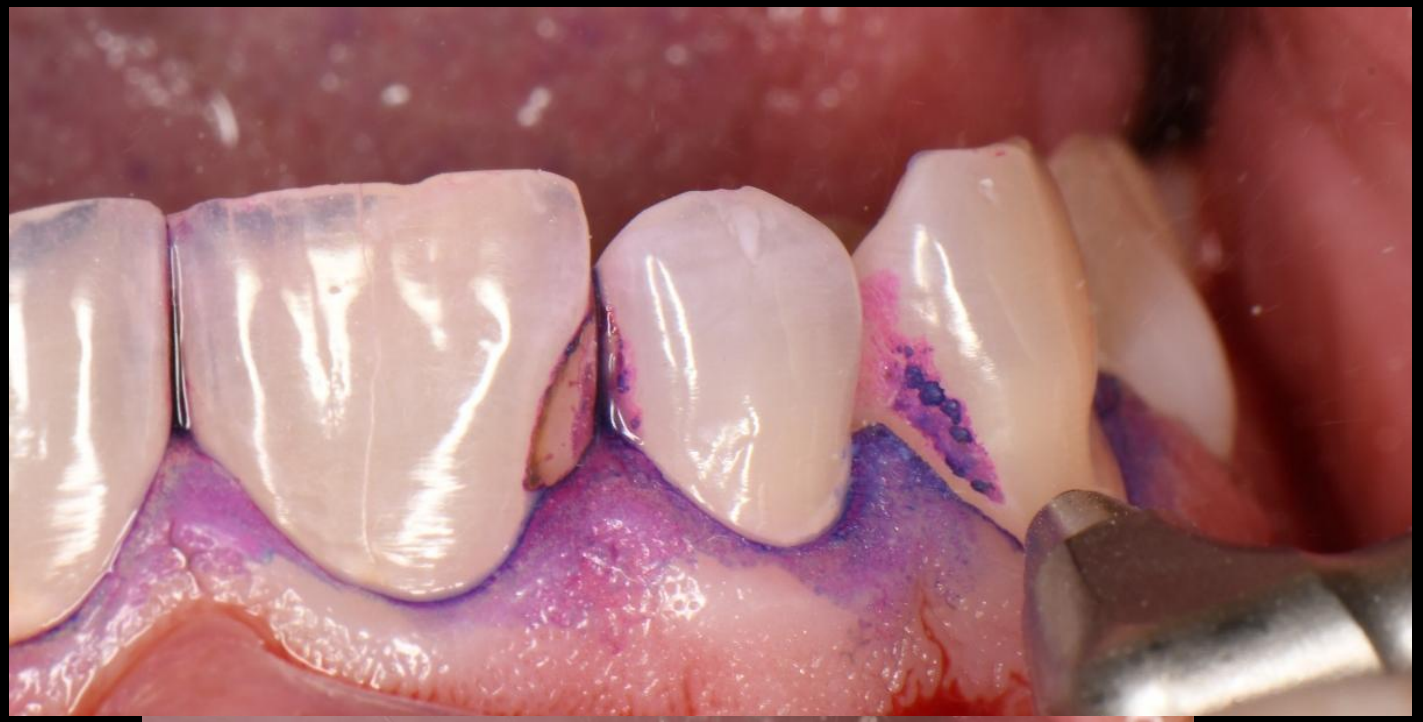


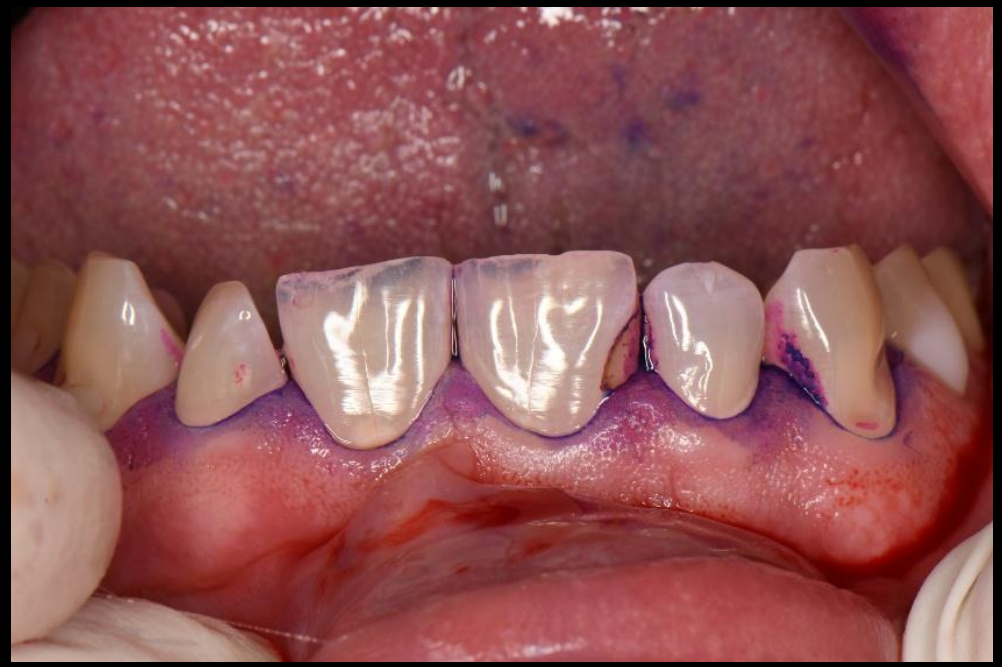


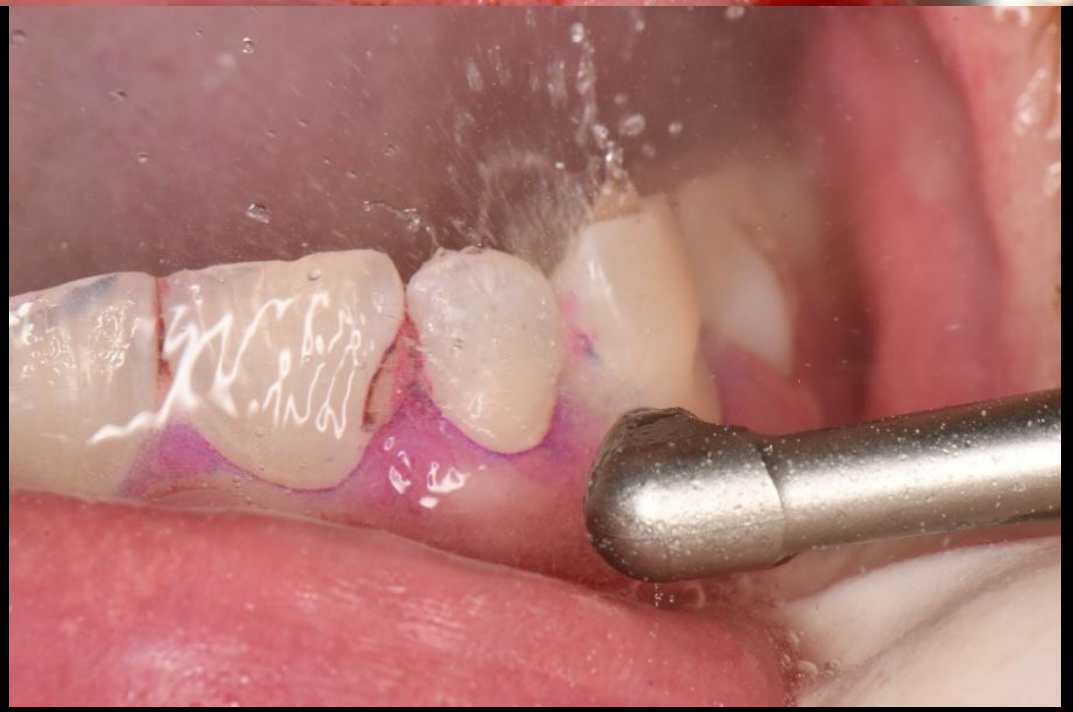


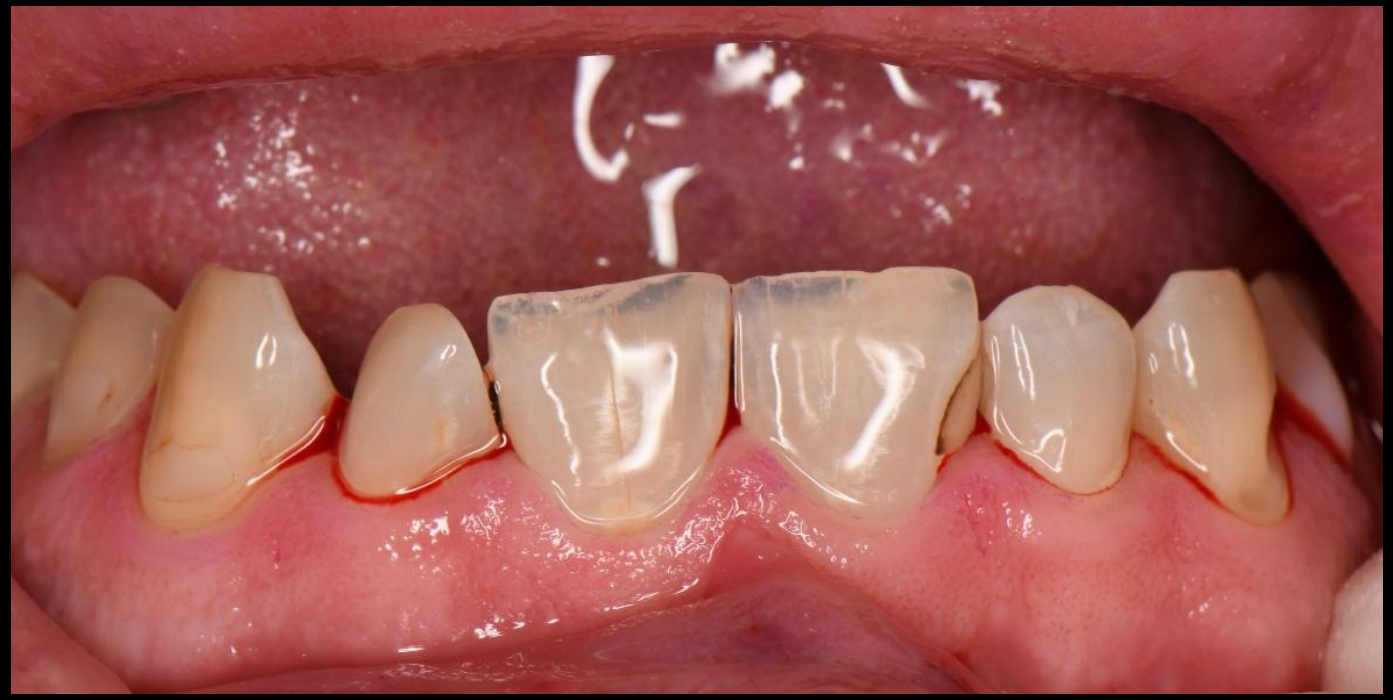
Central Width	Central Height
8.0mm	10.0mm
8.5mm	10.6mm
9.0mm	11.2mm
9.5mm	11.8mm
10.0mm	12.5mm

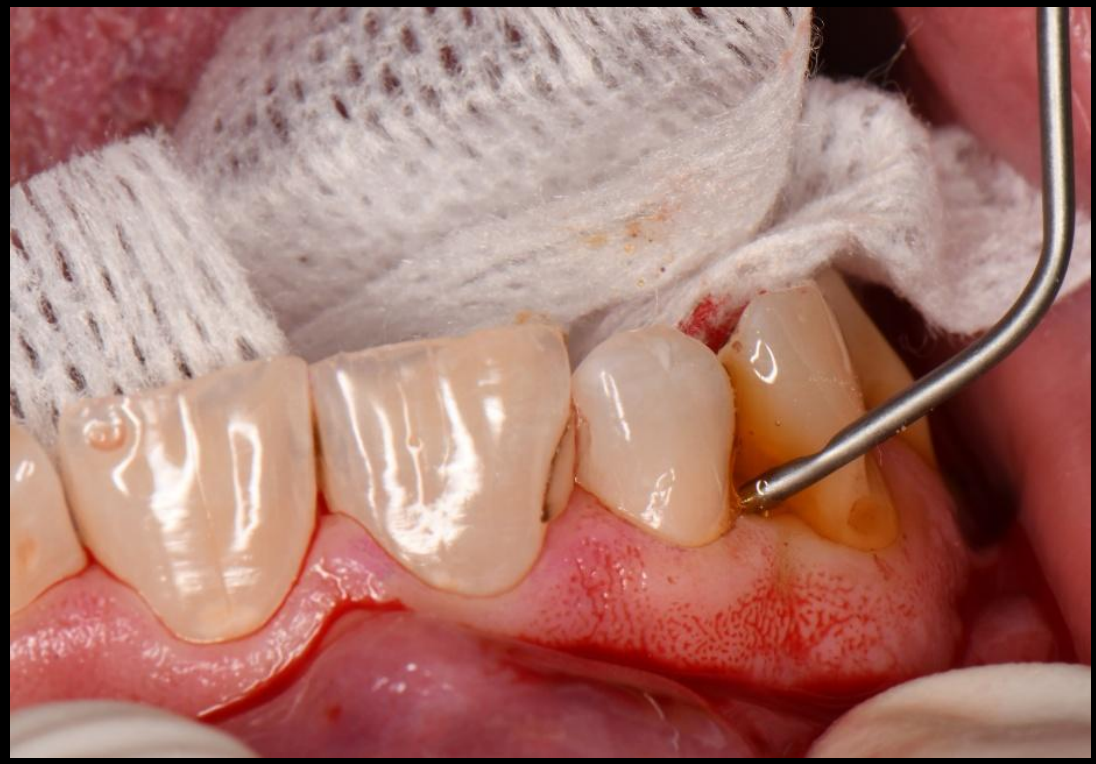


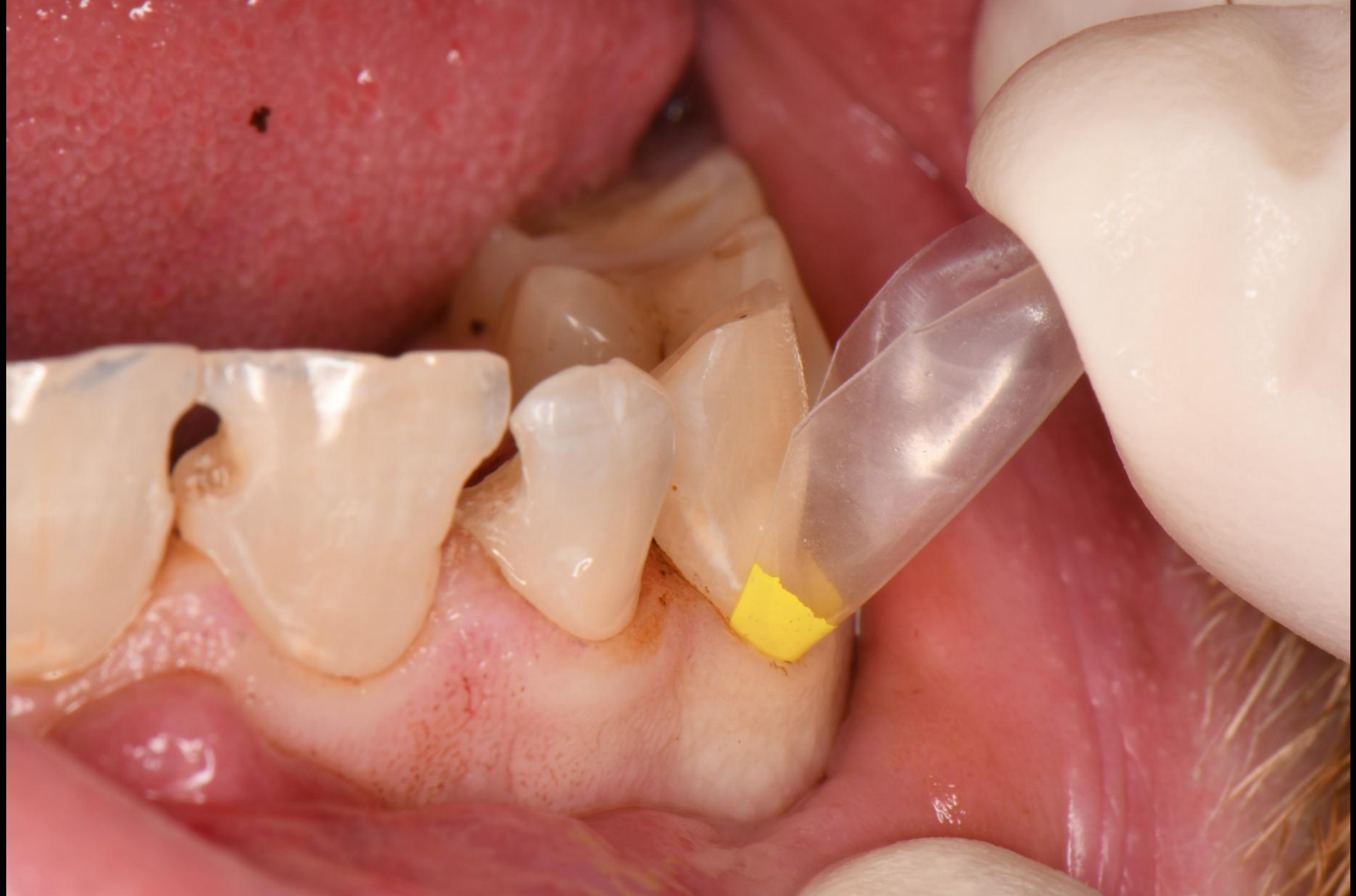


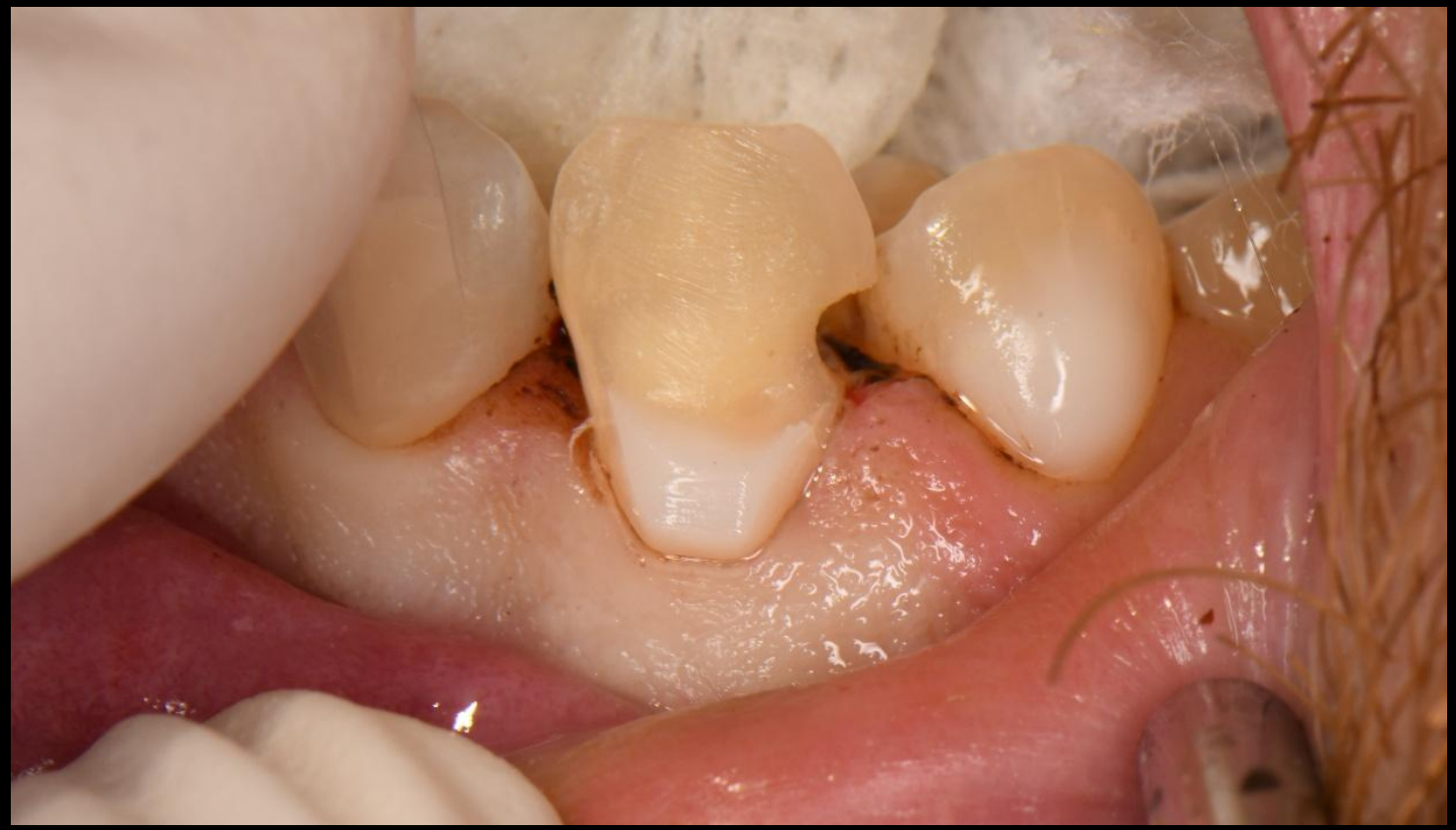


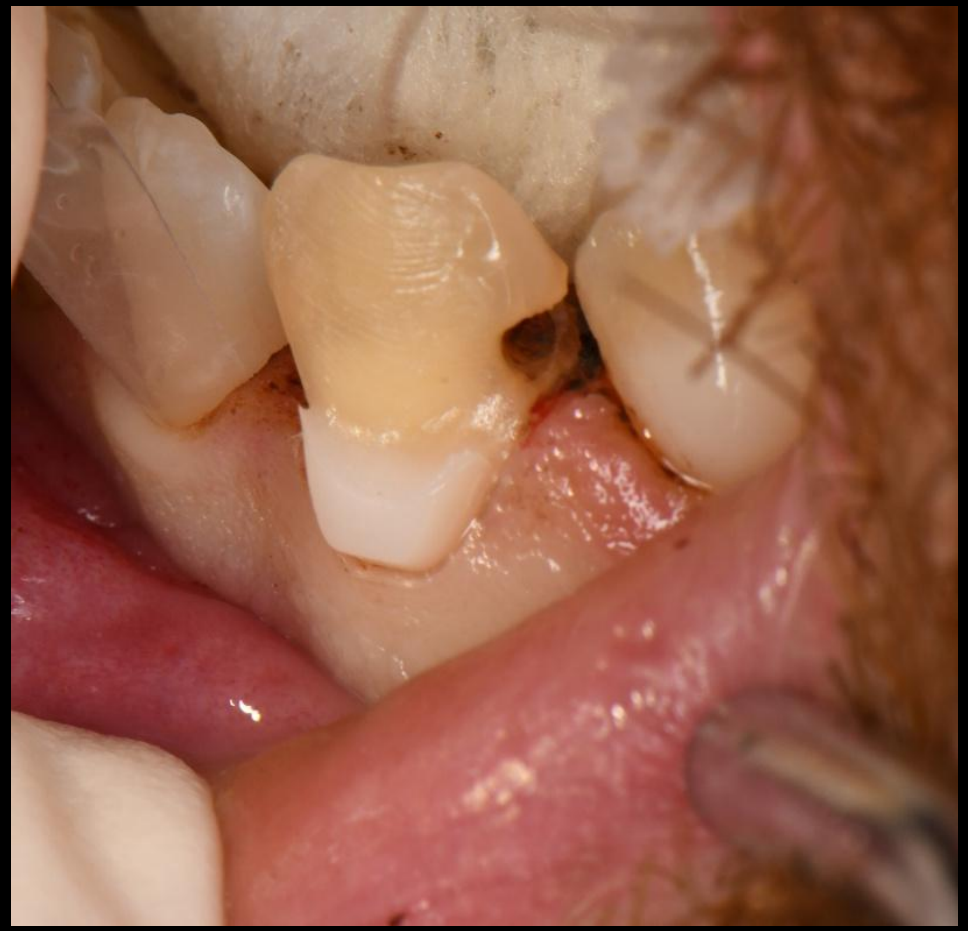


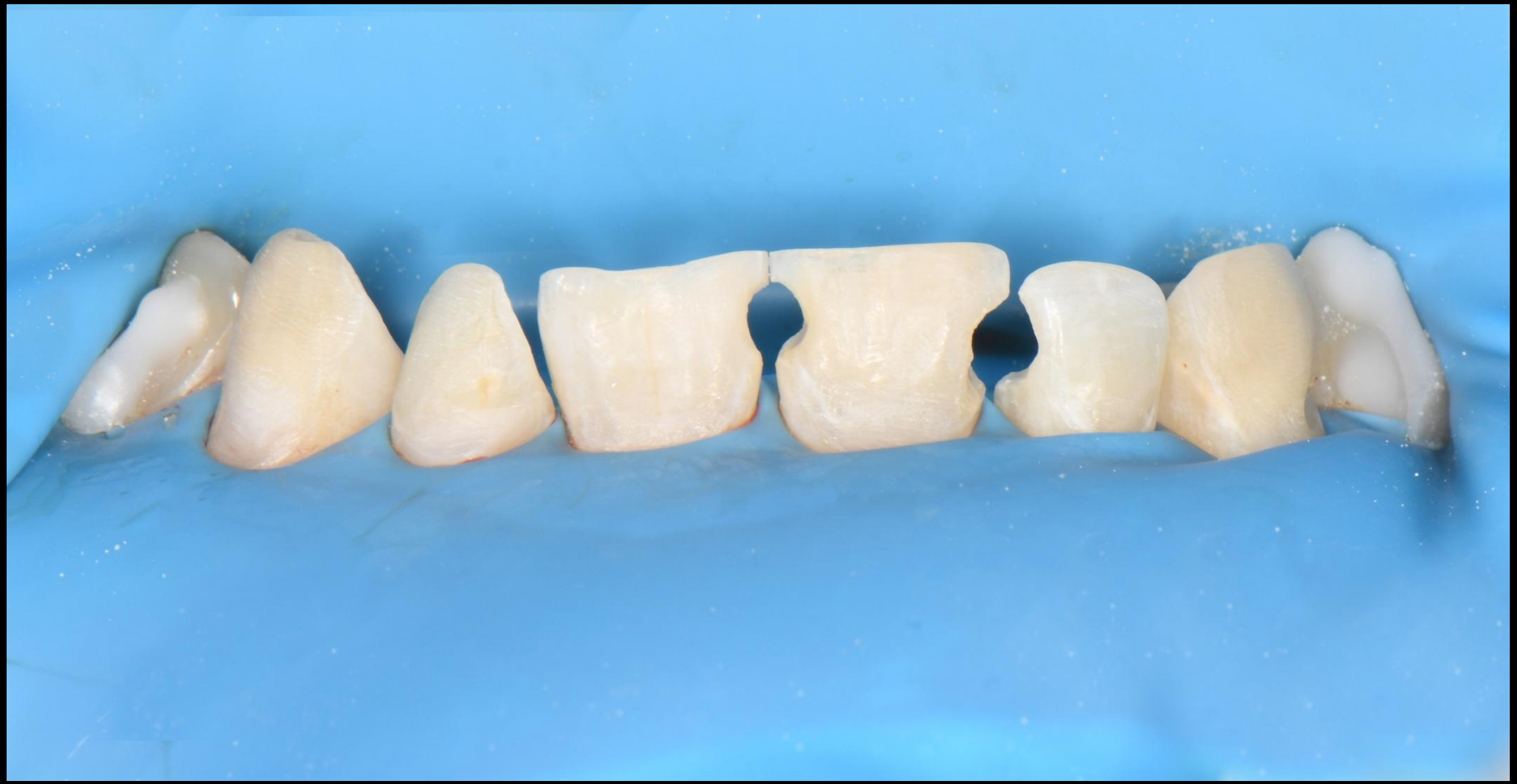










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The next generation of anterior matrices:
We're taking the guesswork out of to matrix selection


8M X 8D
7M


X 8M X 8D

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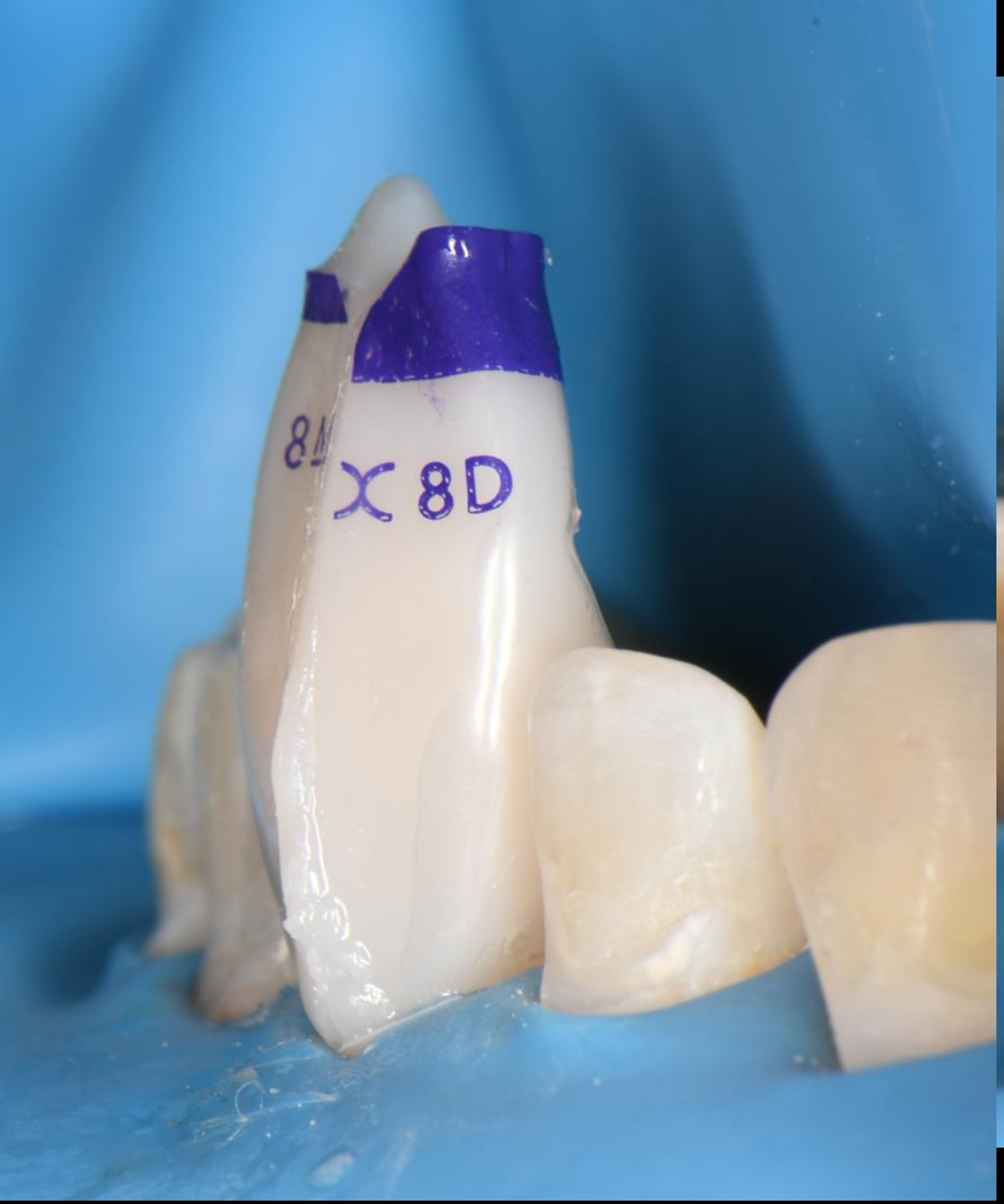
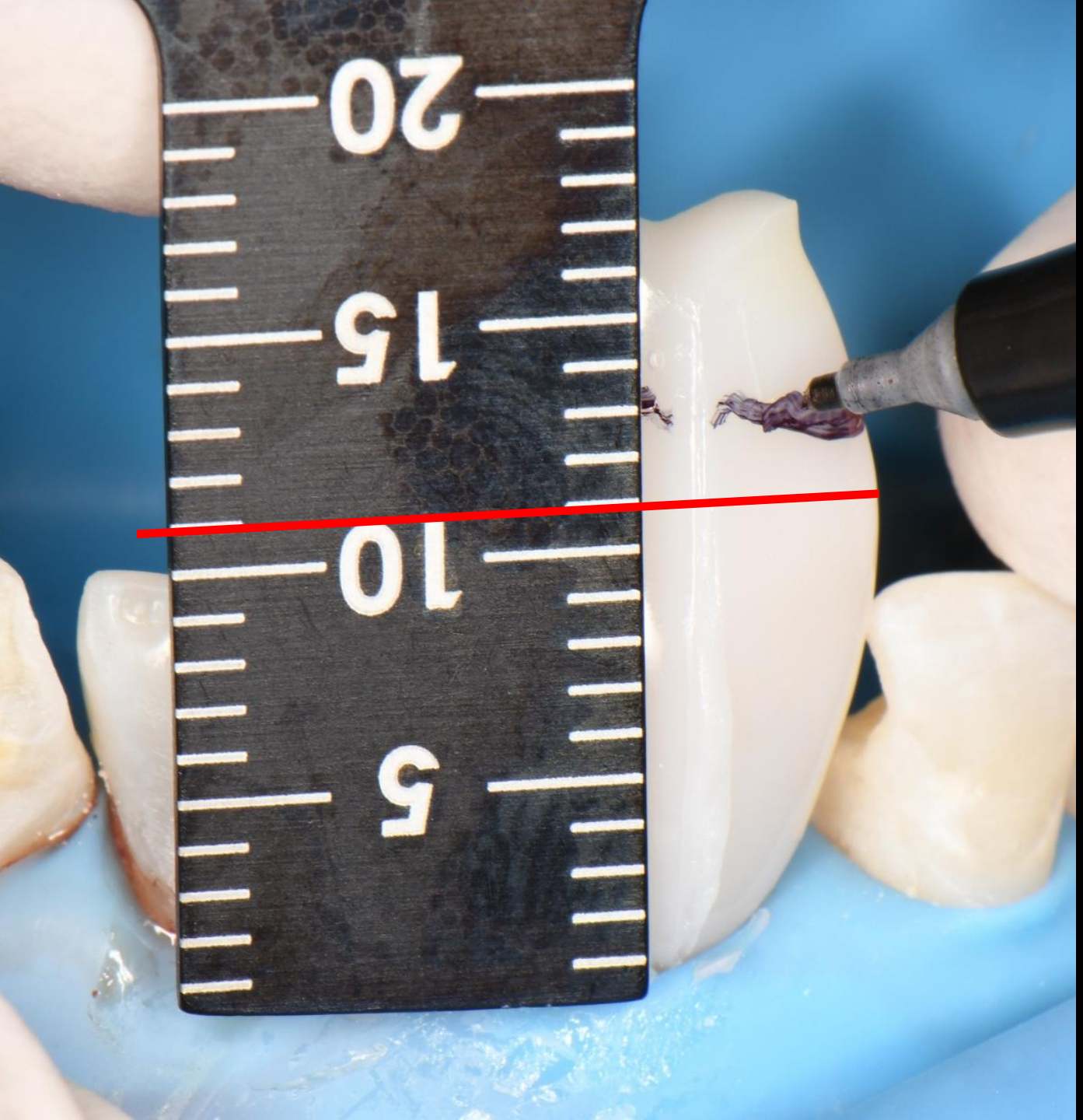



X 8D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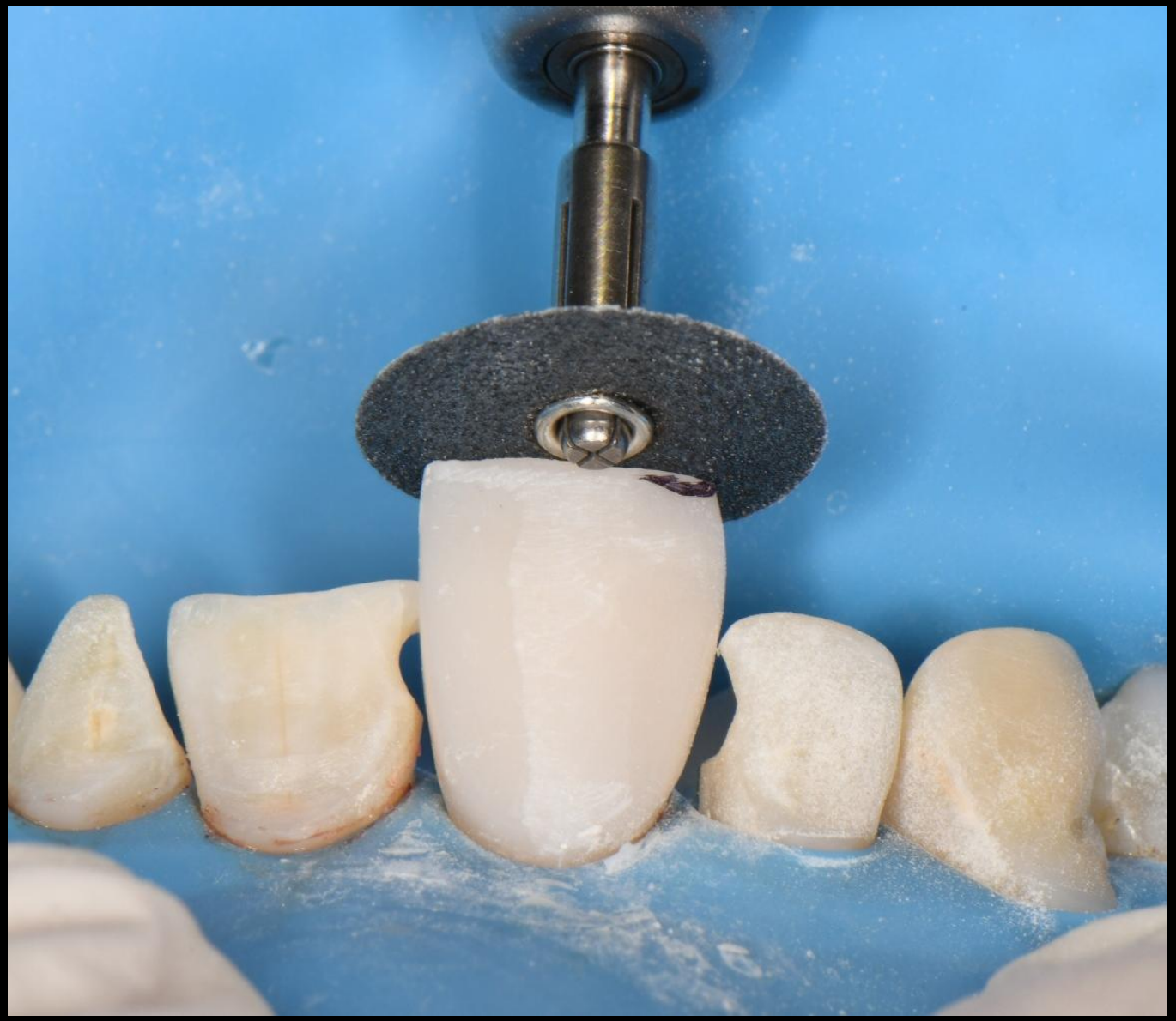

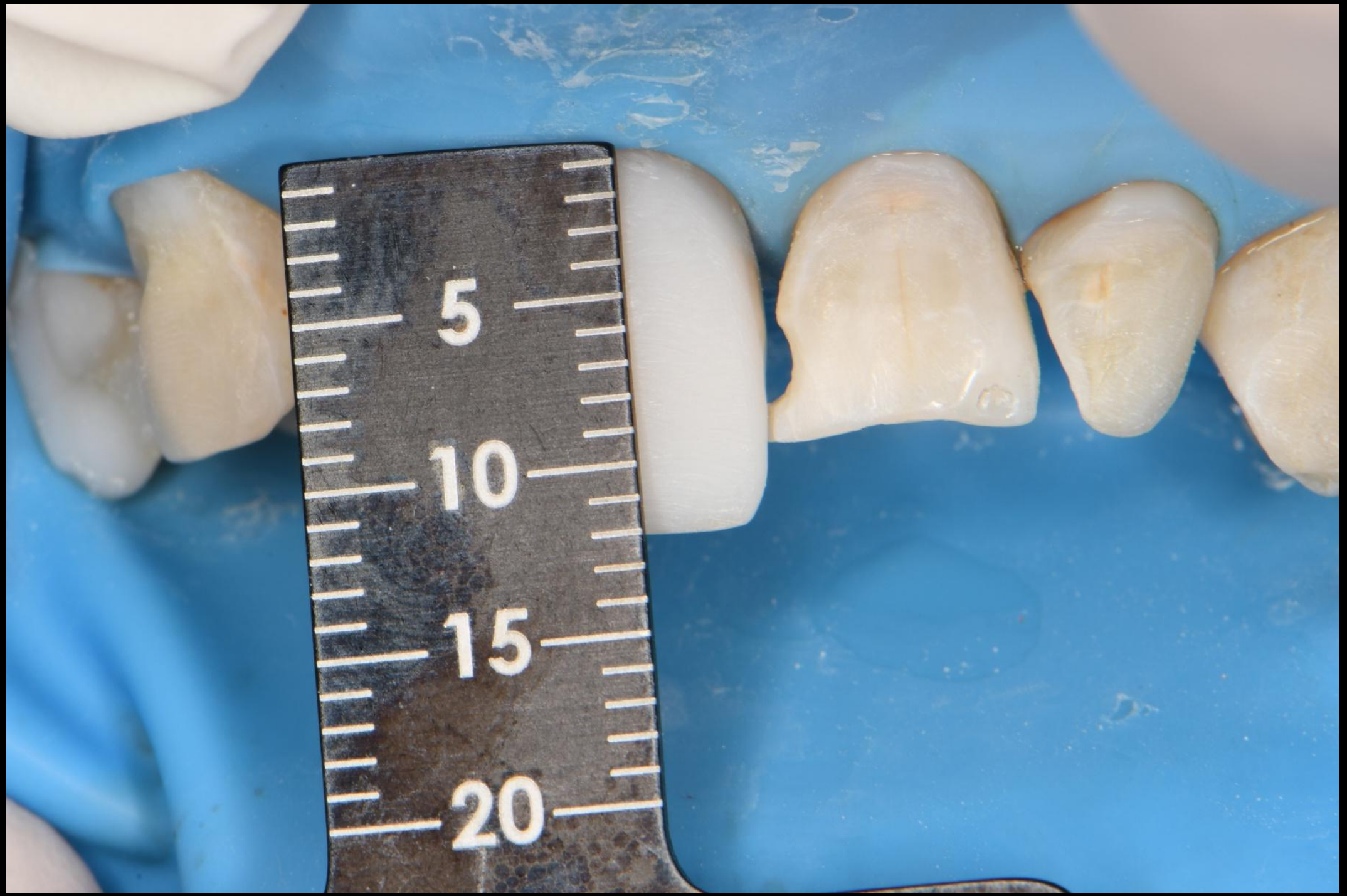
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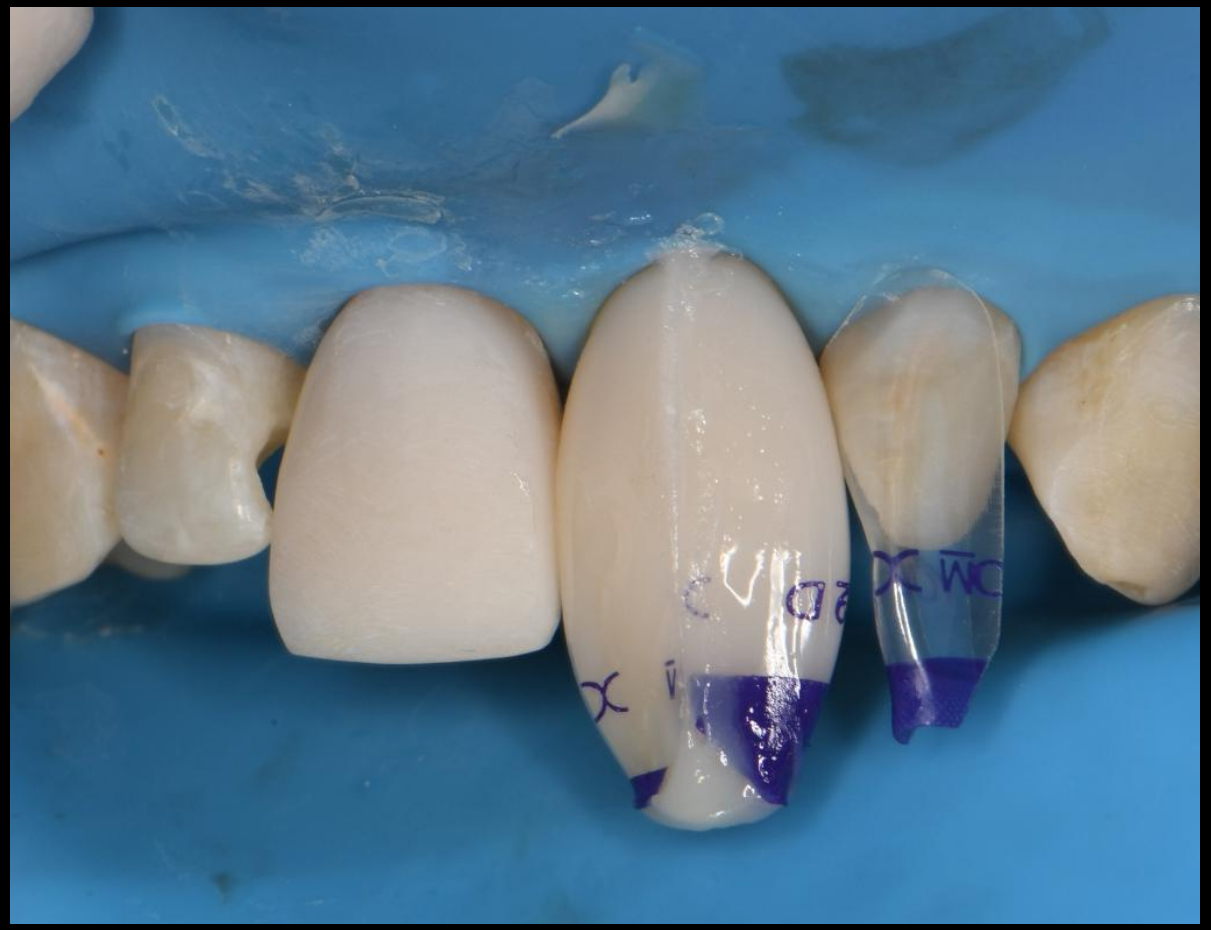

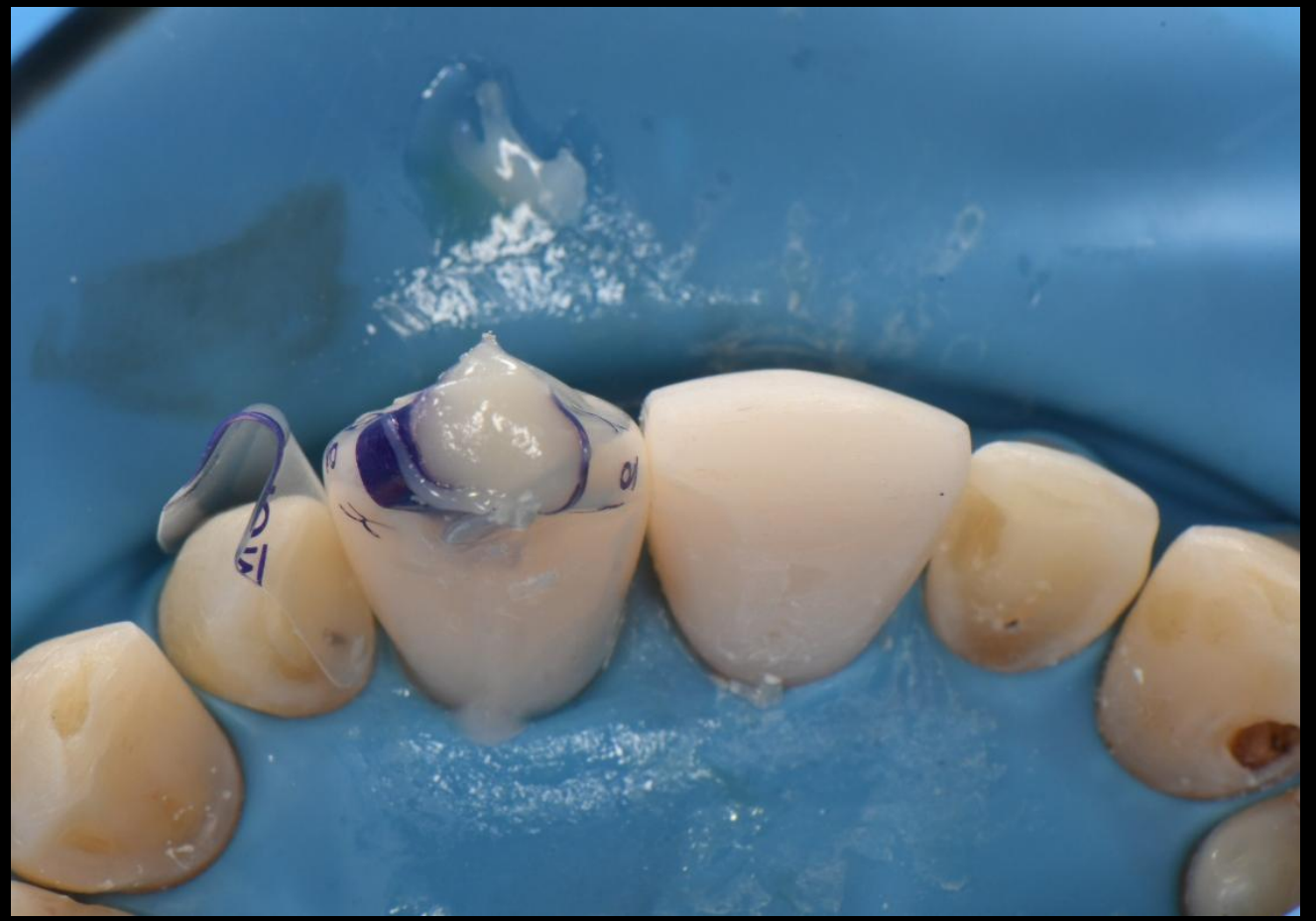

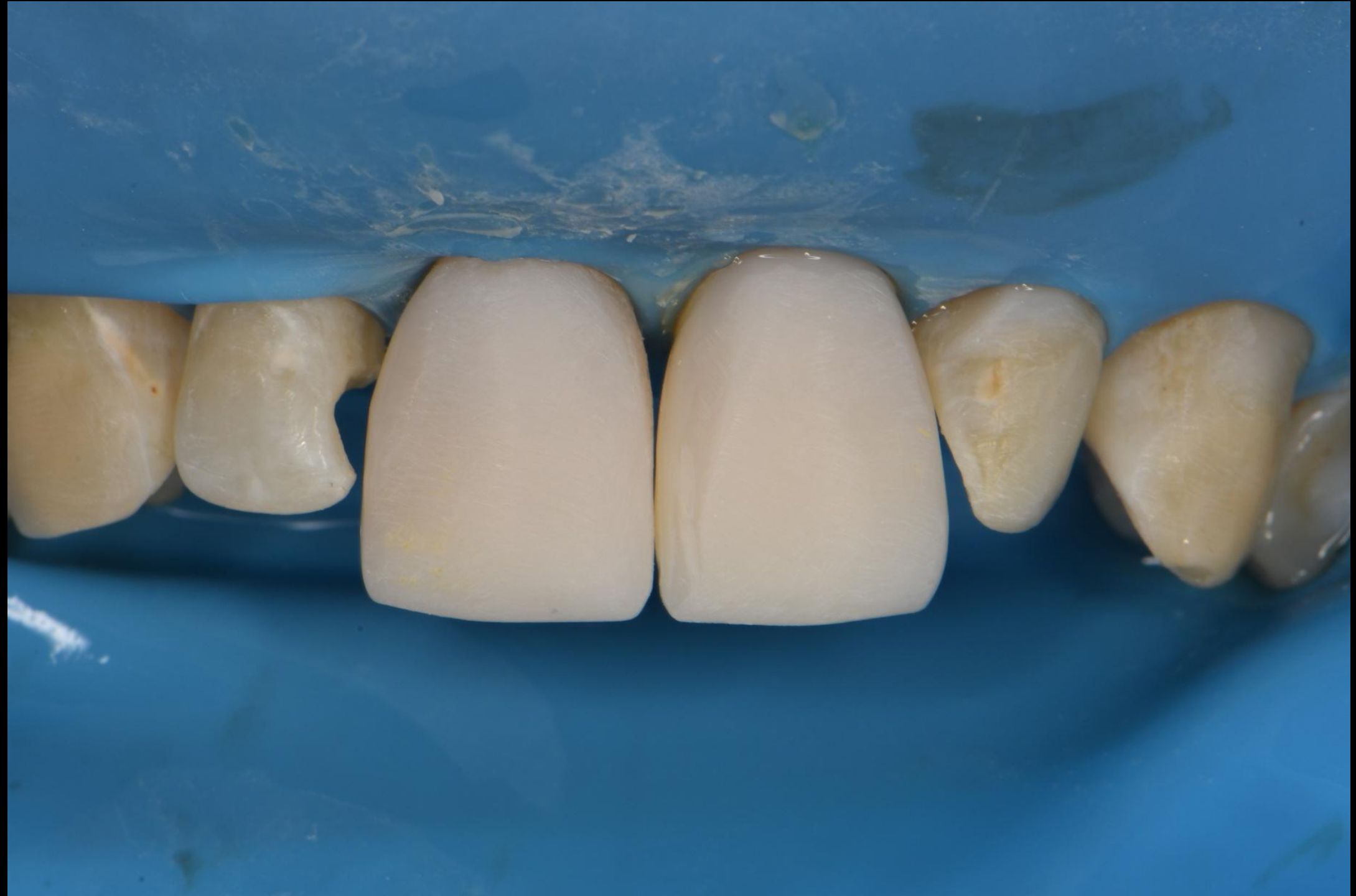


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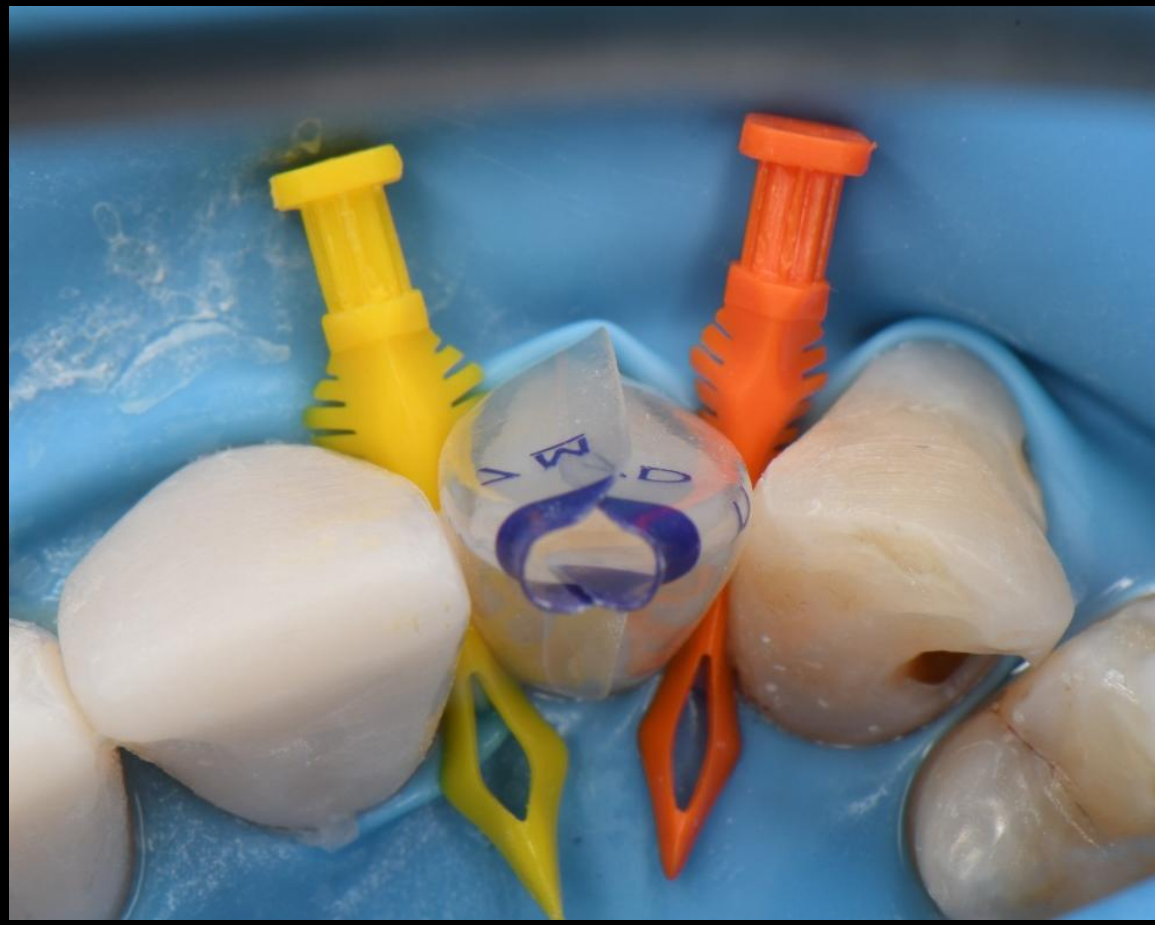


7M
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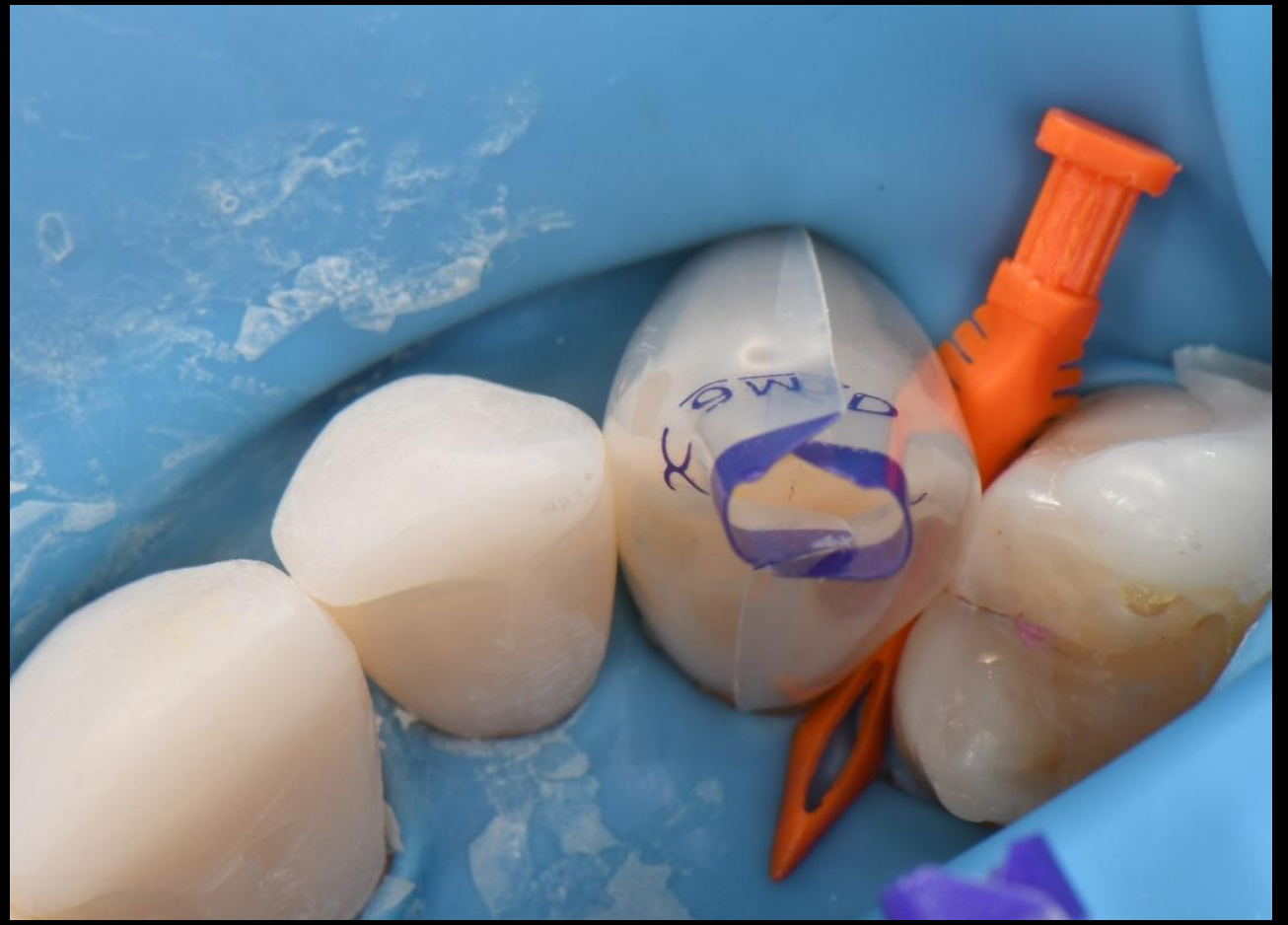

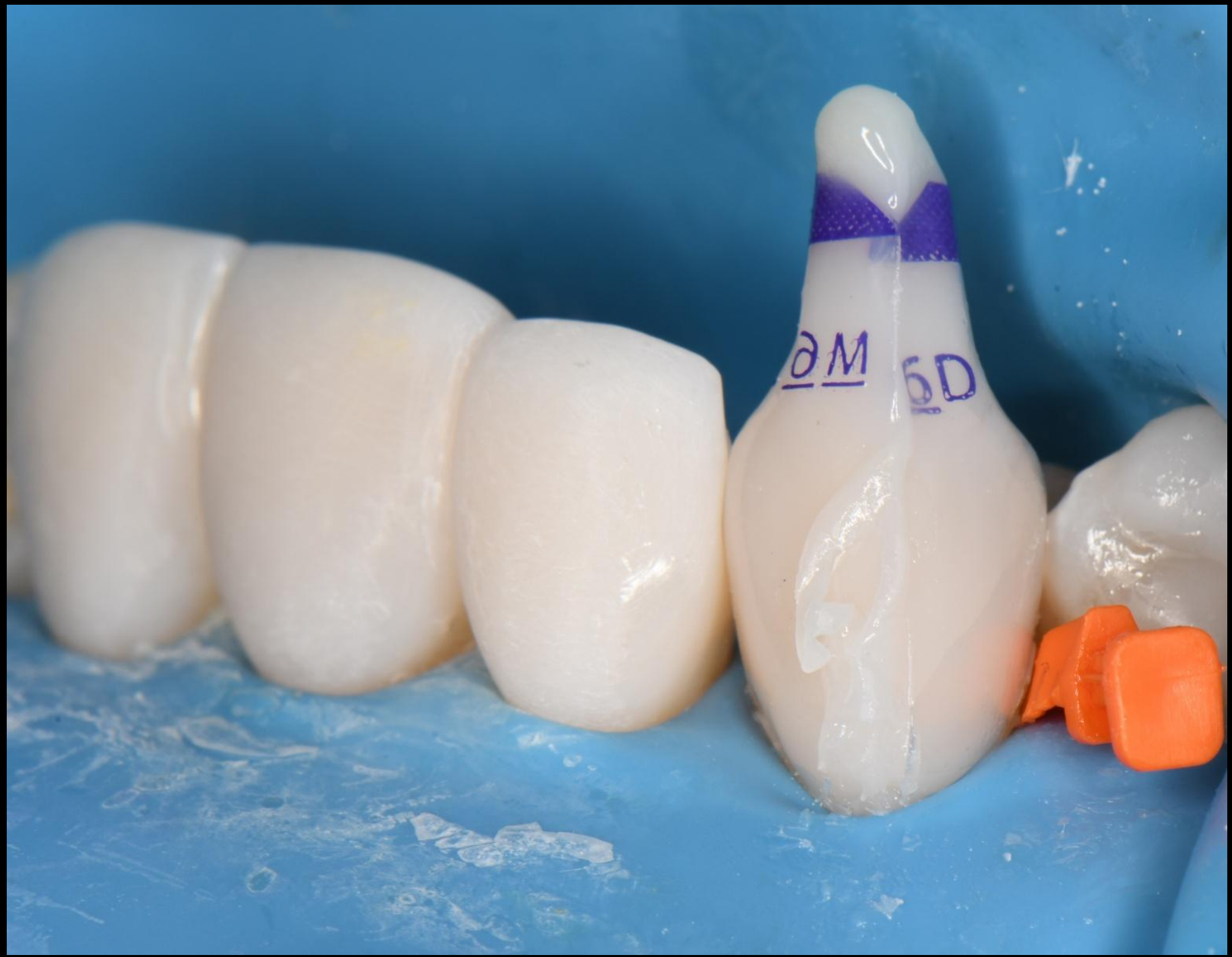
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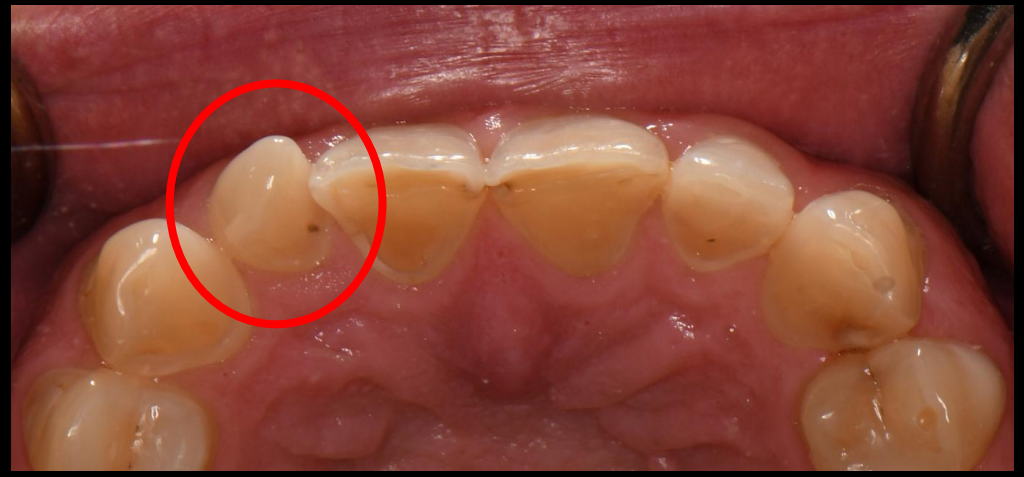
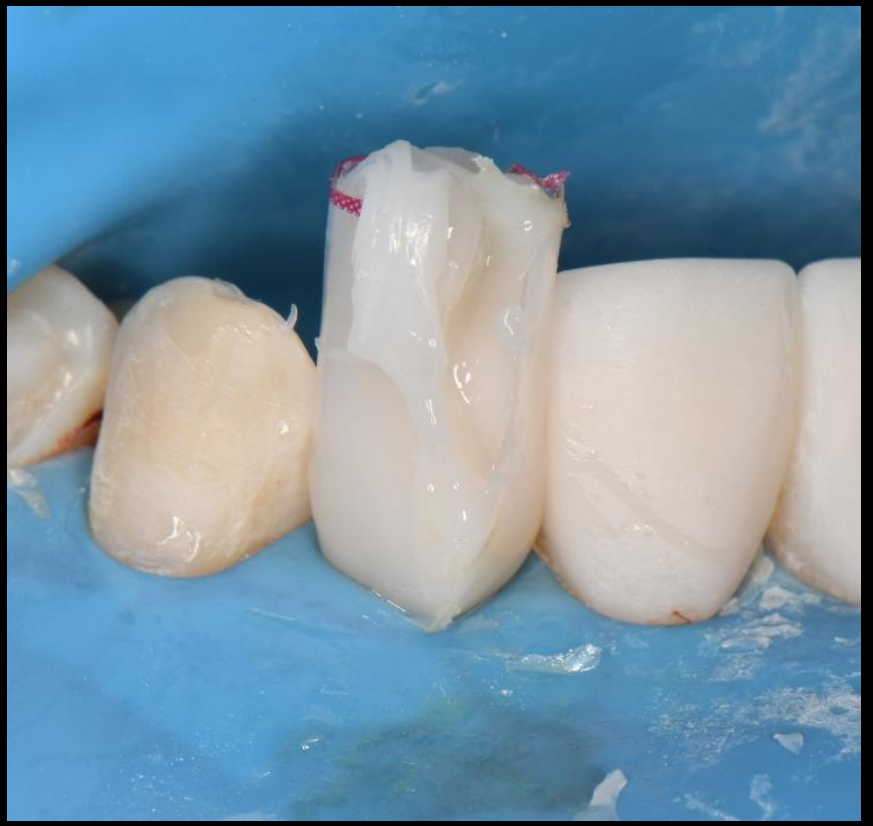
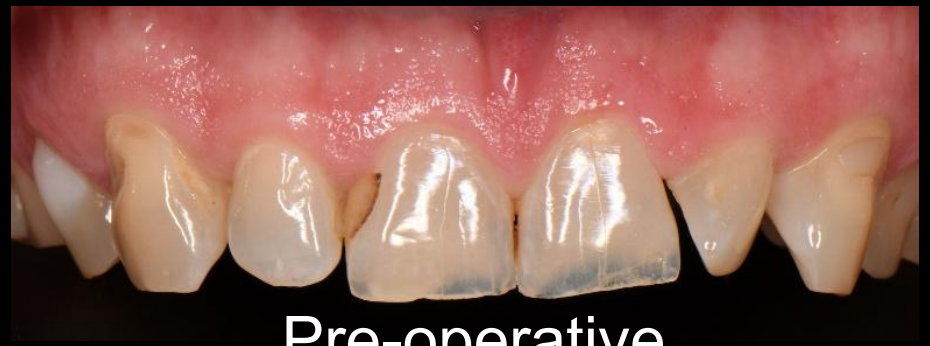
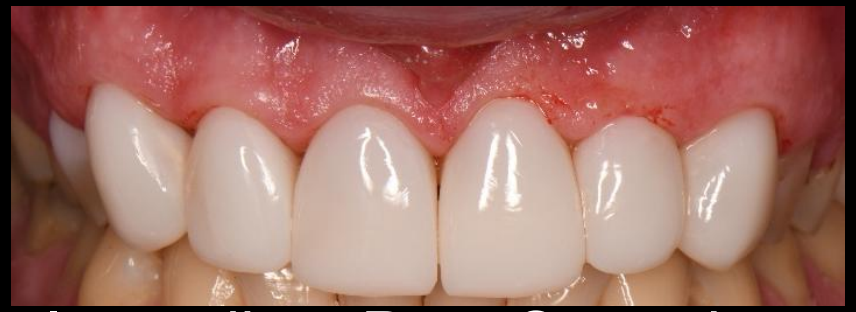





11D X 11

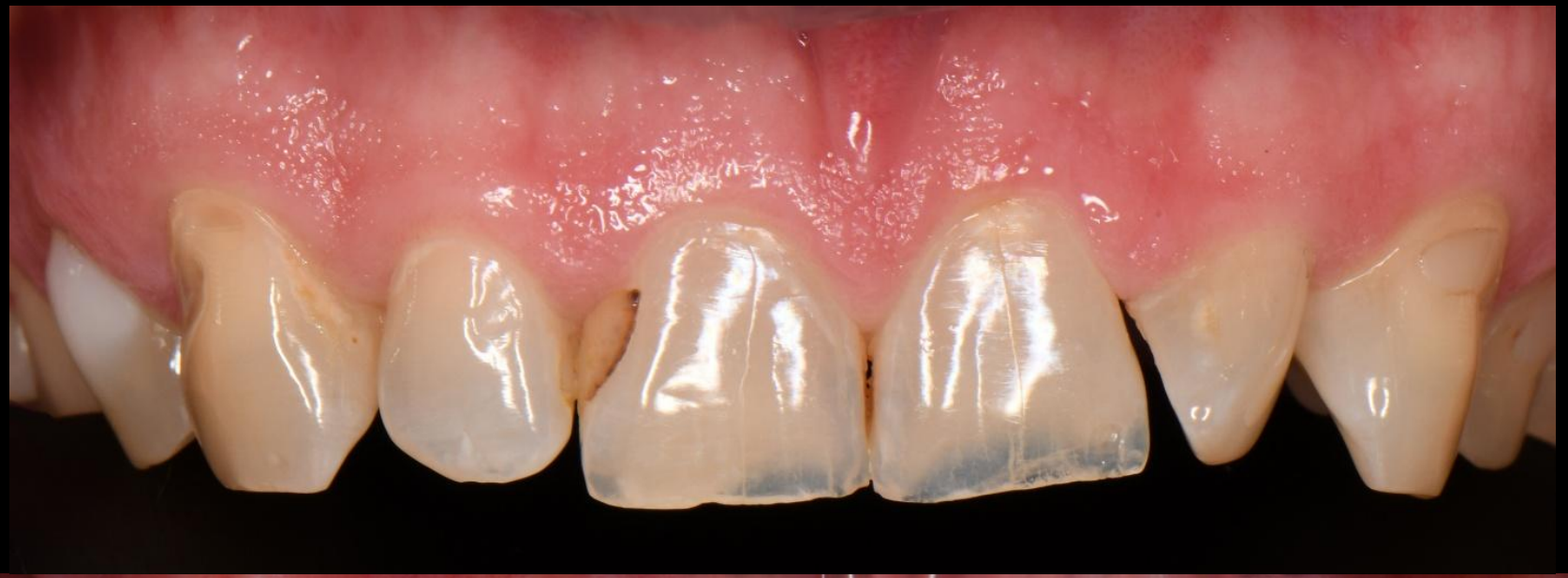


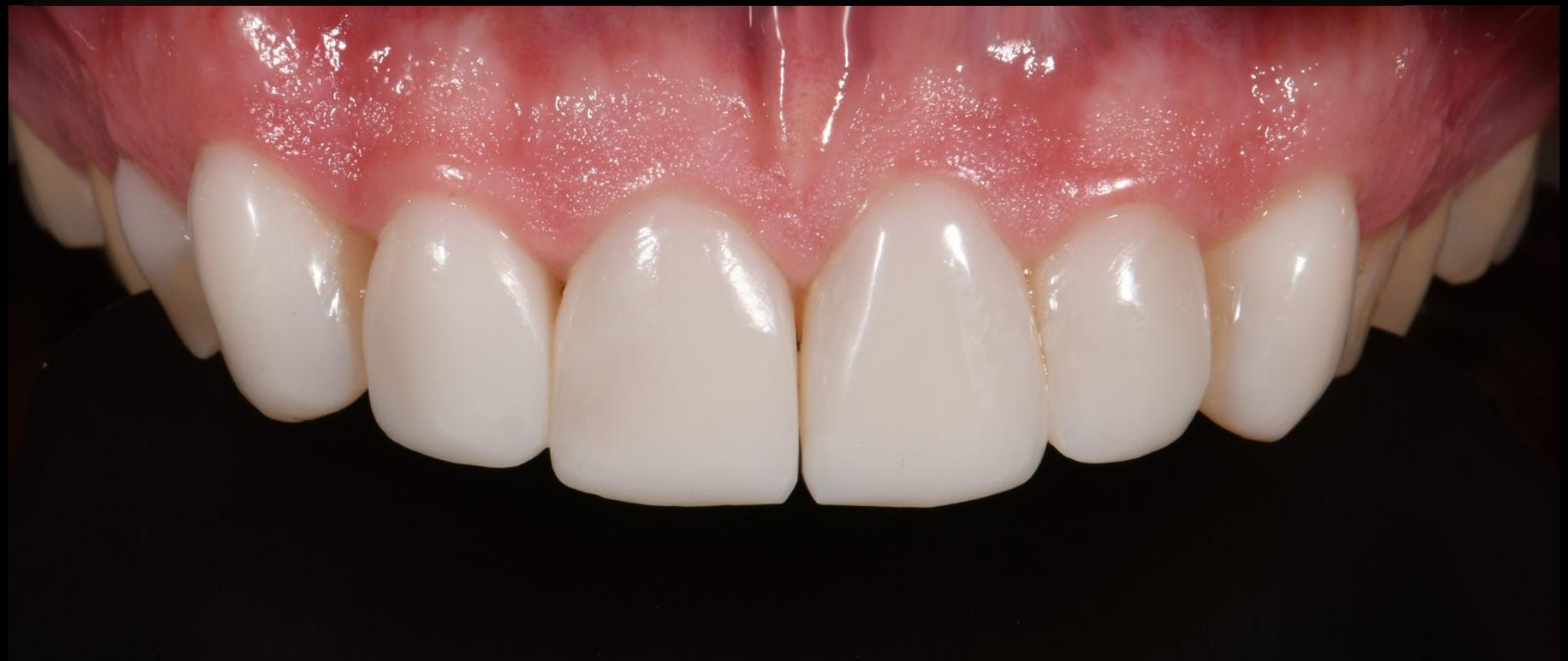
Pre-operative

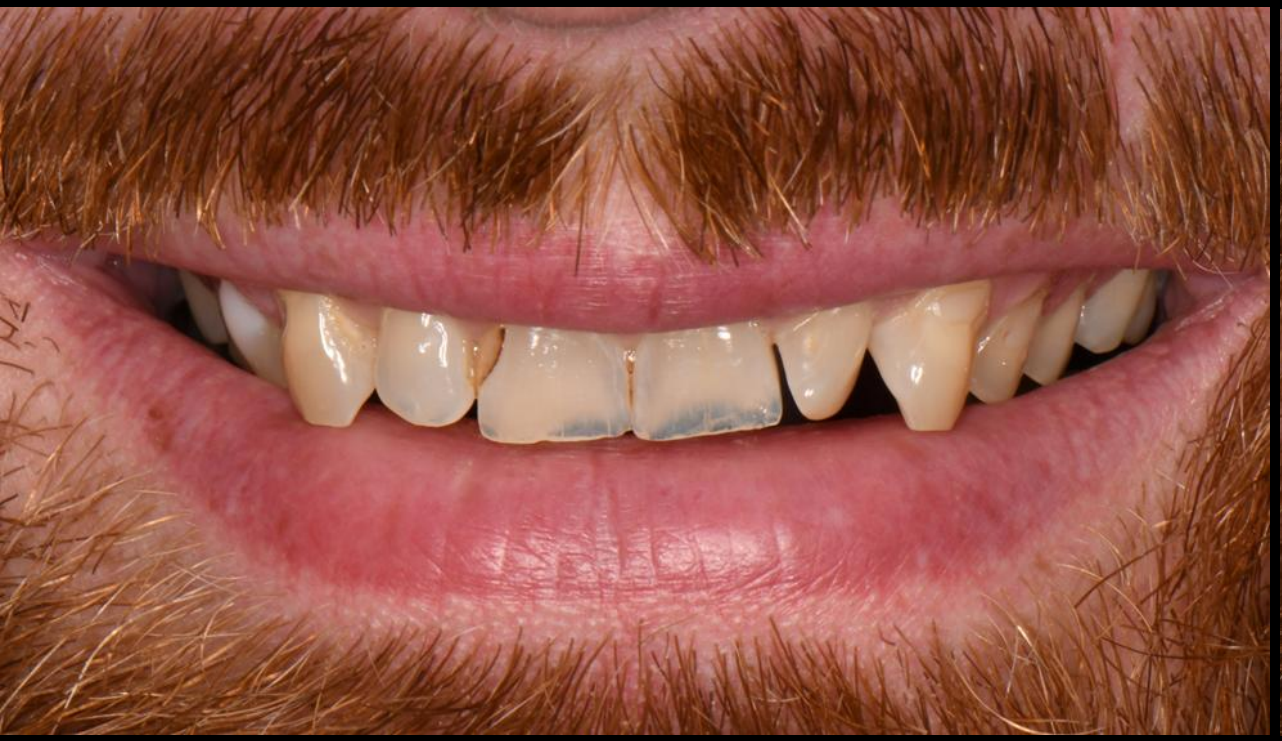


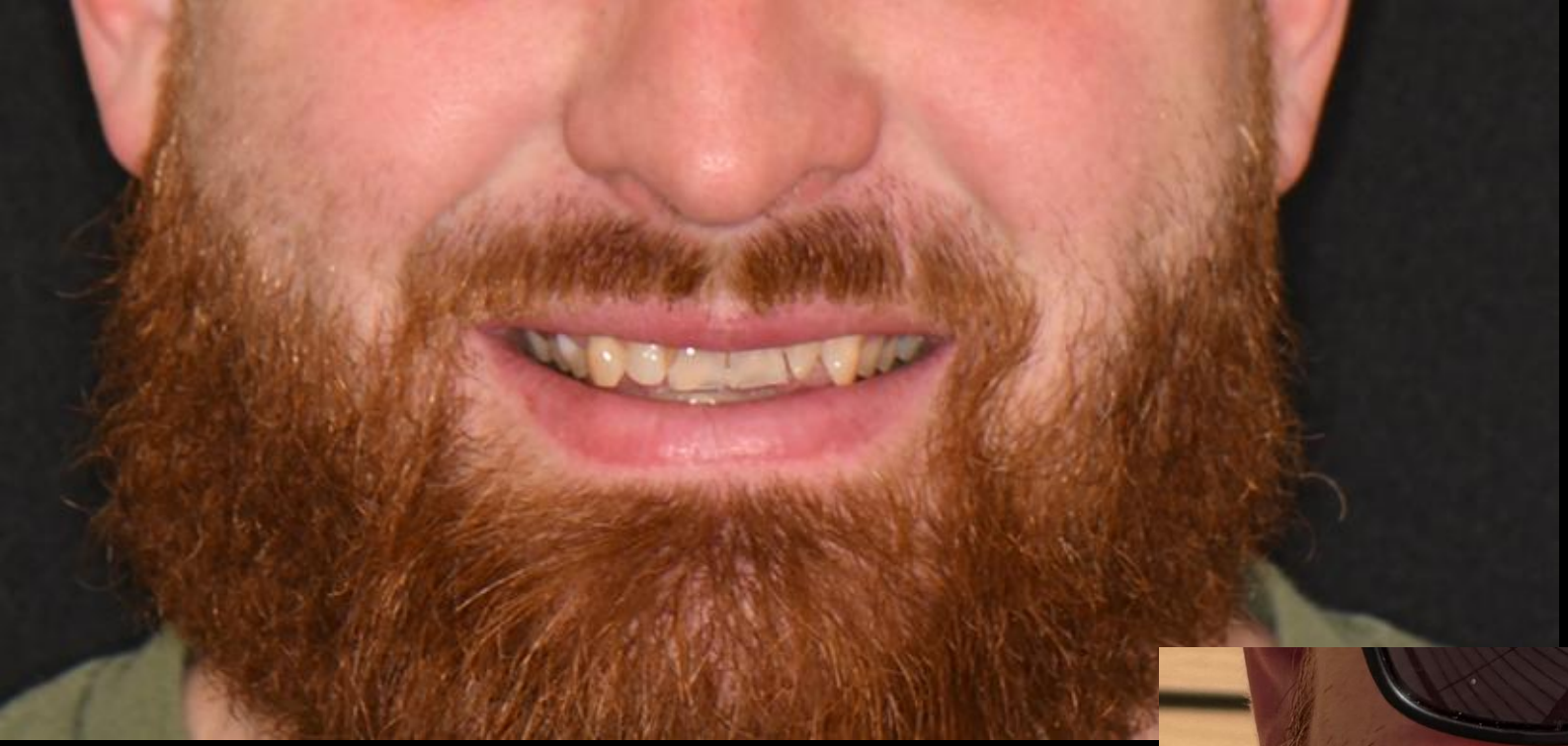
Immediate Post-Operative

One Week Post-Operative

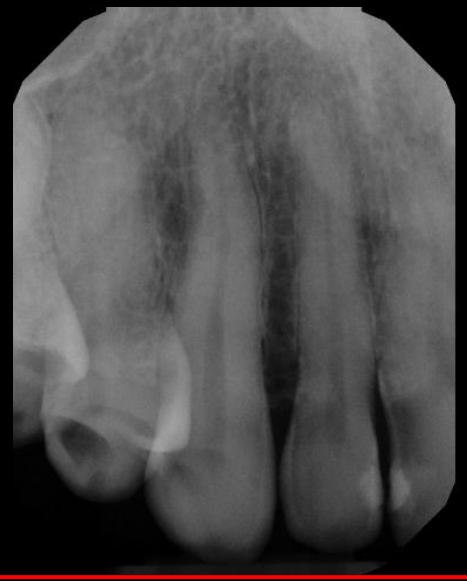
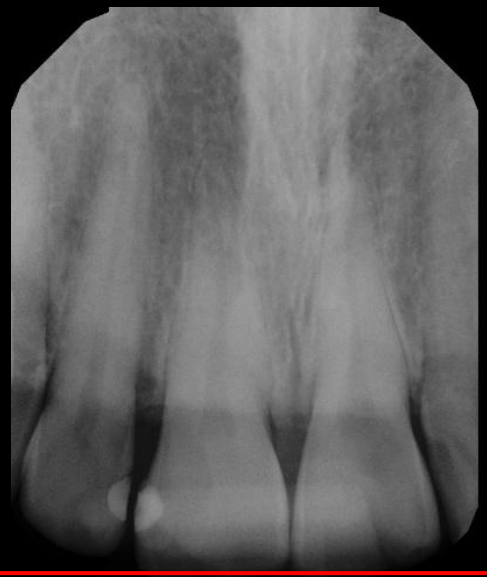
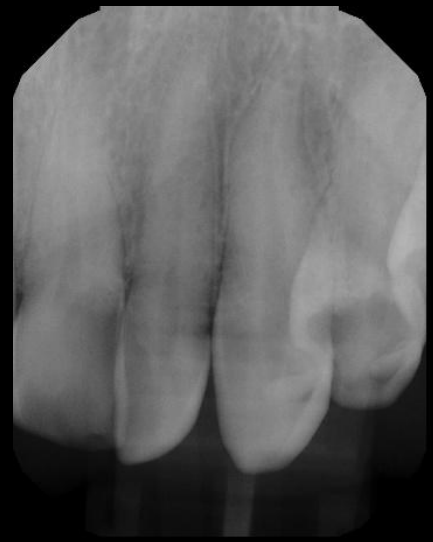
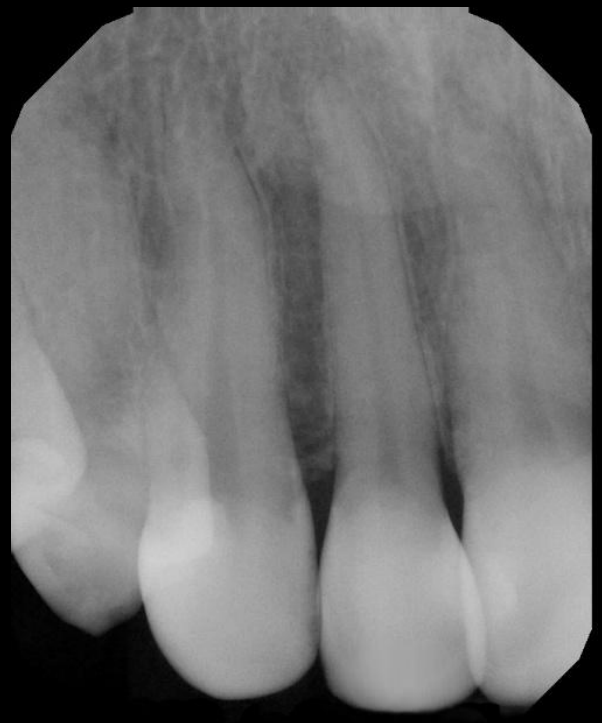
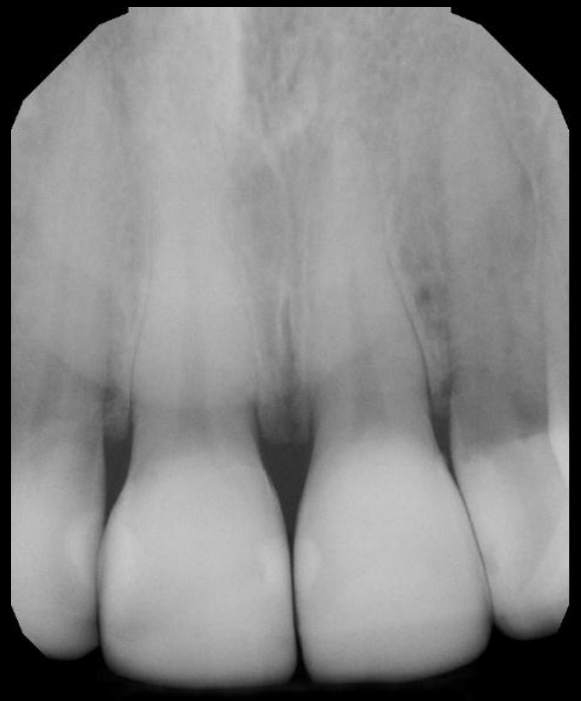
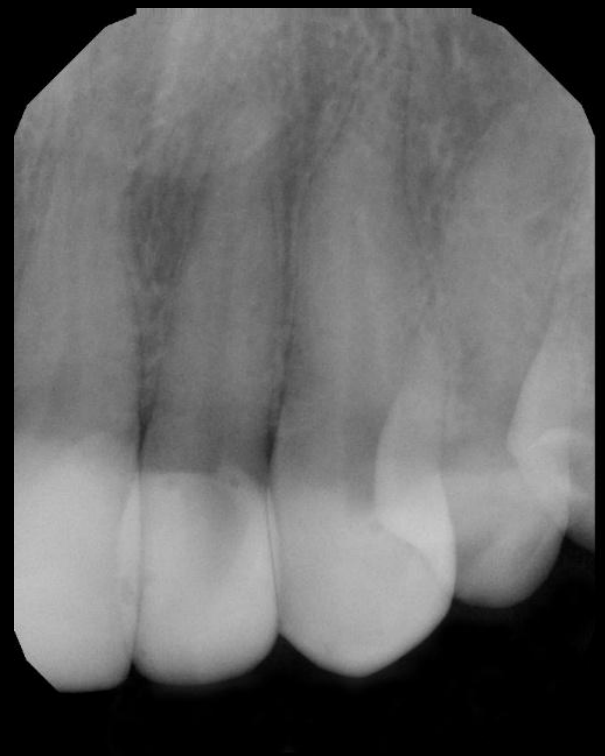


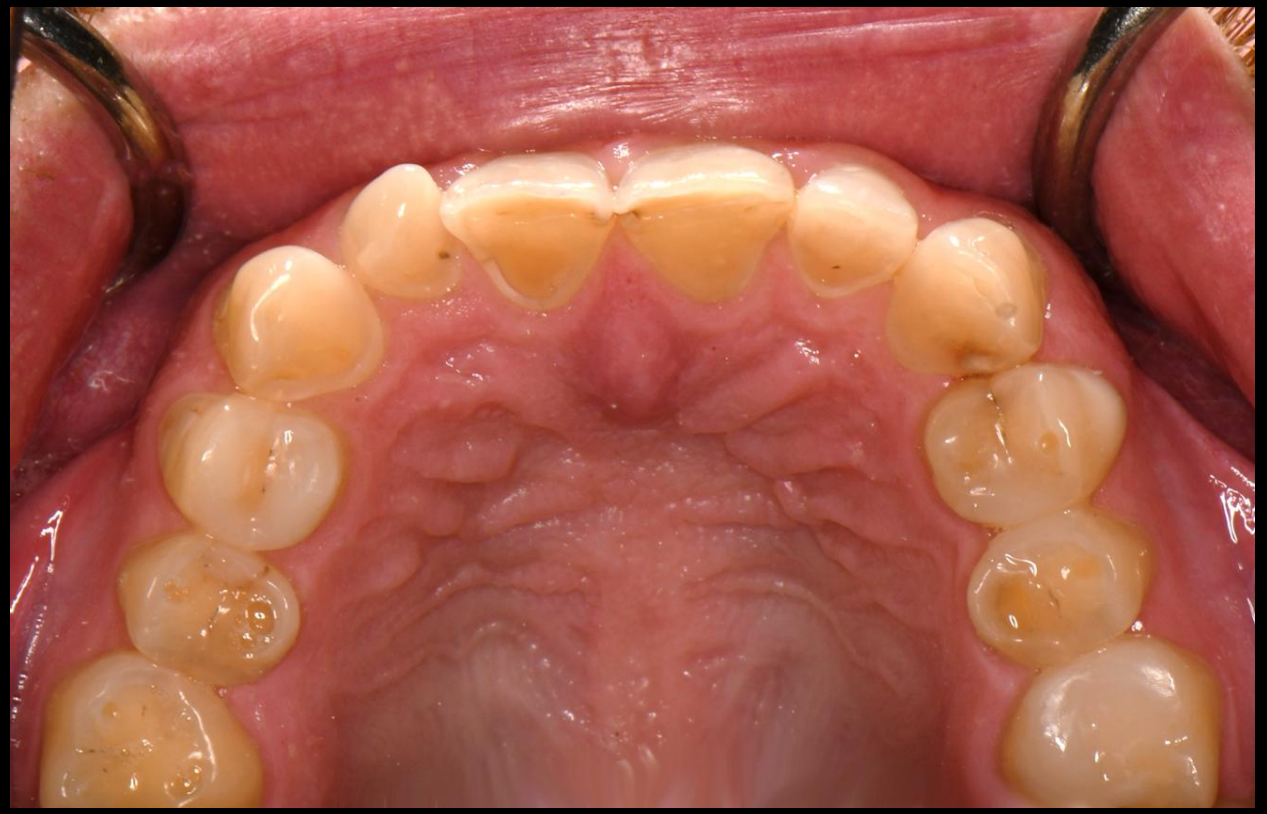


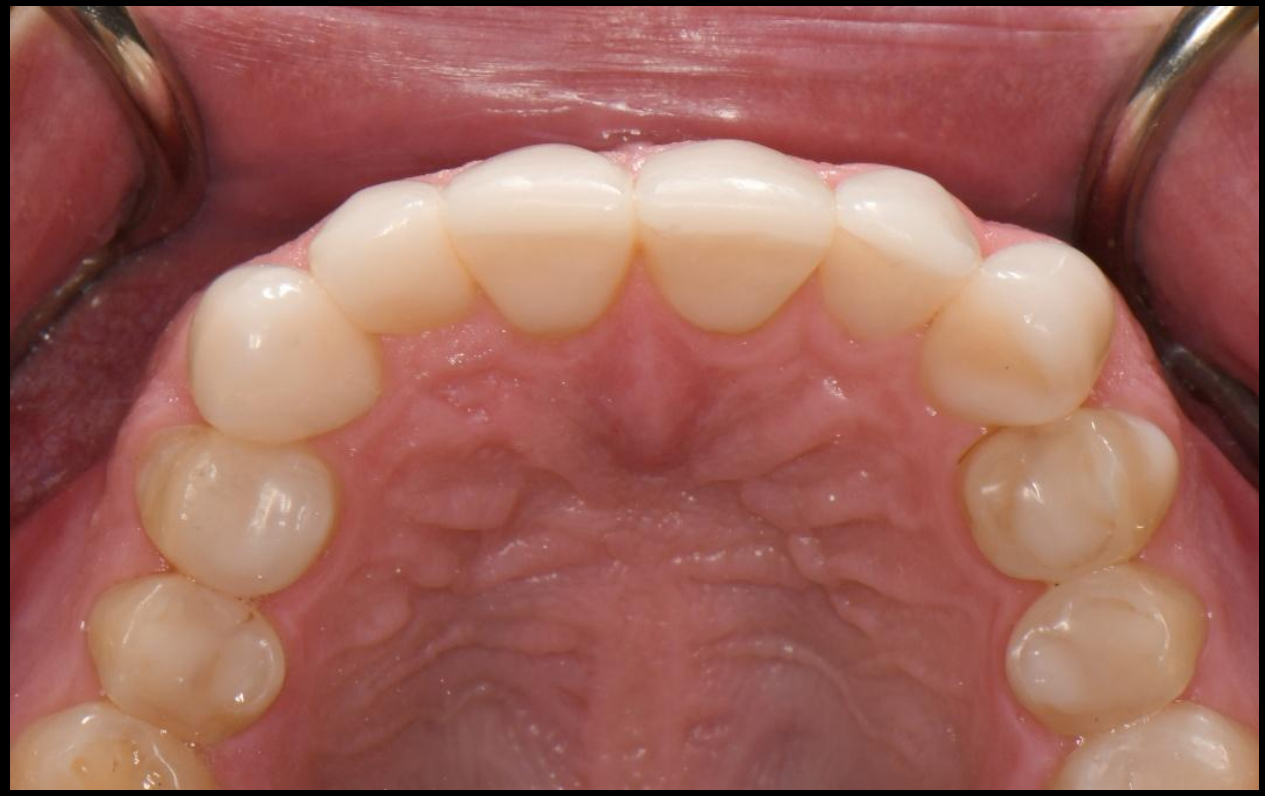


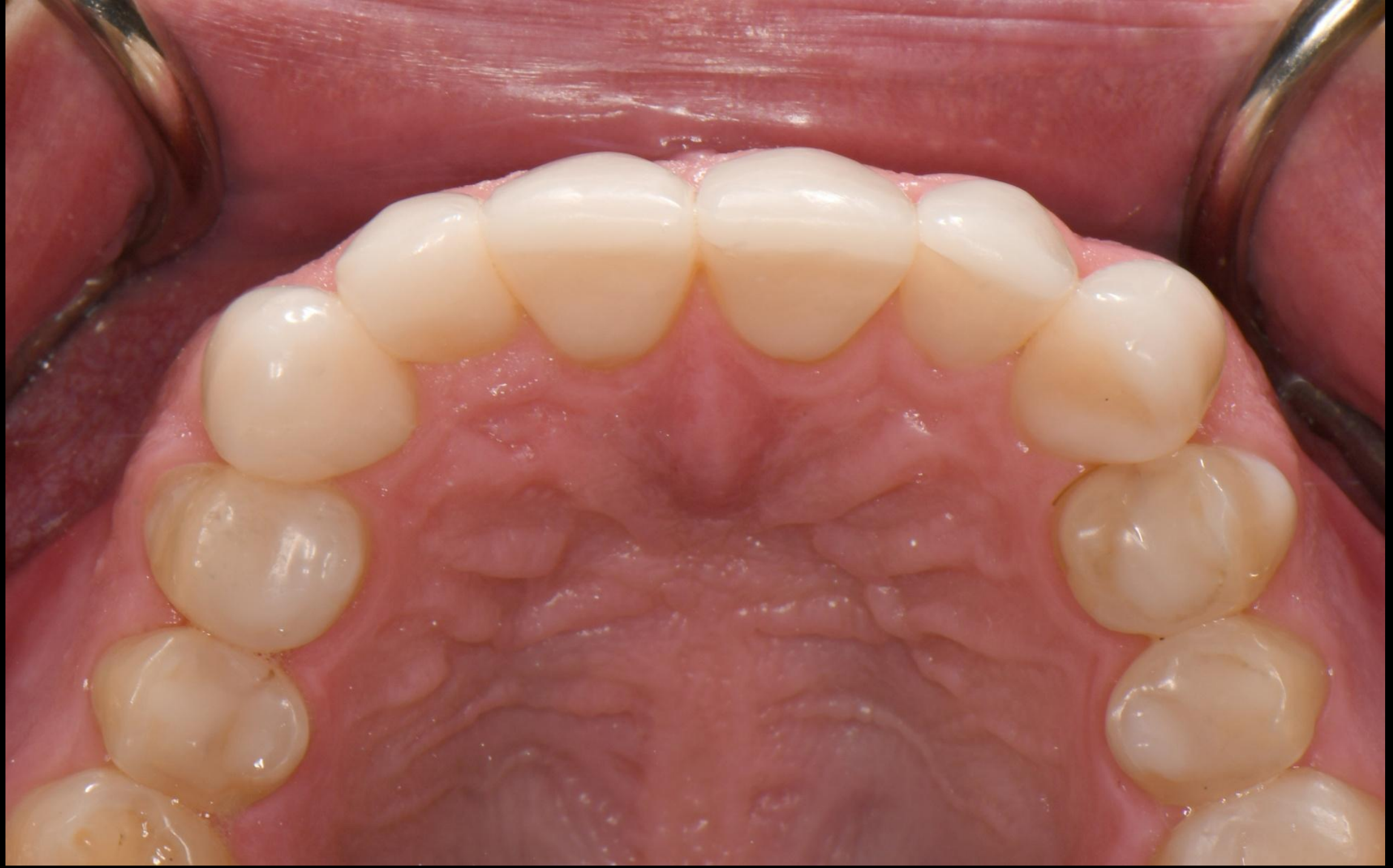



Monolithic Kuraray Majesty ES Paste & Flow: Shade EW (extra white) with Bioclear TSS Matrix

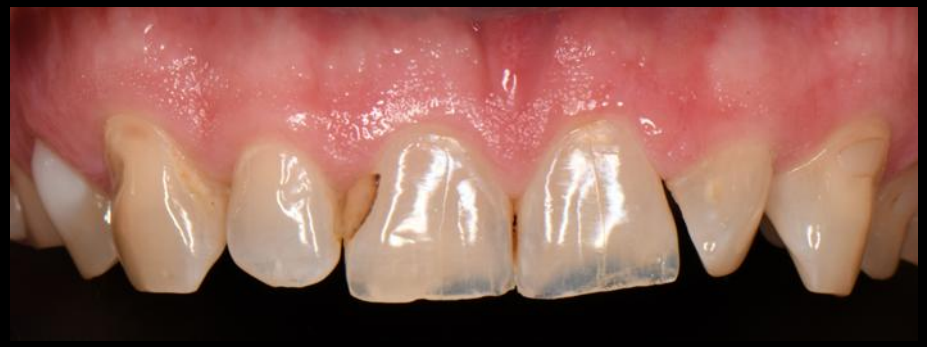













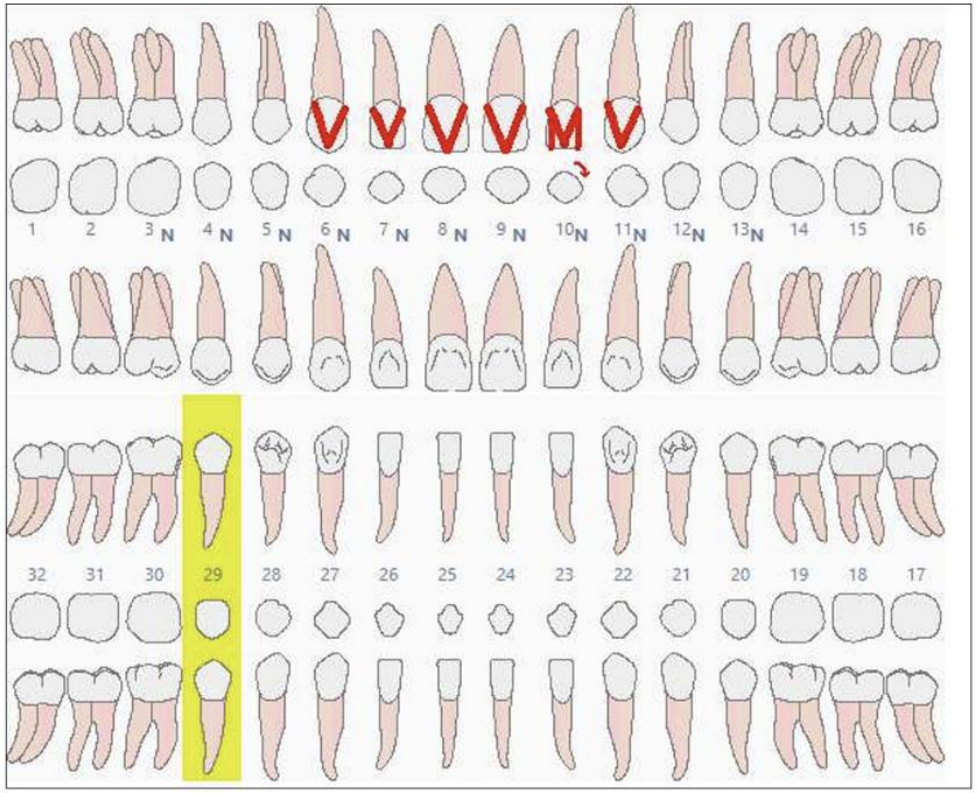
Day of treatment:
About 4 hours



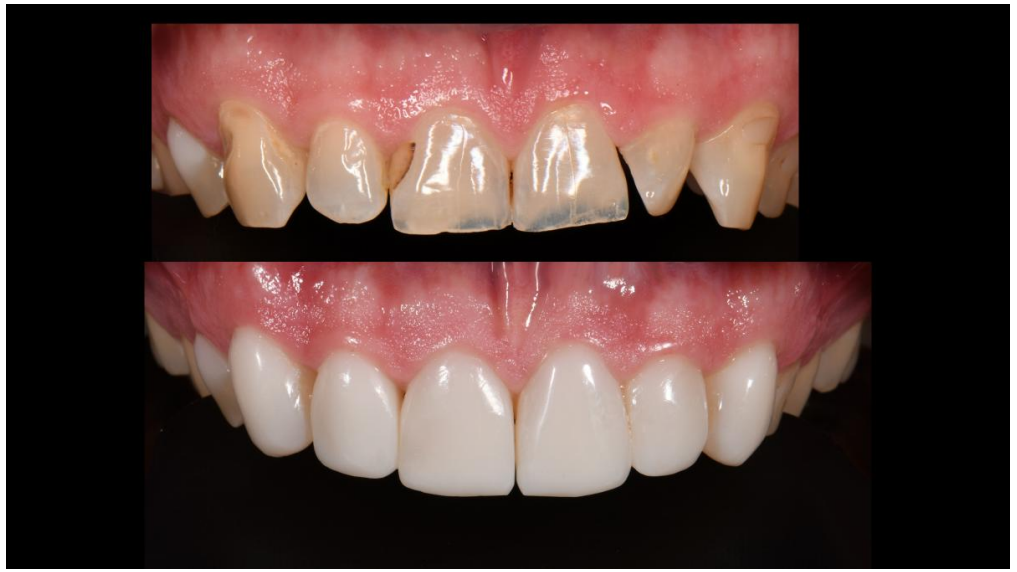
1-week post-op

Patient Chart

Patient Name [redacted]
Patient ID

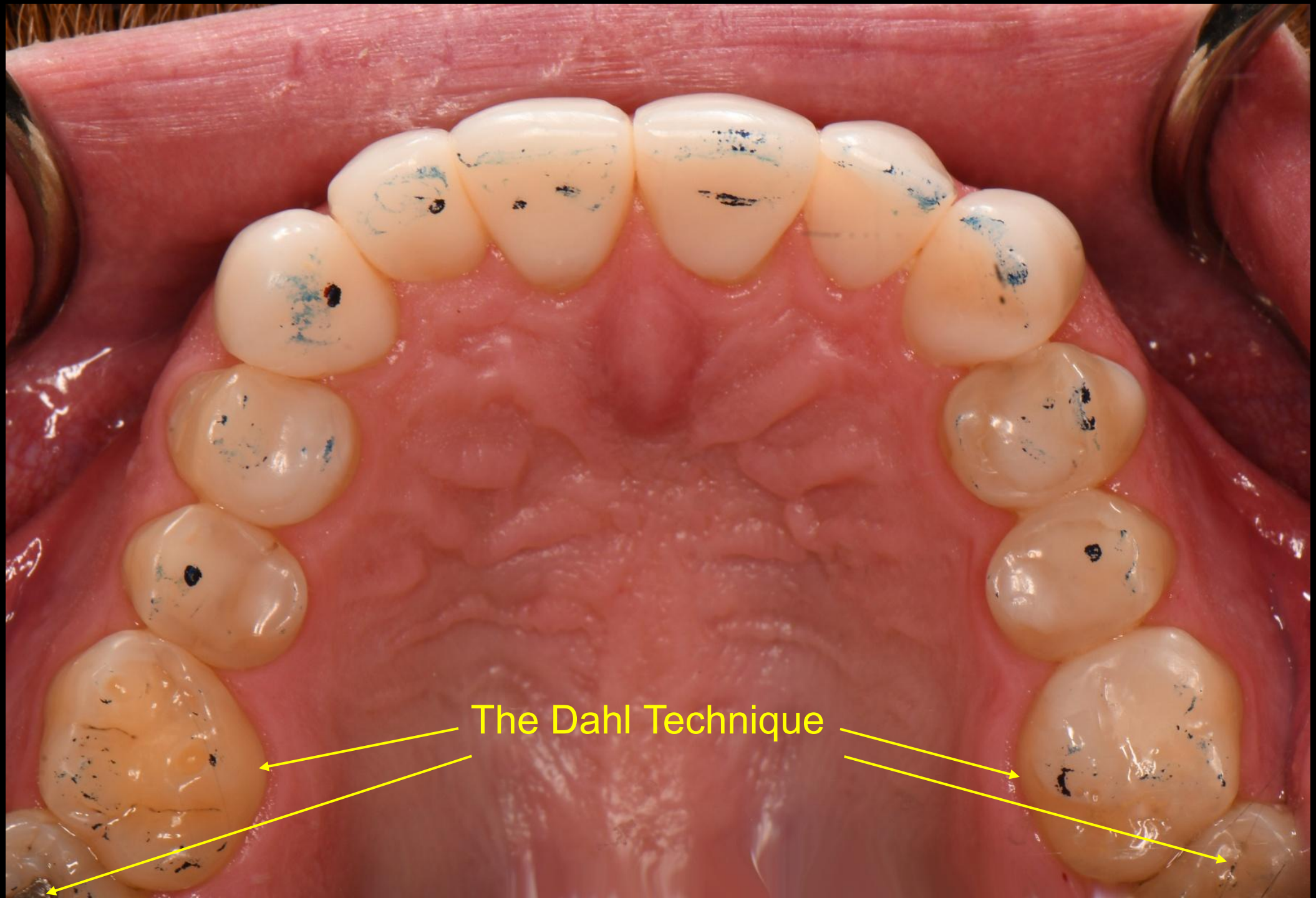


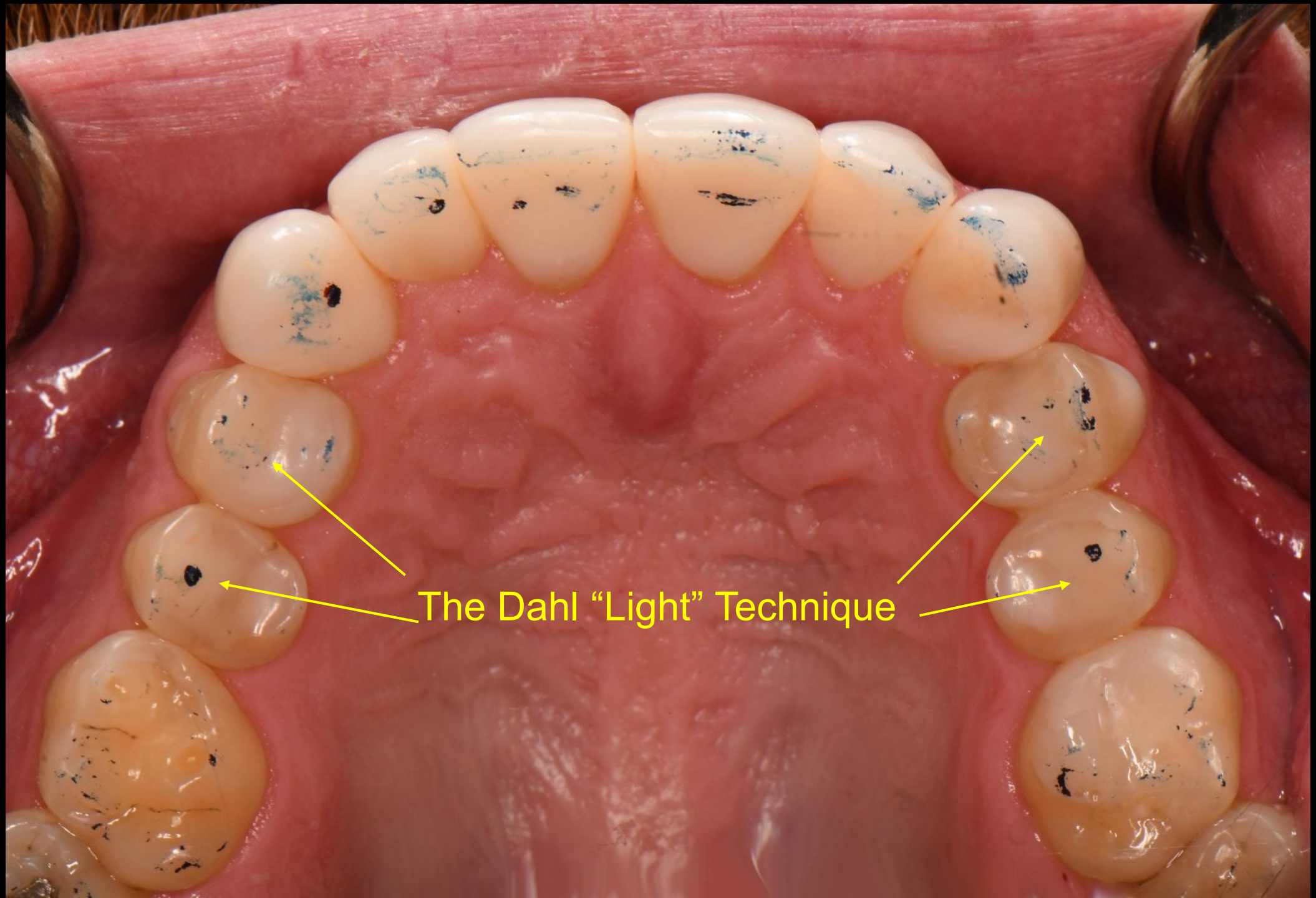
Date	Description	Provider	Tth	Surf	Status	Fee
1/15/2026	2993A - BIOCLEAR 360 REJUVENATION COMPLEX	David J. Clark, D.D.S.	6		Proposed	$1,840.00
1/15/2026	2993A - BIOCLEAR 360 REJUVENATION COMPLEX	David J. Clark, D.D.S.	7		Proposed	$1,840.00
1/15/2026	2993A - BIOCLEAR 360 REJUVENATION COMPLEX	David J. 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

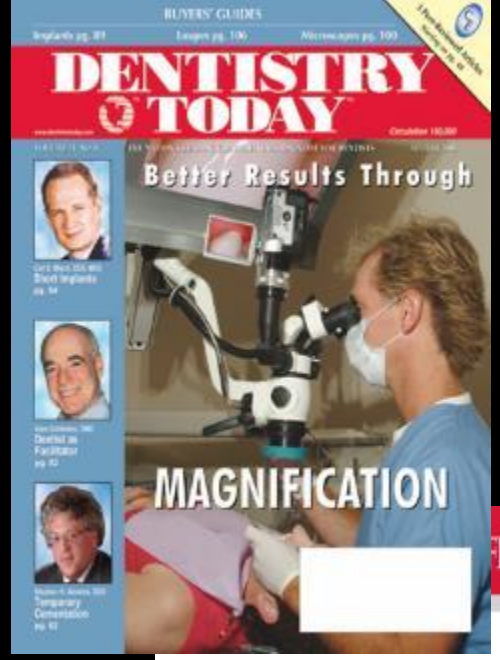


Total Bioclear Case Fee?

$11,631

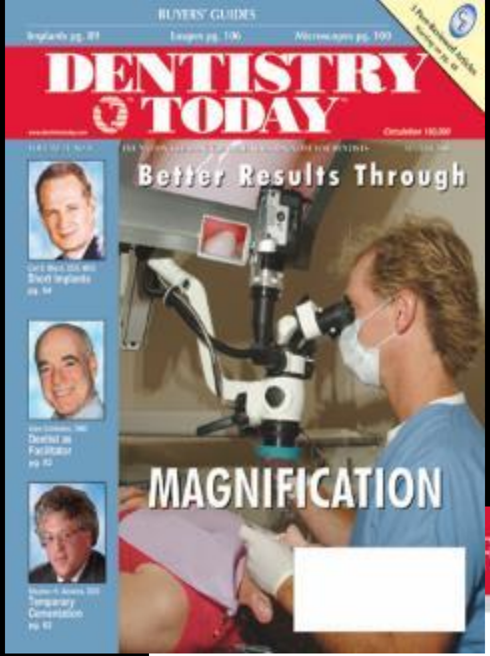

The Dahl Technique


The Dahl “Light” Technique



The Epidemic of Cracked and Fracturing Teeth

"Dentistry's last great mystery, that of fracturing, is a poorly understood process."

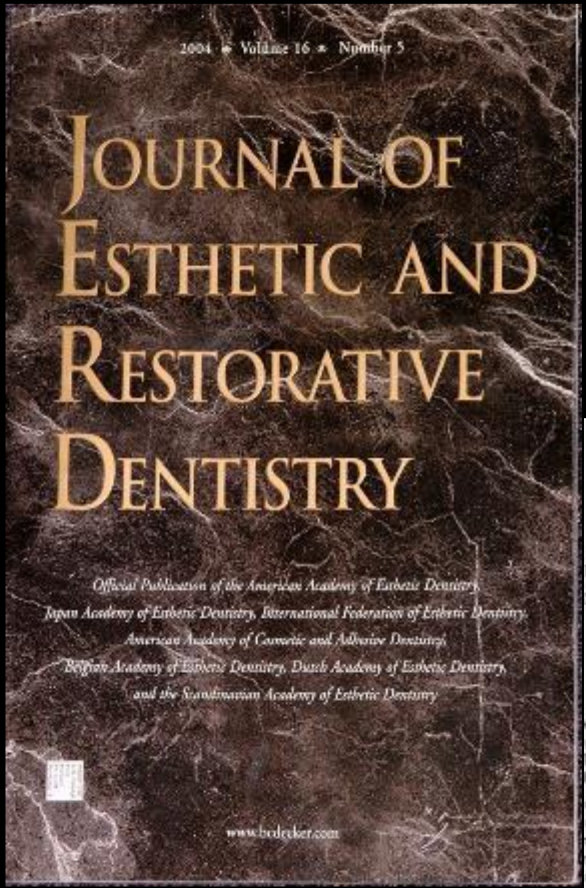


The Epidemic of Cracked and Fracturing Teeth

DRINGING DIAGNOSIS AND PREVENTION OUT OF THE STONE AGE

Table 1. How Can We Eliminate Teeth Fracturing?

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



...nitive Diagnosis of Early Enamel and Dentinal ...cks Based on Microscopic Evaluation

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

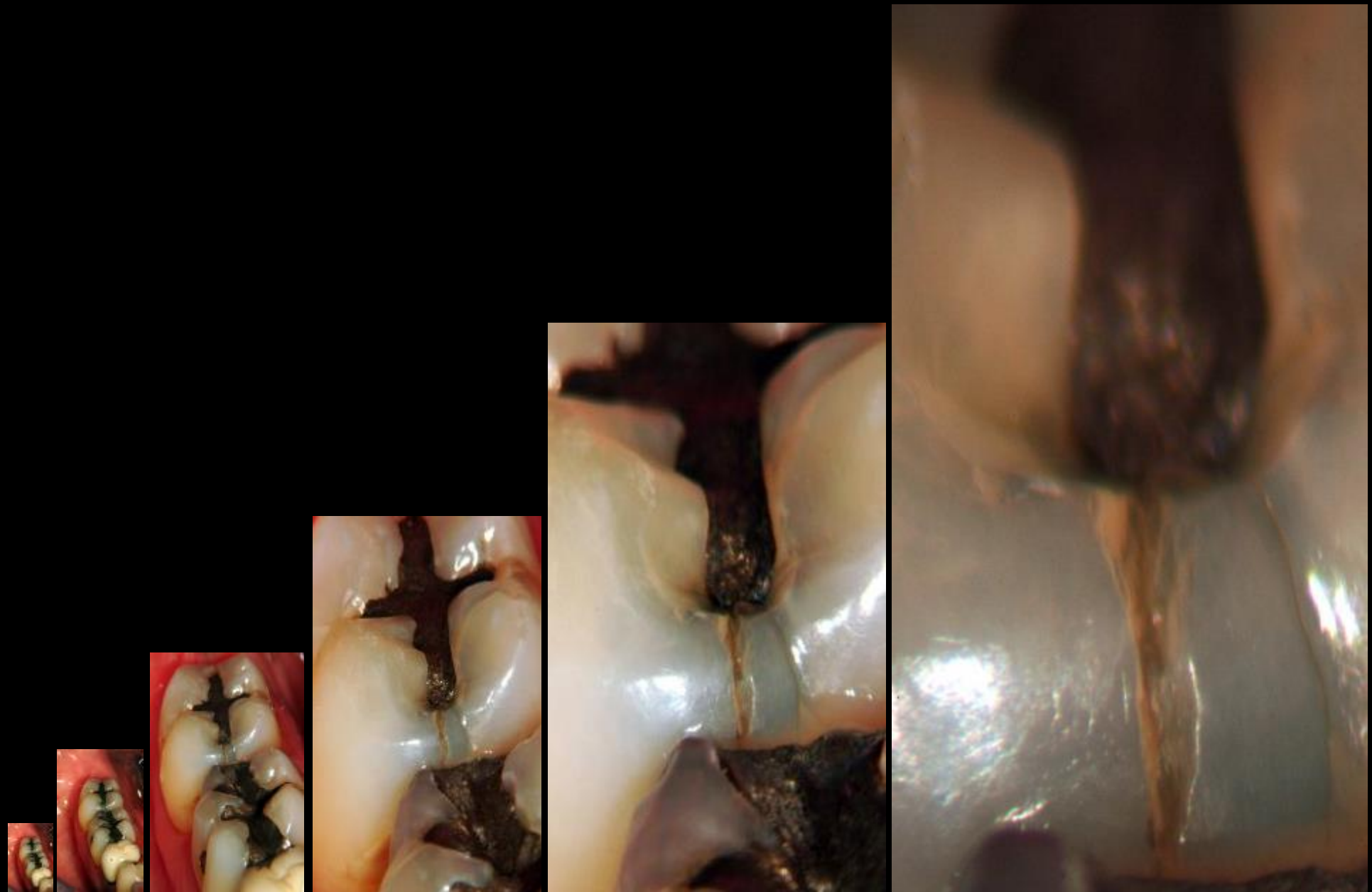
CLINICAL SIGNIFICANCE

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

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

Microscopic and symptom-driven diagnoses have been the accepted modalities for cracked teeth. The inherent limitations of the lack of visual confirmation result in therapies that often come too late in the treatment process. One lasting first impression of vision through a clinical microscope is the staggering array of cracks that exist within tooth structures. Traditional visualization (unaided or ocular assisted) limits the clinician's ability to assess the presence or severity of the majority of these cracks (Figure 1).

At extreme magnification levels (×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 clues can lead restorative dentists to more appropriate early treatment of compromised teeth before devastating fractures, pulpal involvement, and periodontal breakdown occur. The value of early diagnosis of the structural breakdown of teeth will become even more significant with our aging population coupled with increased tooth retention in this population.

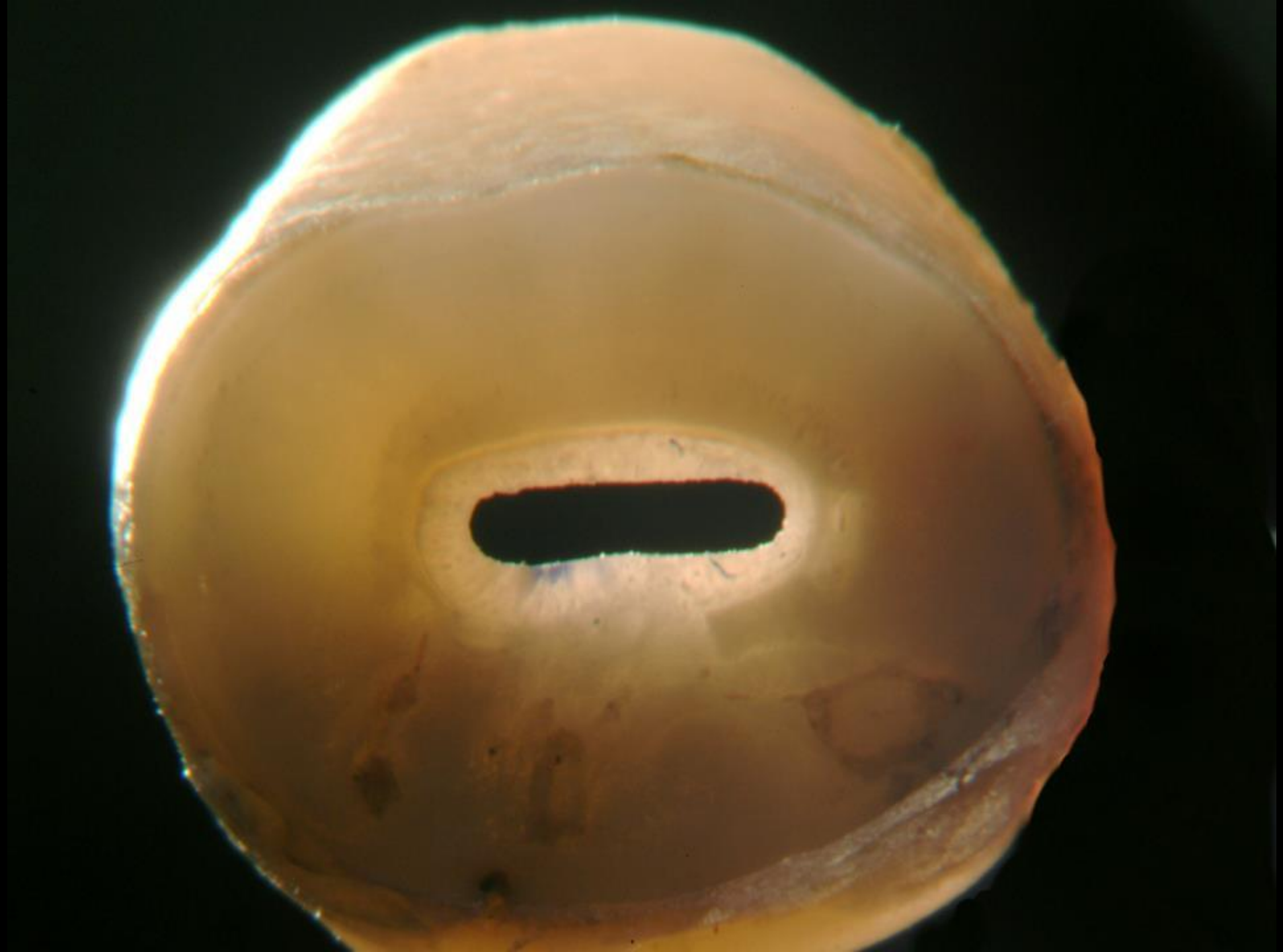


One of the enduring first impressions of clinical microscope dentistry is the staggering array of cracks that are suddenly visible

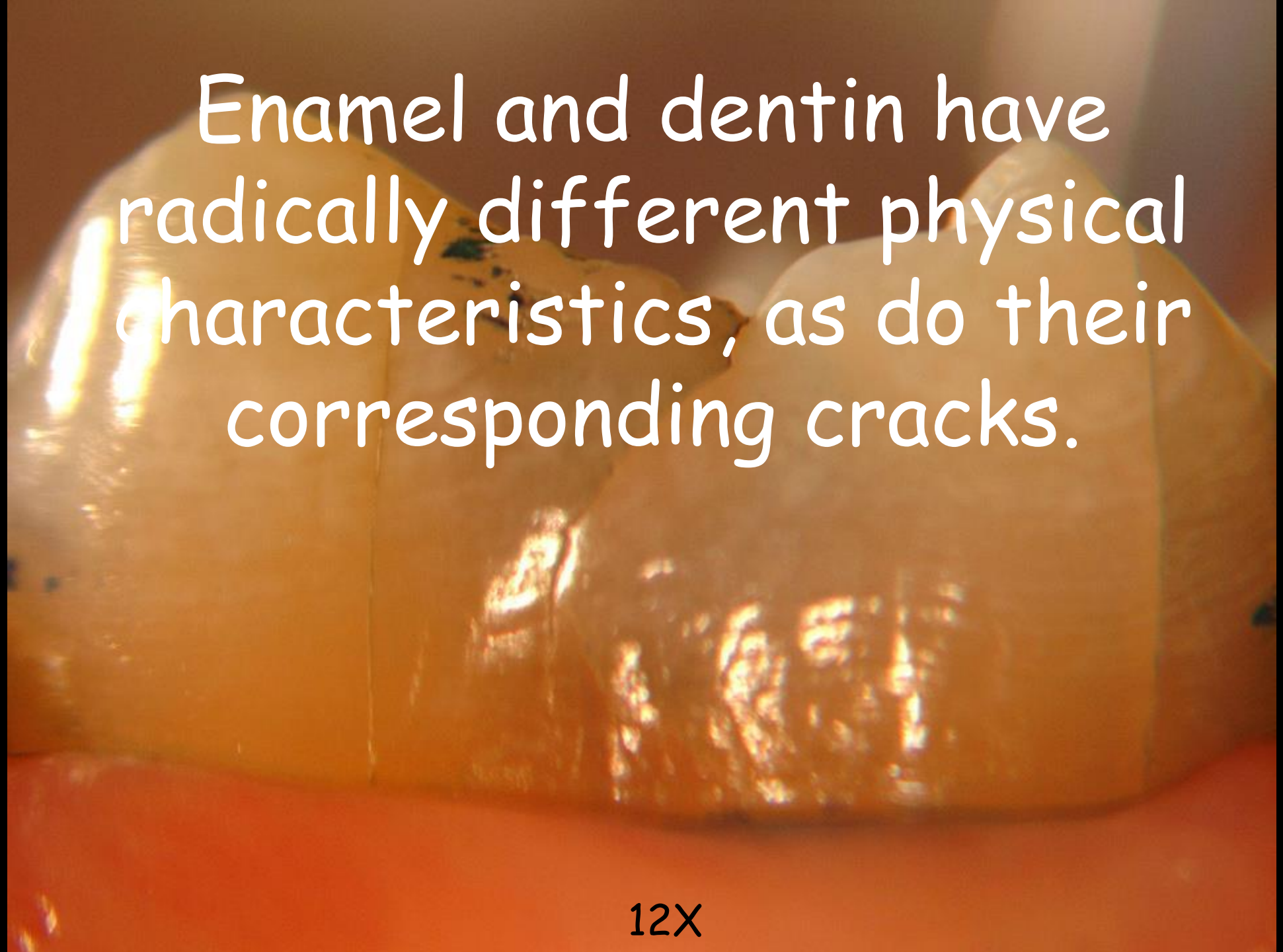
Clark, D.J., Paquette J., Sheets C., *Journal of Esthetic and Restorative Dentistry*; Special Edition, 2004

Nature does
nothing
uselessly.

Aristotle 322 BC

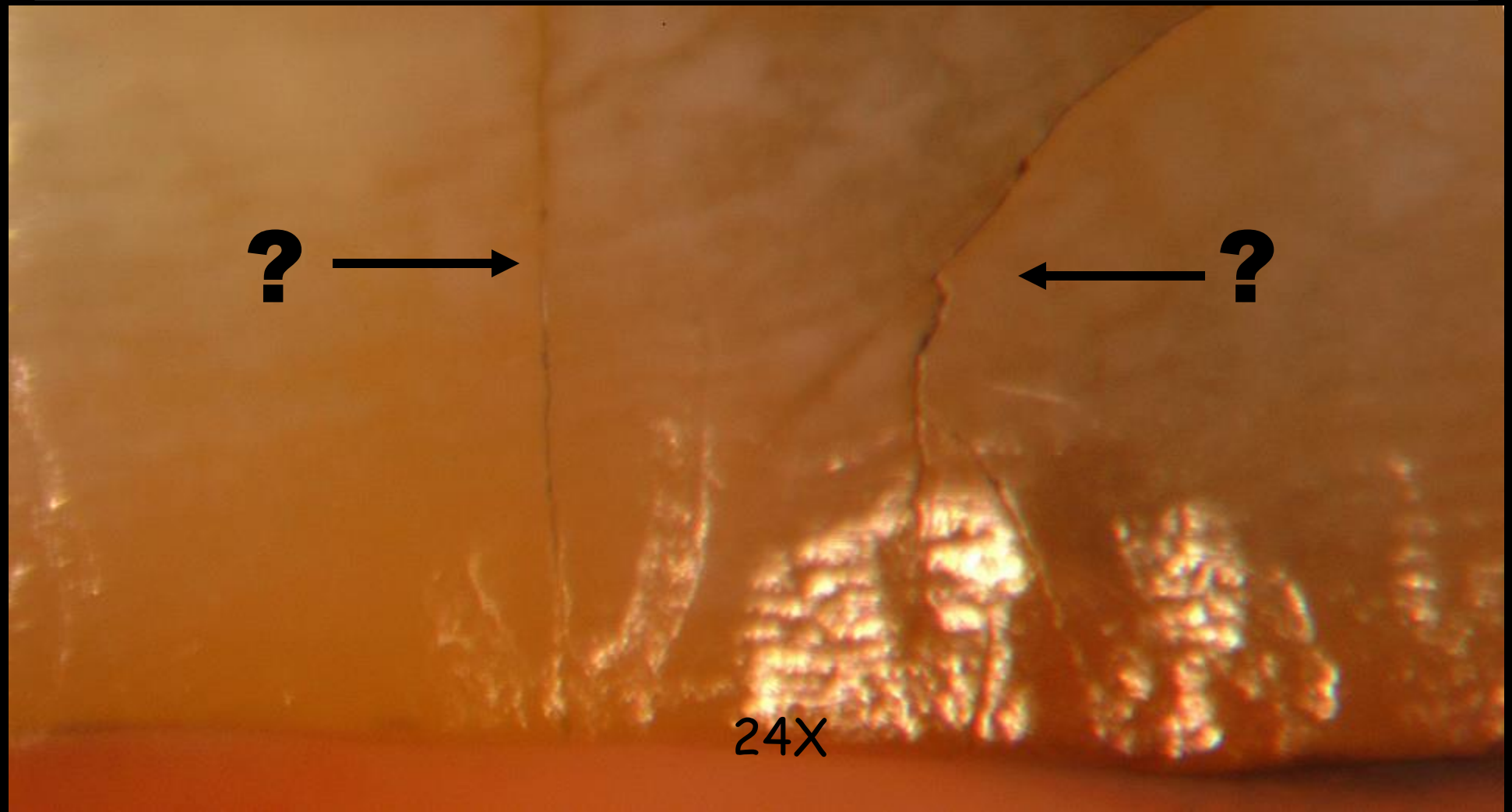


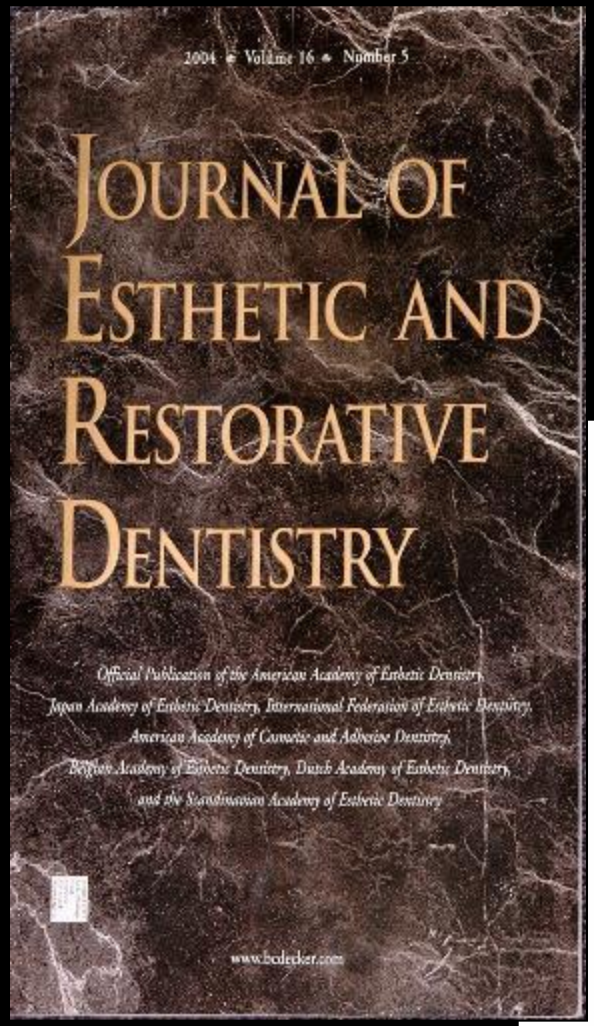
Enamel and dentin have radically different physical characteristics, as do their corresponding cracks.


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?





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

BRUCE J. GLASS, DDS*
CHERILYN G. SHEETS, DDS†
JACQUES M. RAQUET, DDS‡

ABSTRACT

The diagnosis of cracked teeth and incomplete coronal fracture have historically been symptom-based. The detailed operating microscope at 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 devastation to tooth or tissues occurs. 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

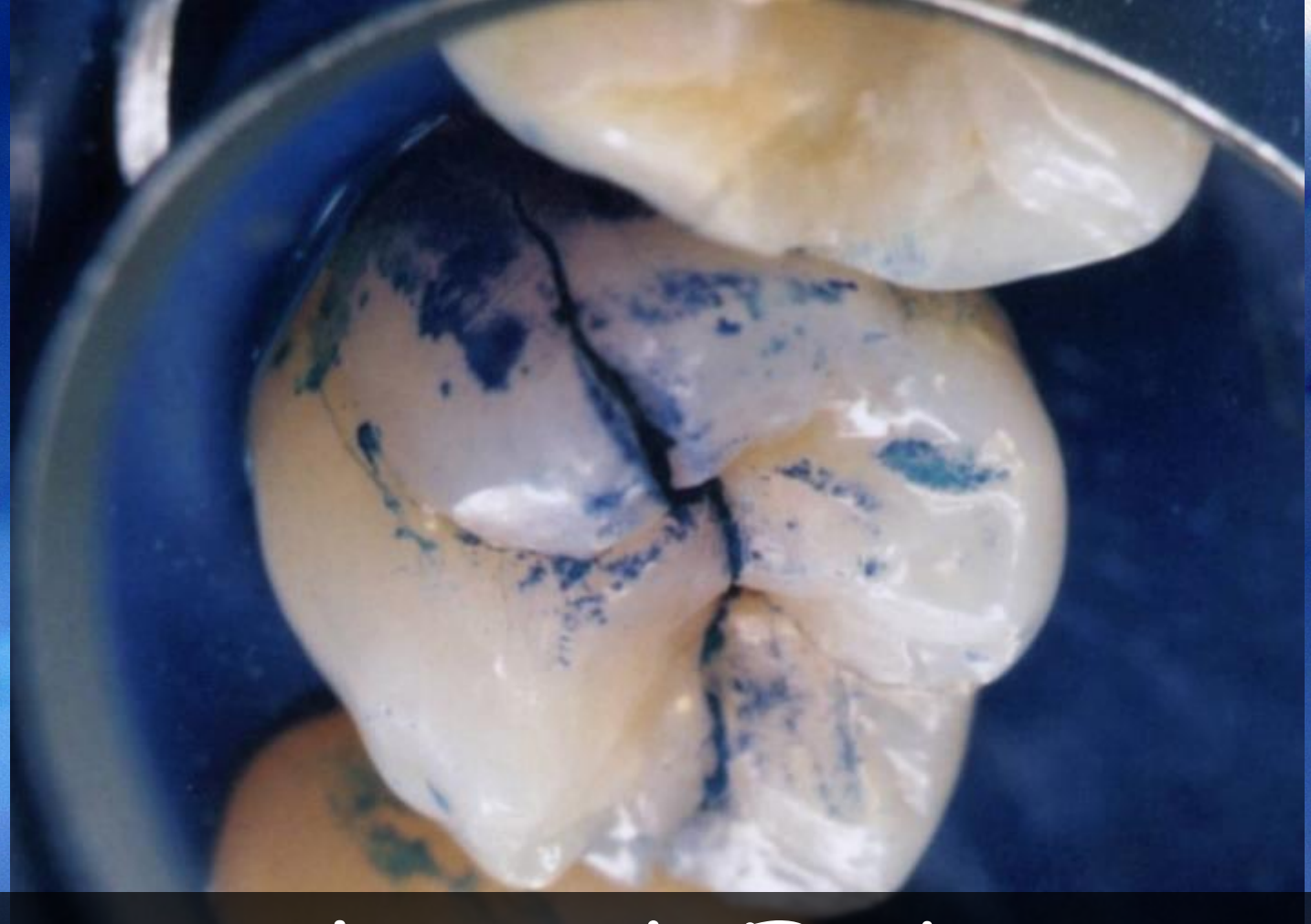
This article gives new guidelines for recognition, examination, classification, and treatment of cracked teeth based on the routine use of 16 magnification. The significance of enamel cracks as they relate to coronal cracks is detailed.

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

Microscopic and symptom-driven diagnoses have been the accepted modalities for cracked teeth. The inherent limitations of the lack of visual confirmation result in therapies that often come too late in the treatment process. One limiting factor: impressions of vision through a dental microscope is the staggering array of cracks that exist within tooth structures. Traditional visualization (unaided ocular assisted) limits the clinician's ability to assess the presence or severity of the majority of these cracks (Figure 1).

At extreme magnification levels (16 X magnification), 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 clues can lead restorative dentists to more appropriate early treatment of compromised teeth before devastating fractures, pulpal involvement, and periodontal breakdown occur. The value of early diagnosis of the structural breakdown of teeth will become even more significant with our aging population complex with increases in tooth retention in this population.

*Fellow, Academy of Microscope Enhanced Dentistry
†Consultative dentist, Newport Coast Oral Facial Institute, Newport Beach, CA; clinical professor, Rutherford Dentistry, USC School of Dentistry, Los Angeles, CA, USA
‡Consultative dentist, Newport Coast Oral Facial Institute, Newport Beach, CA; associate professor, Rutherford Dentistry, USC School of Dentistry, Los Angeles, CA, USA

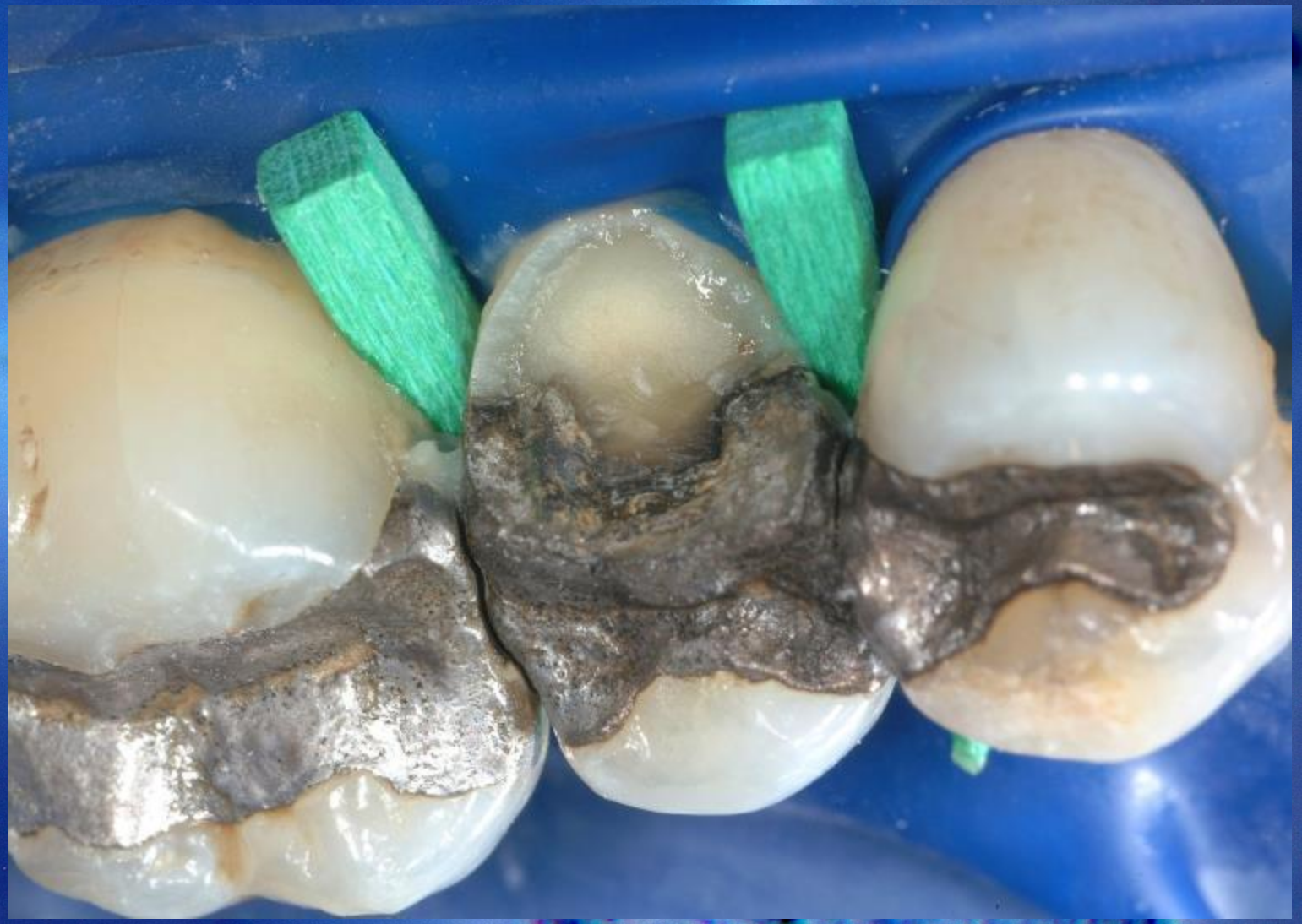


Vertical Crack End Stage:
Complete Tooth Fracture

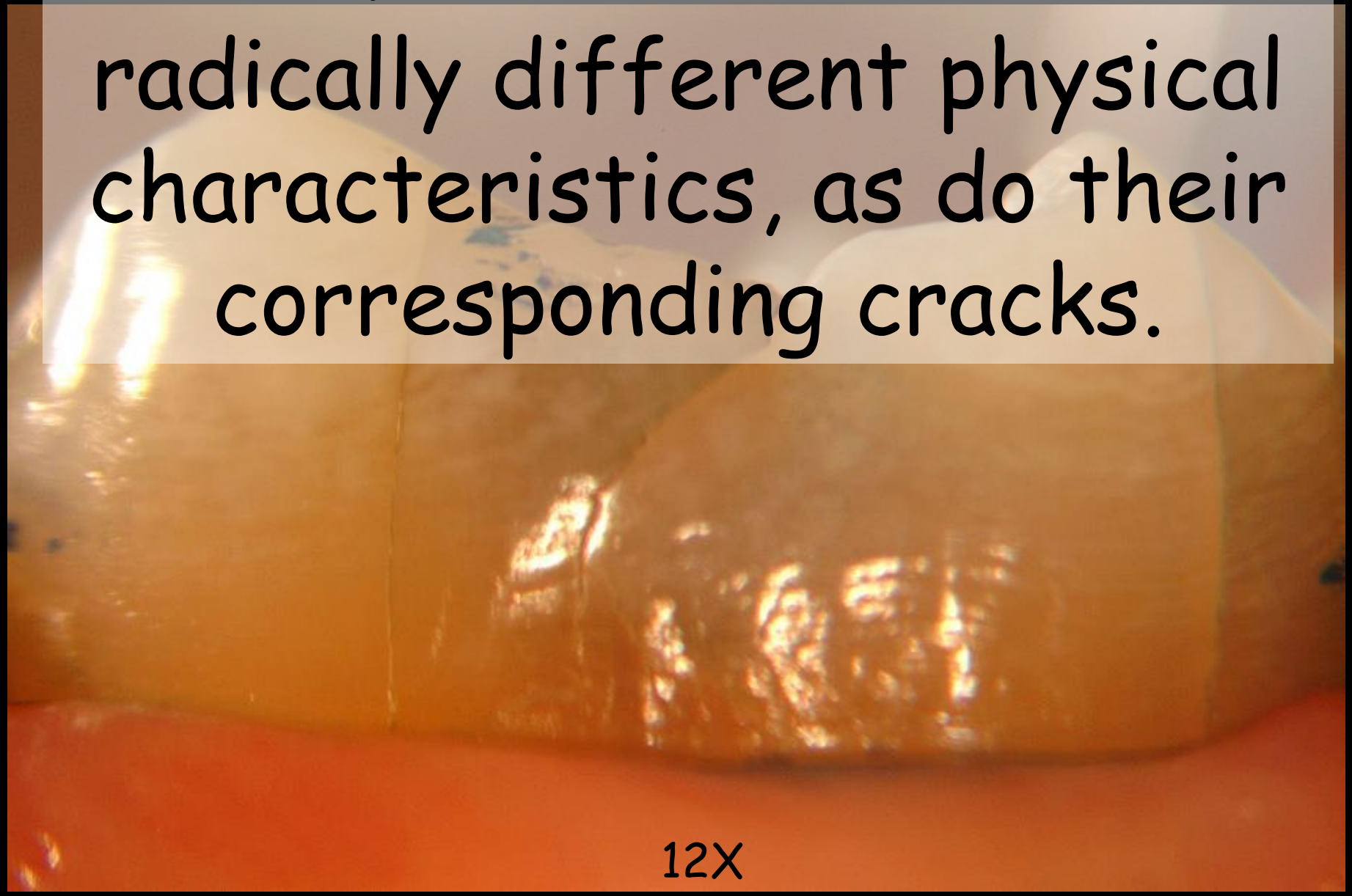
(split tooth)

Endstage Oblique Fracture

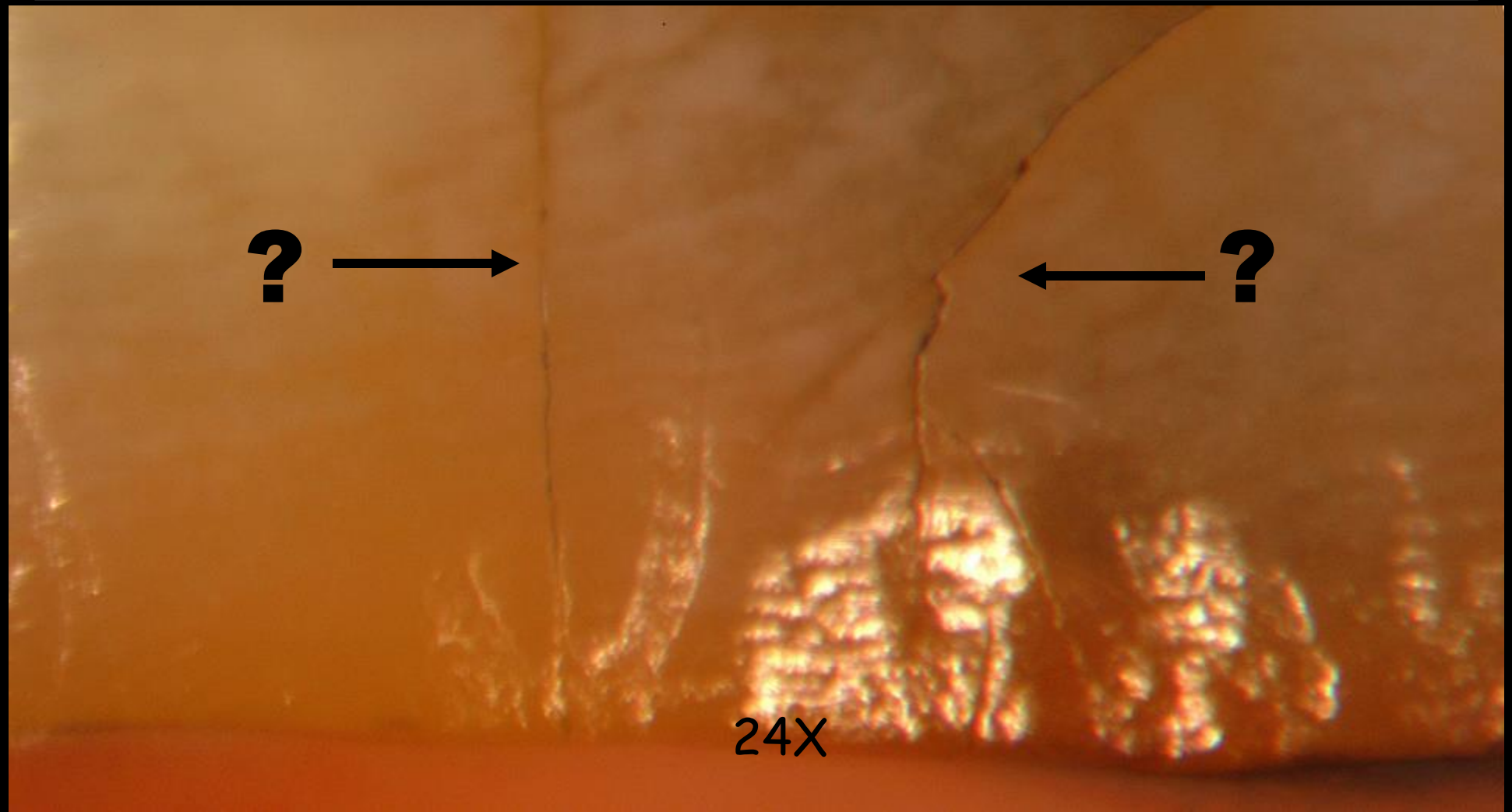
Cuspal Fracture



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

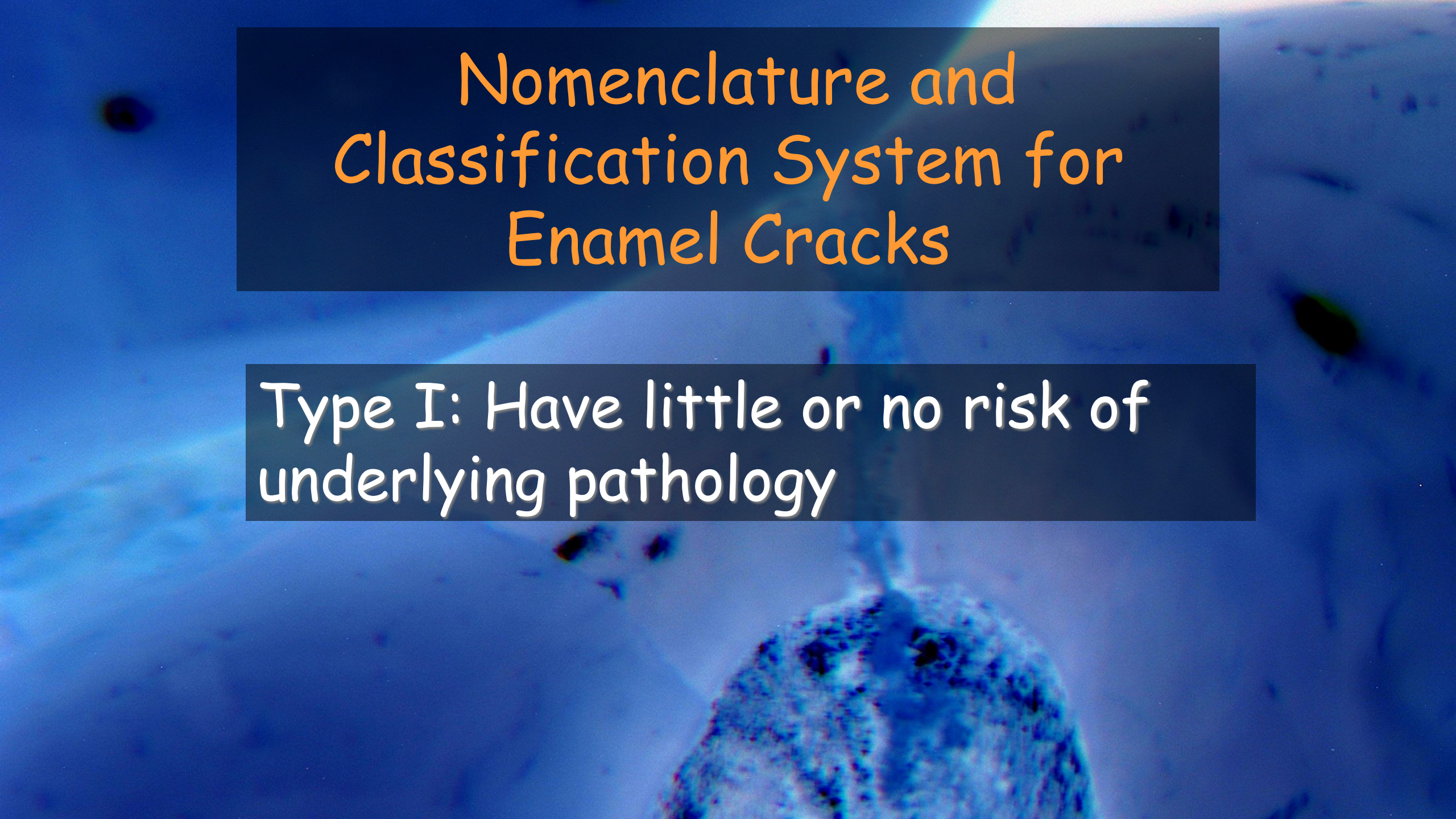


Which enamel crack is "native", which crack is indicative of underlying pathology?



Nomenclature and Classification System for Enamel Cracks

Type I: Have little or no risk of underlying pathology



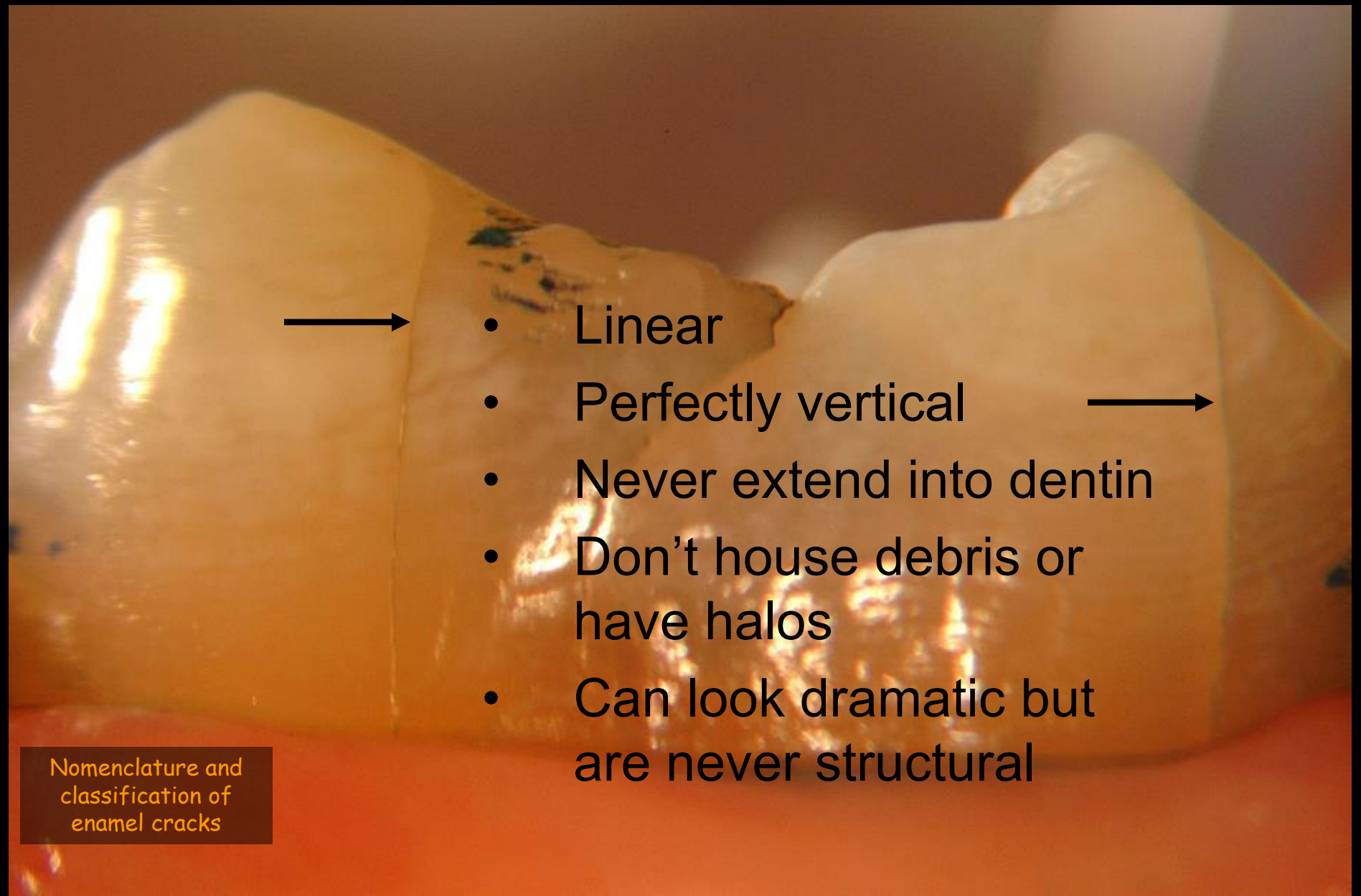
Type I: Have little or no risk of underlying pathology

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

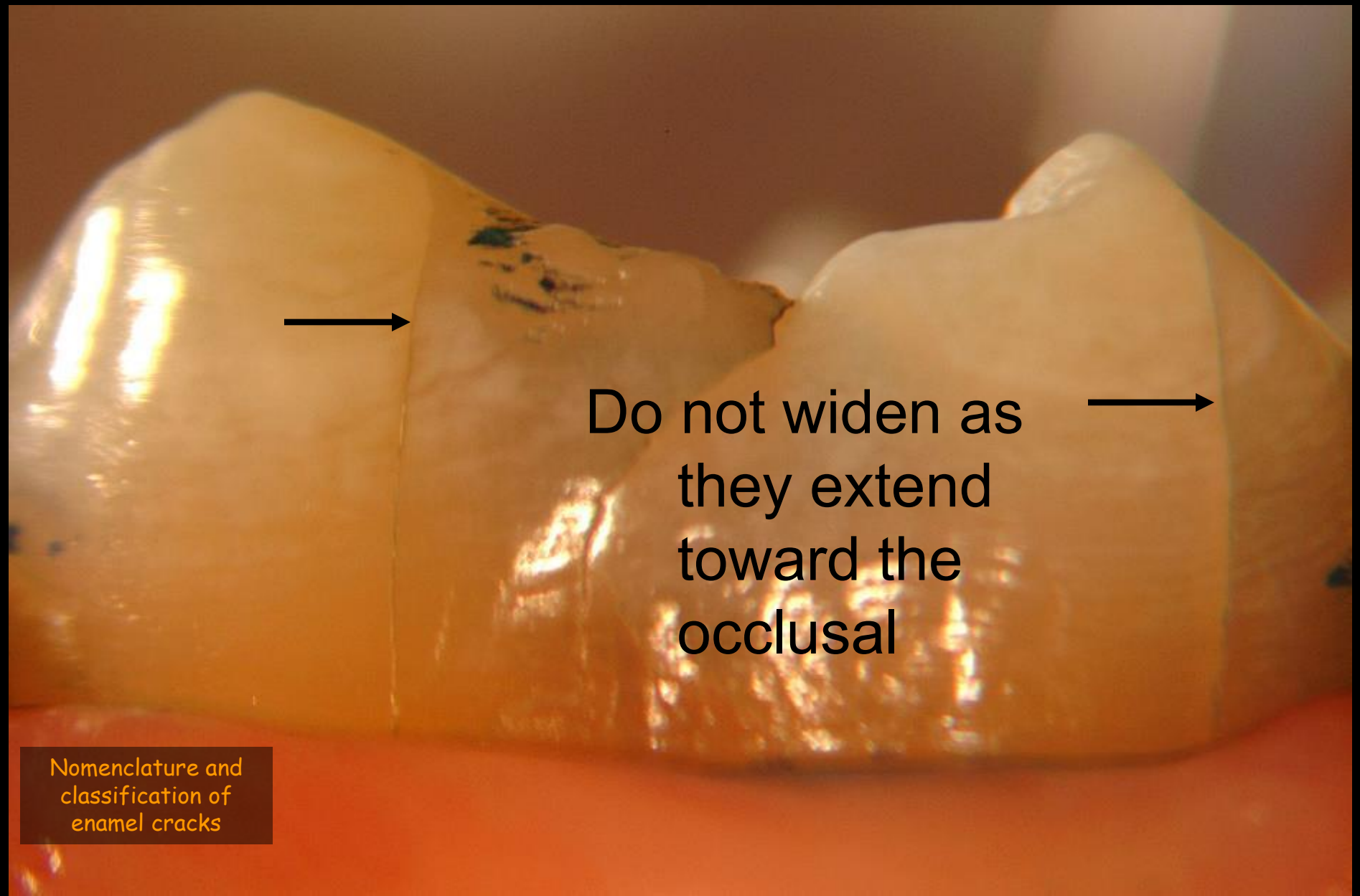
Craze Lines



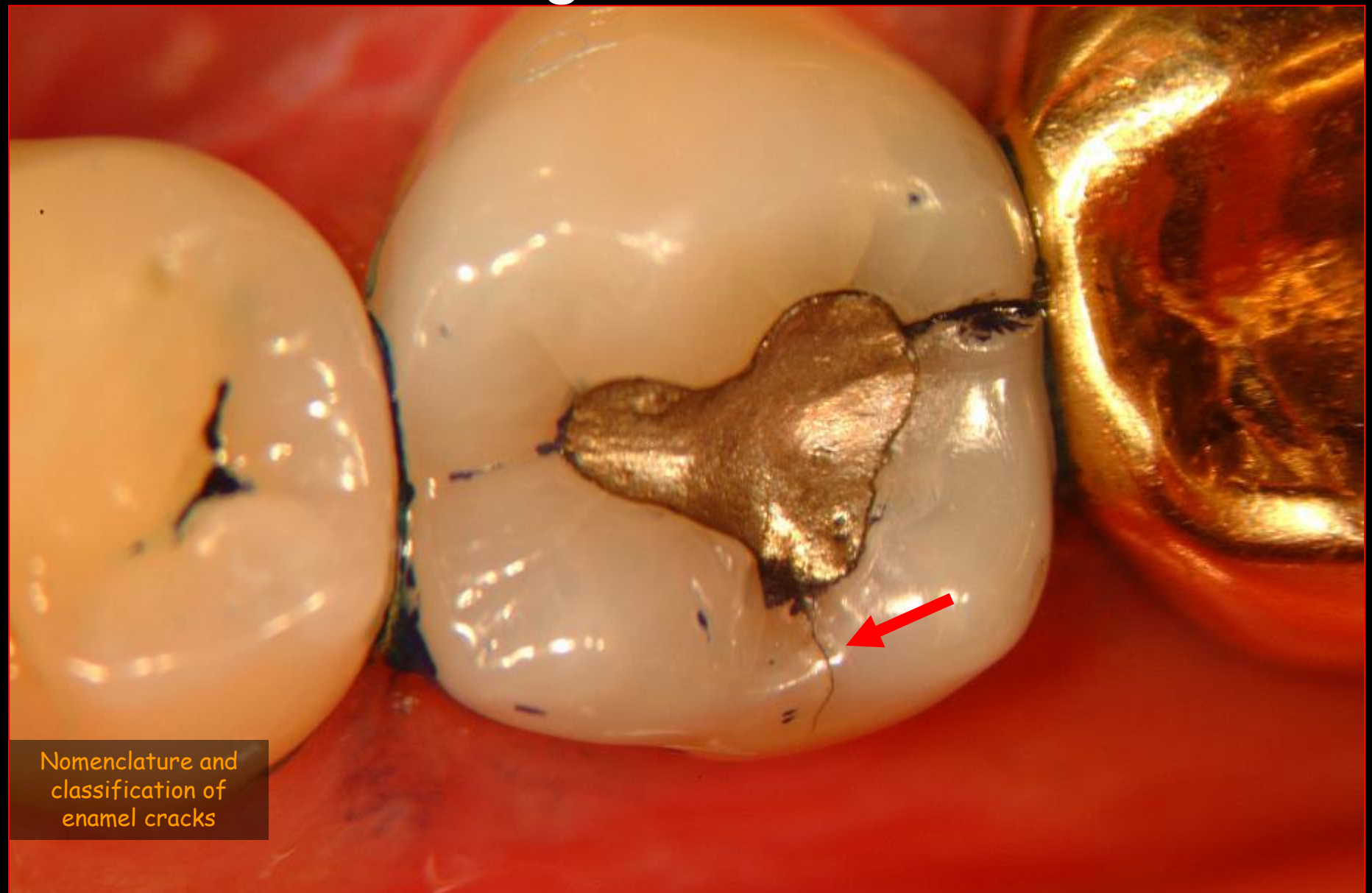
- Linear
- Perfectly vertical
- Never extend into dentin
- Don’t house debris or have halos
- Can look dramatic but are never structural

Nomenclature and classification of enamel cracks

Craze Lines

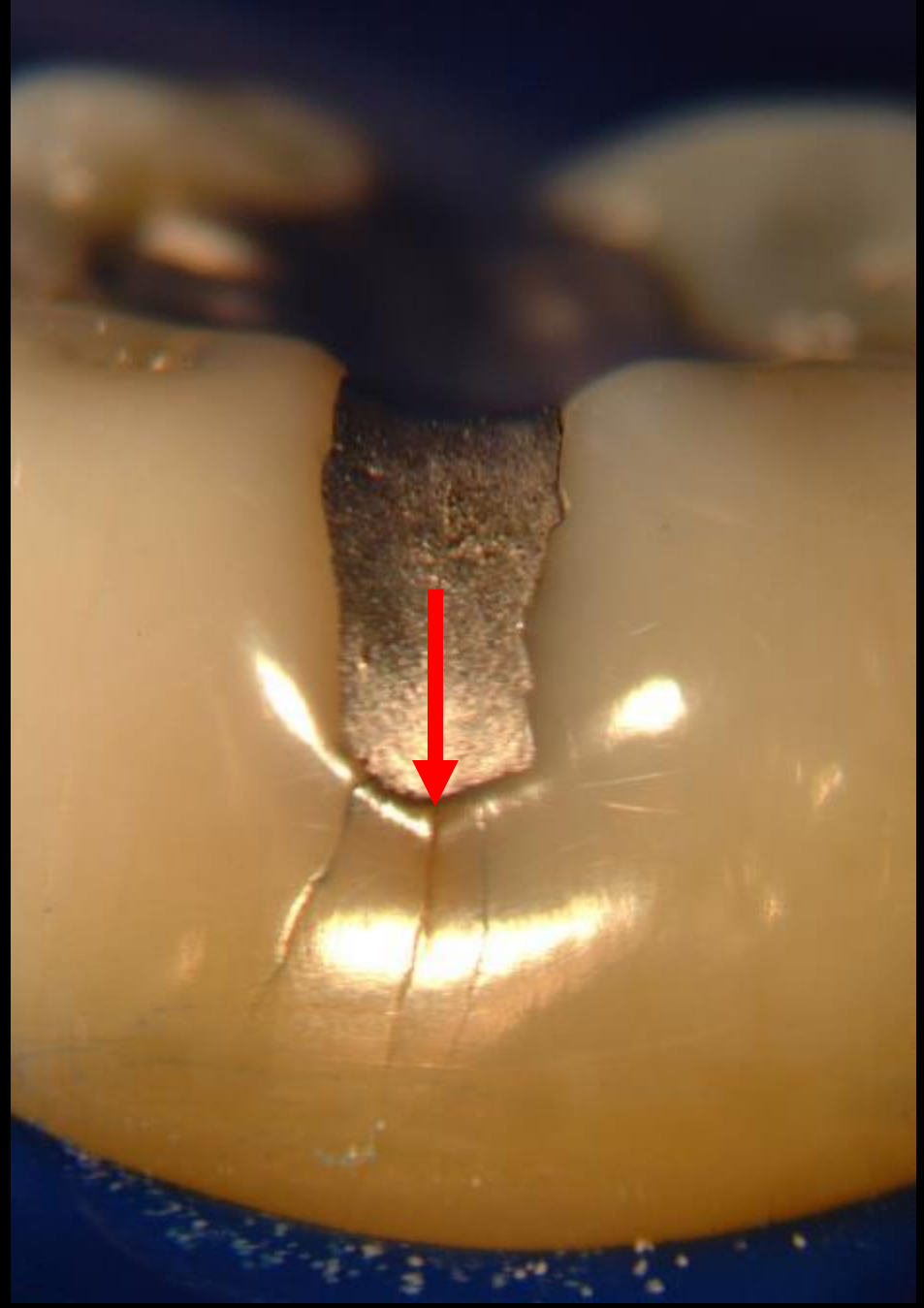

Do not widen as they extend toward the occlusal
Nomenclature and classification of enamel cracks

C. Cracks that follow anatomic grooves



C. Cracks that follow natural anatomic grooves

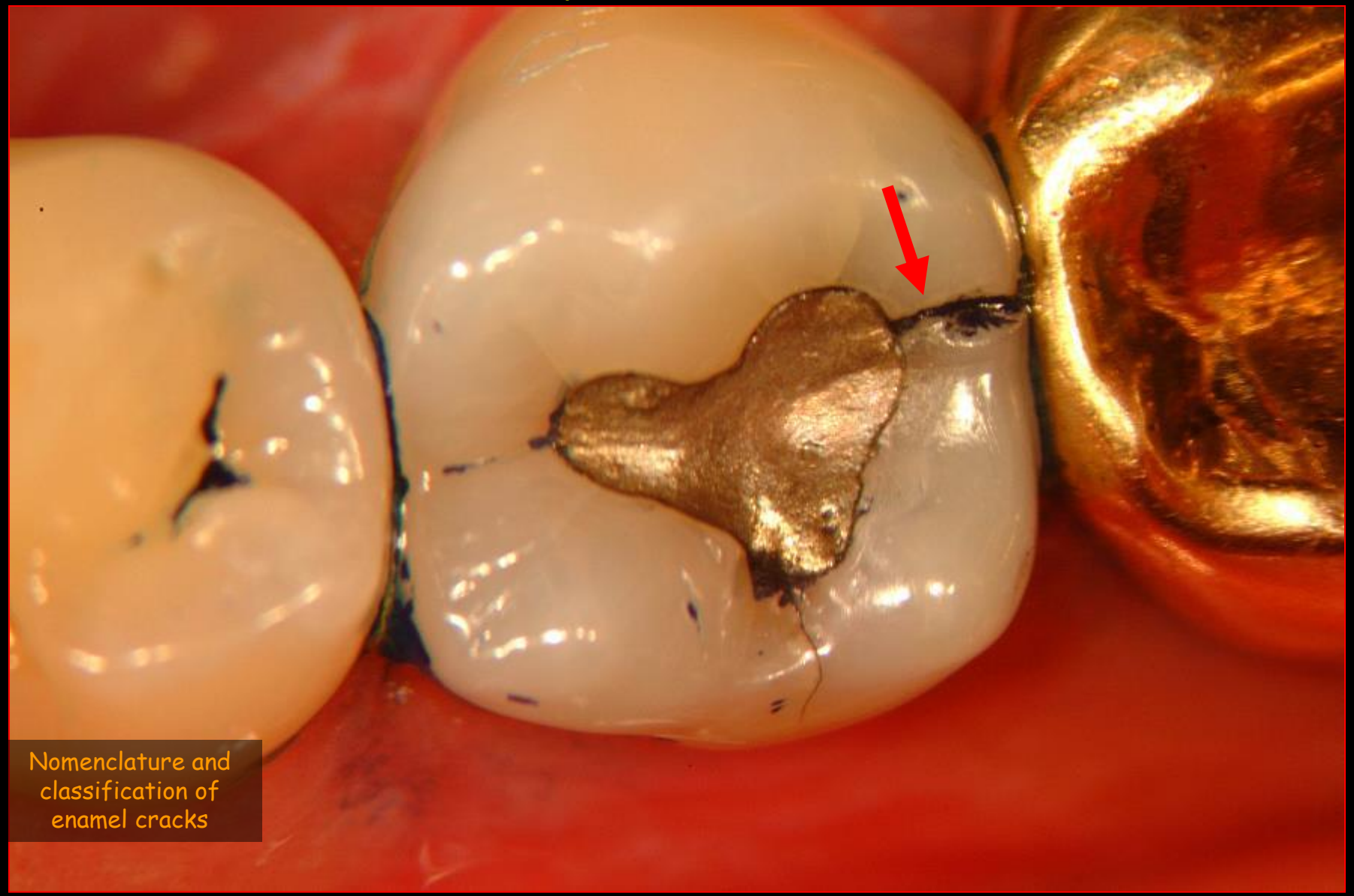
D Superficially Stained Cracks



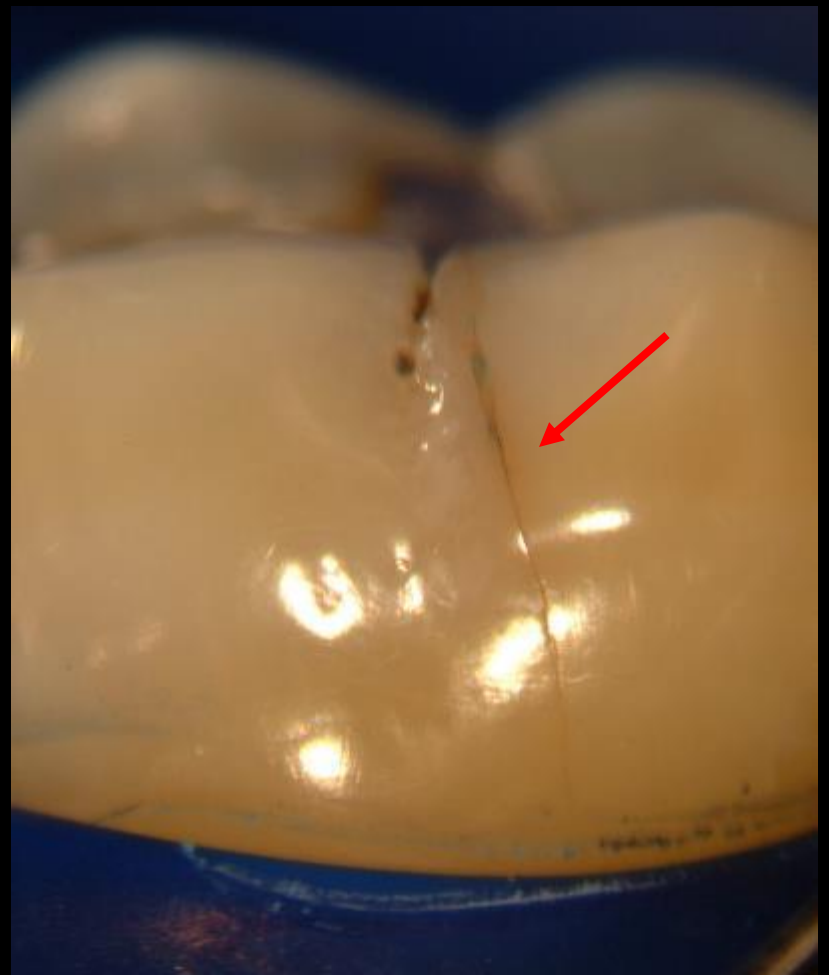
Type II: Have moderate risk of underlying pathology

- 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

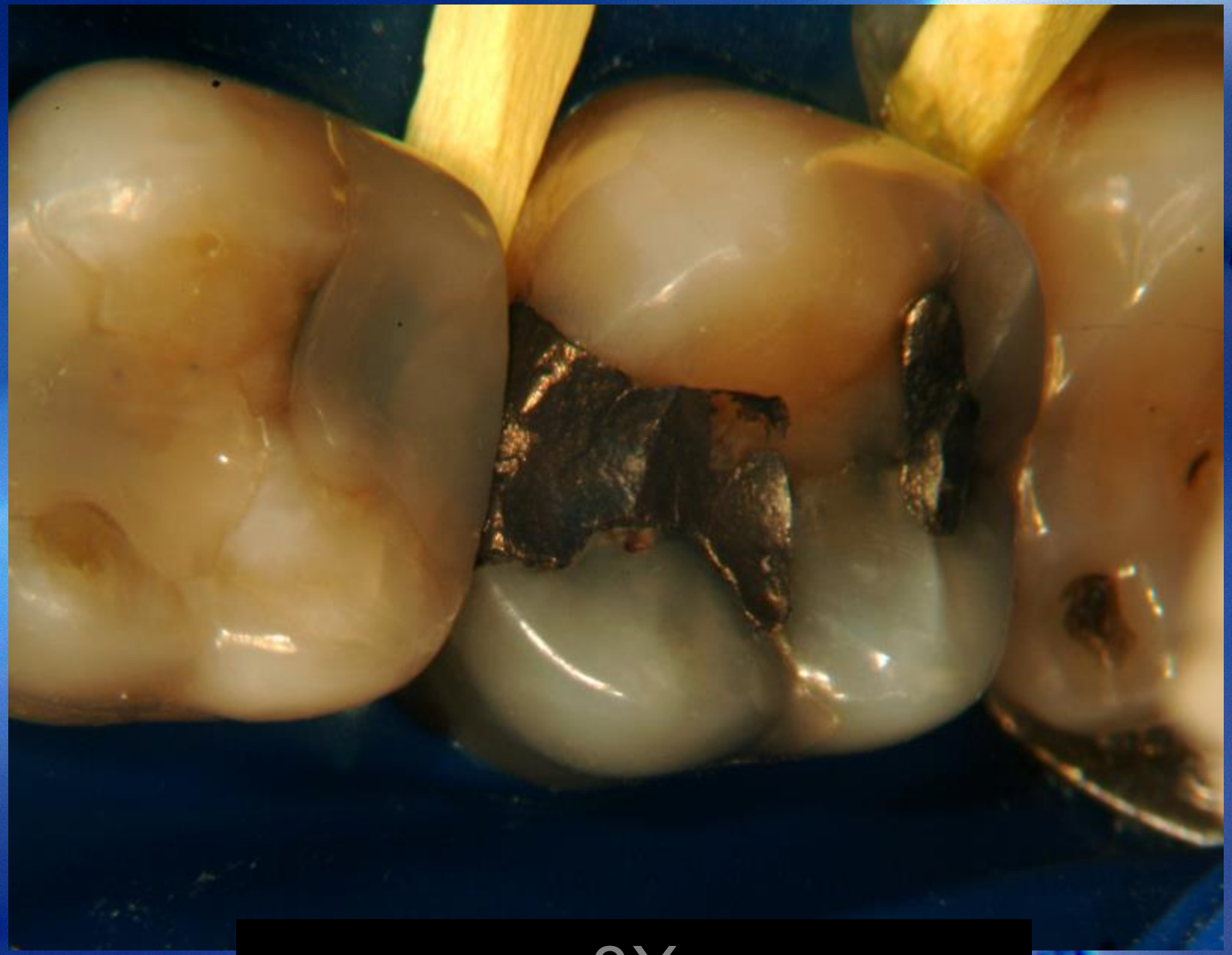


C. Non linear cracks that detour from or do not follow natural anatomic grooves

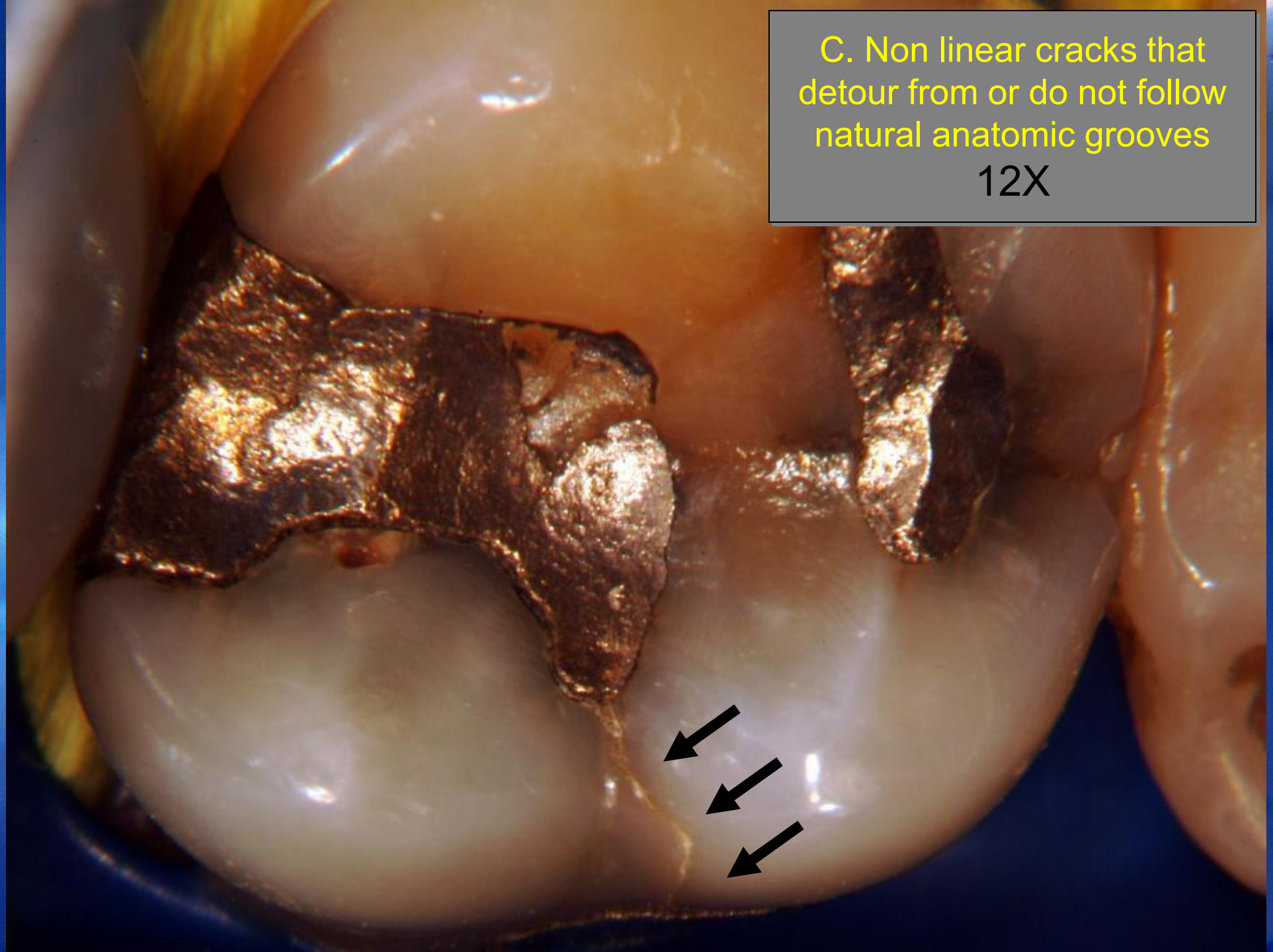


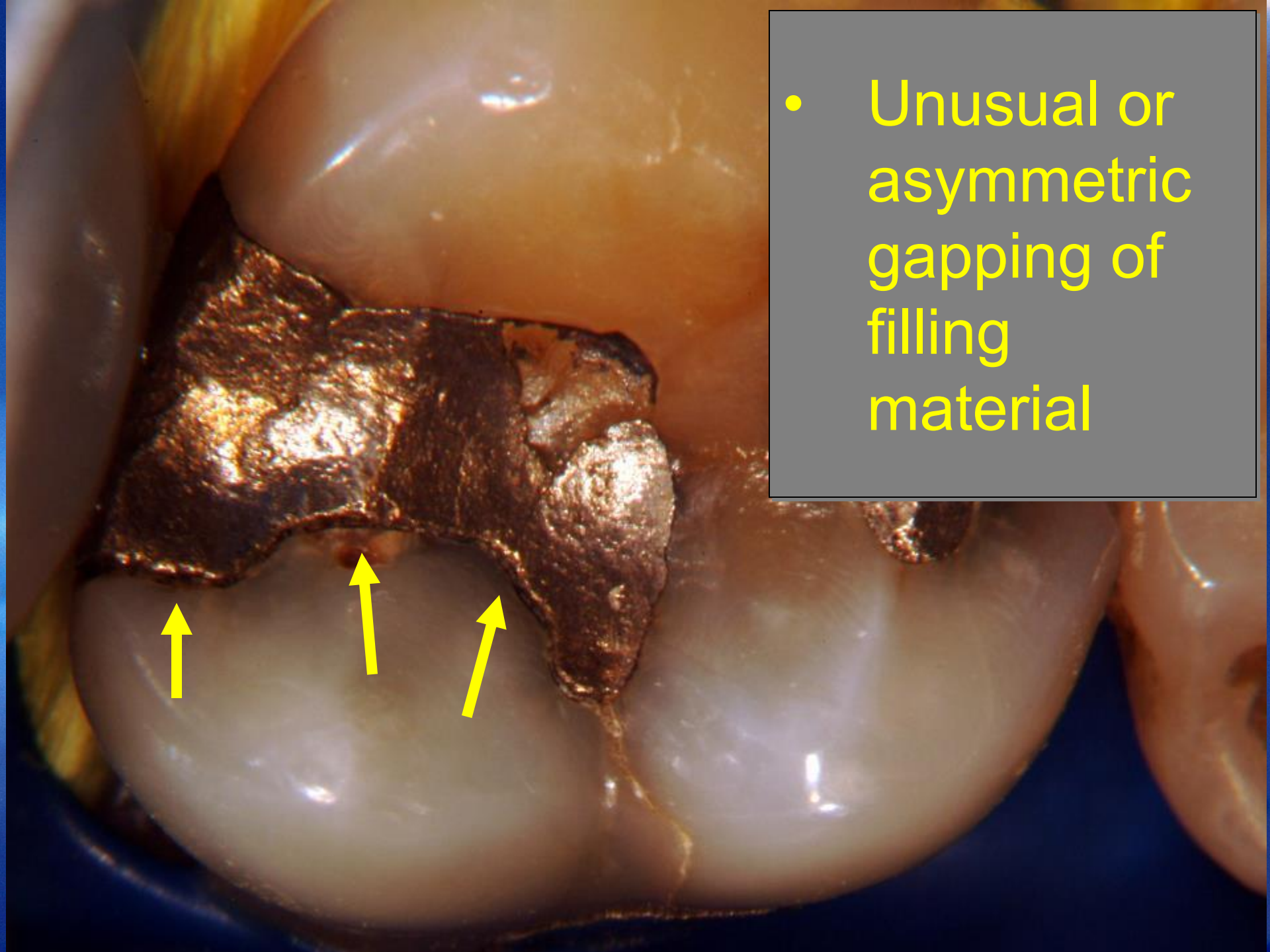
Type II: Have moderate risk of underlying pathology

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

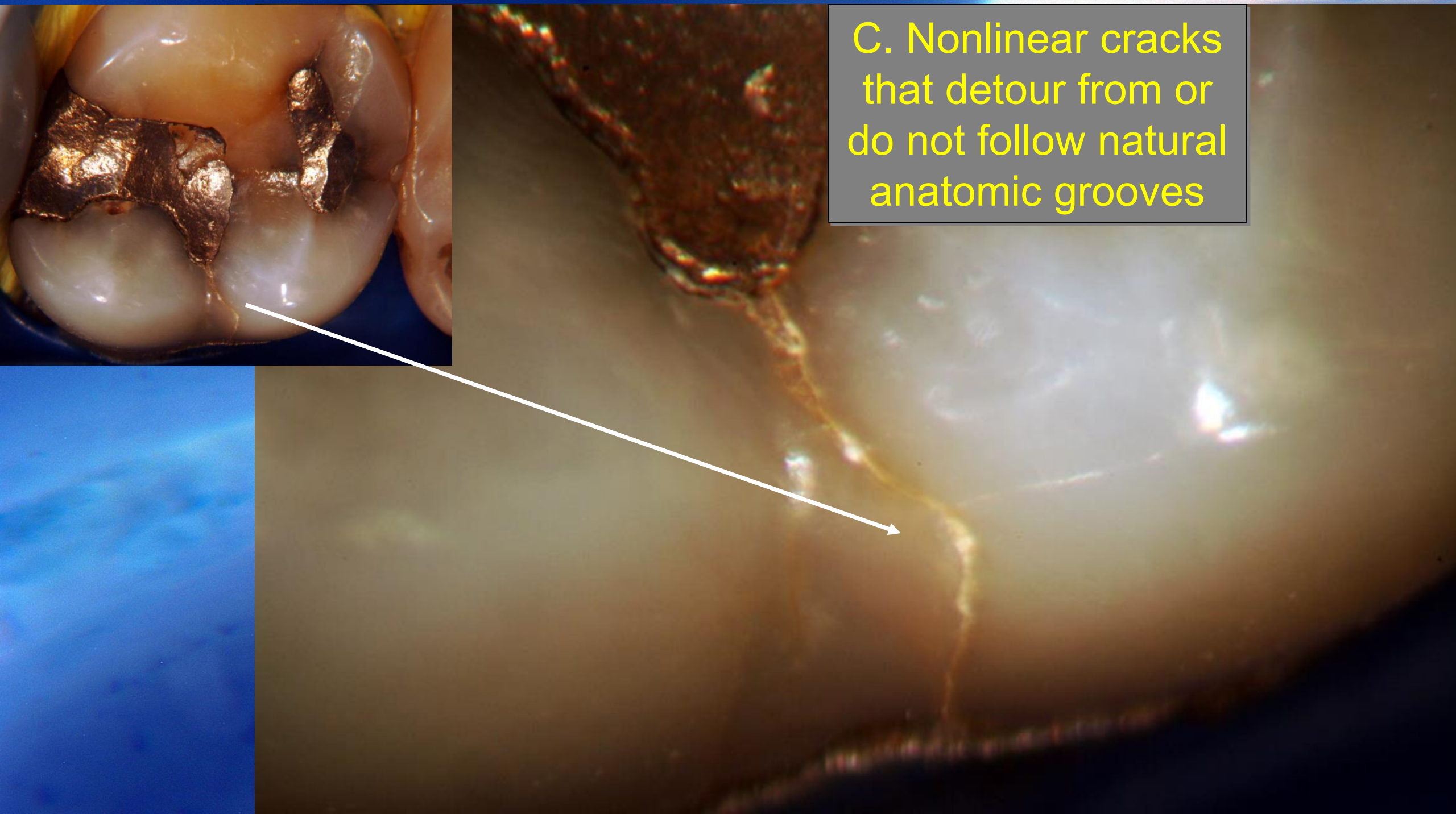


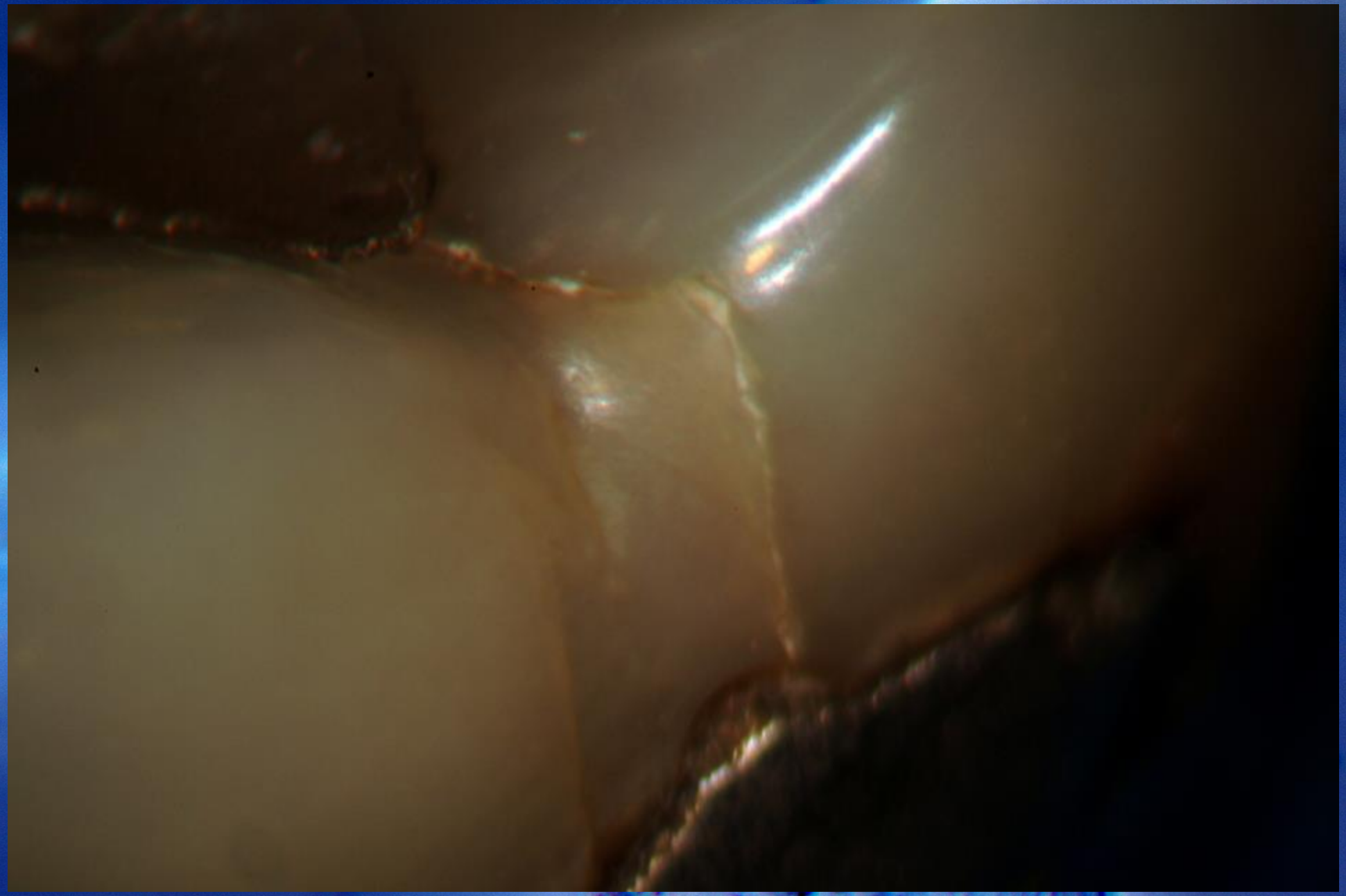
8X


C. Non linear cracks that detour from or do not follow natural anatomic grooves
12X

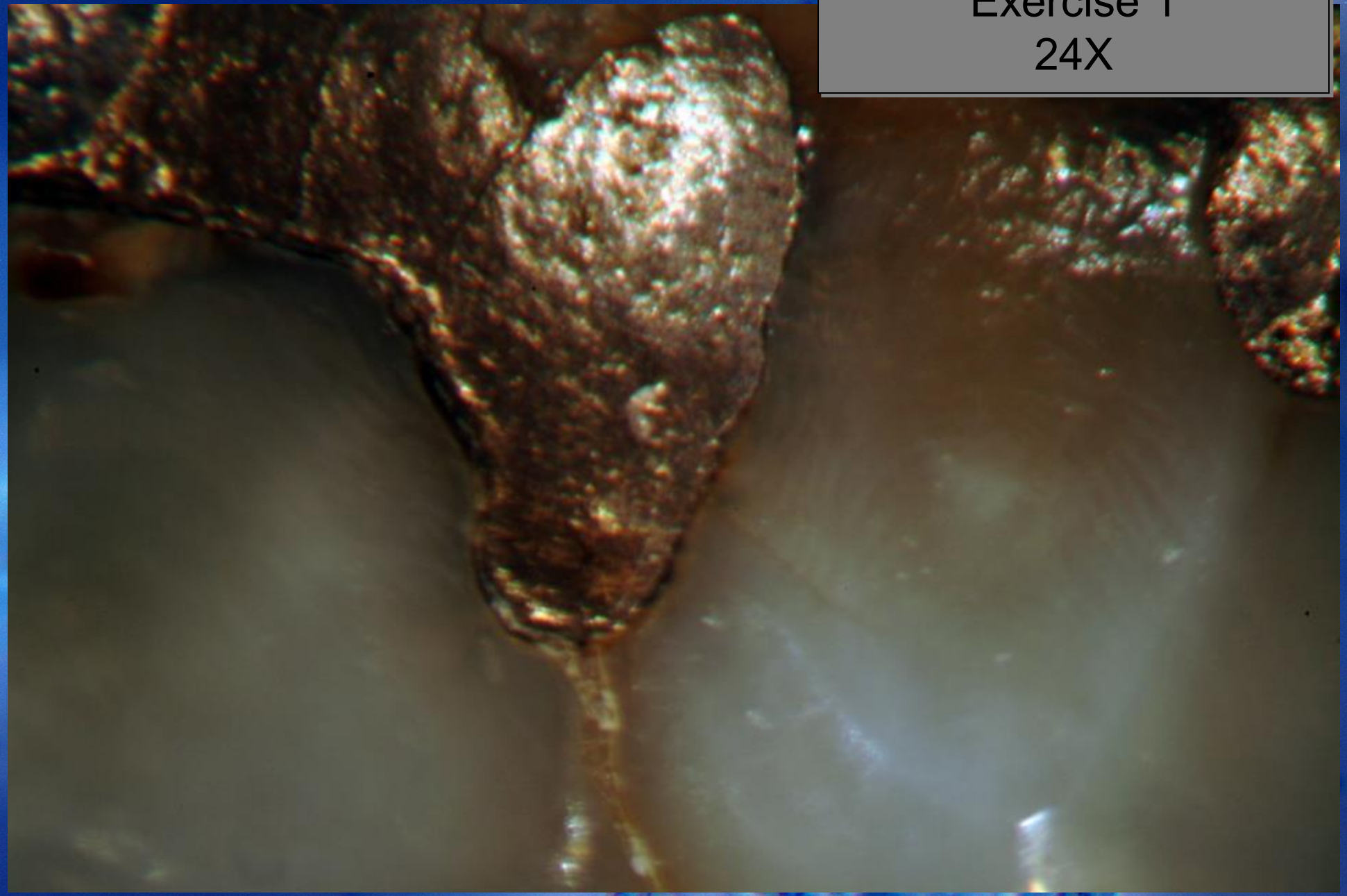


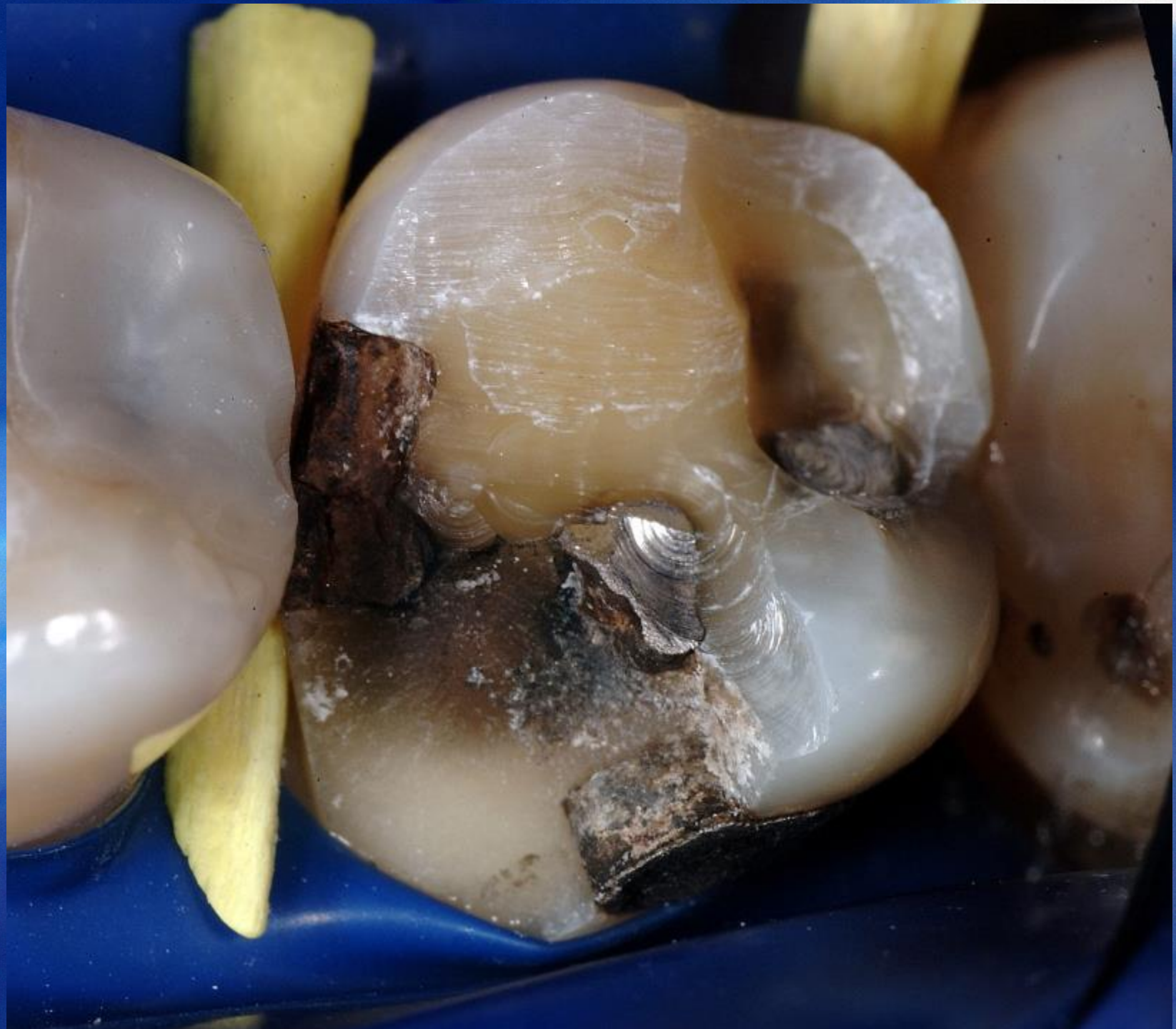
- Unusual or asymmetric gapping of filling material

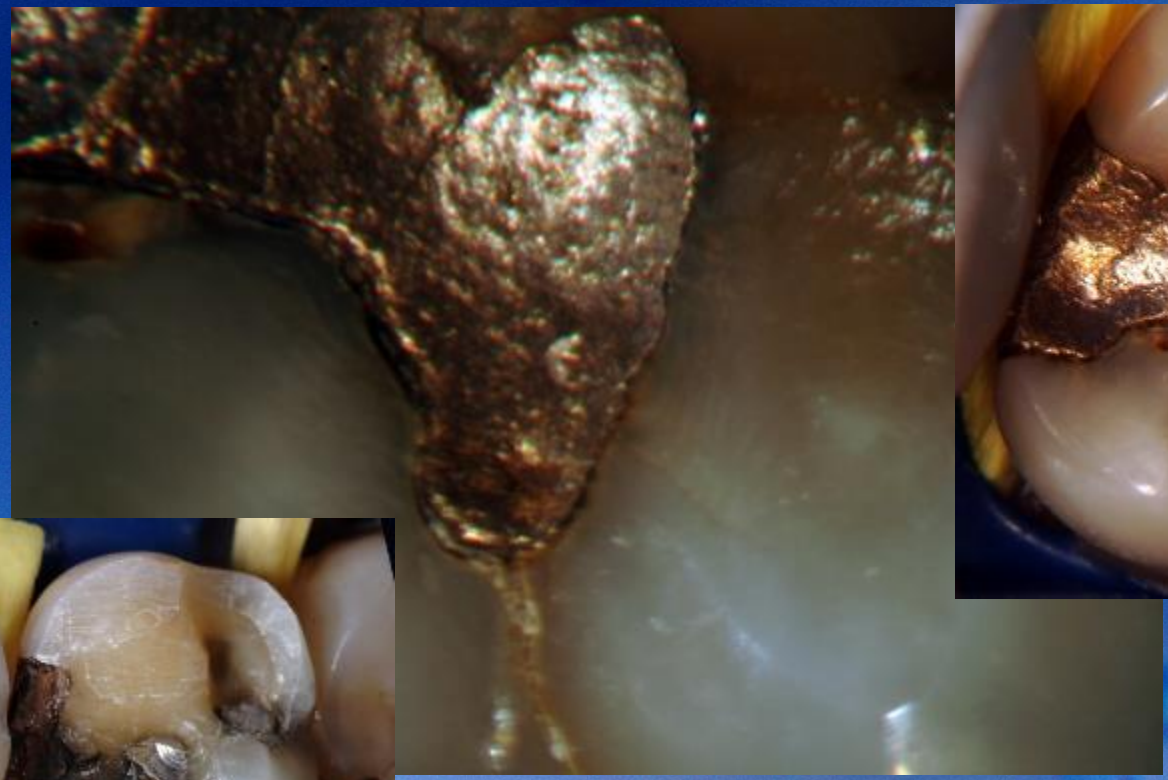
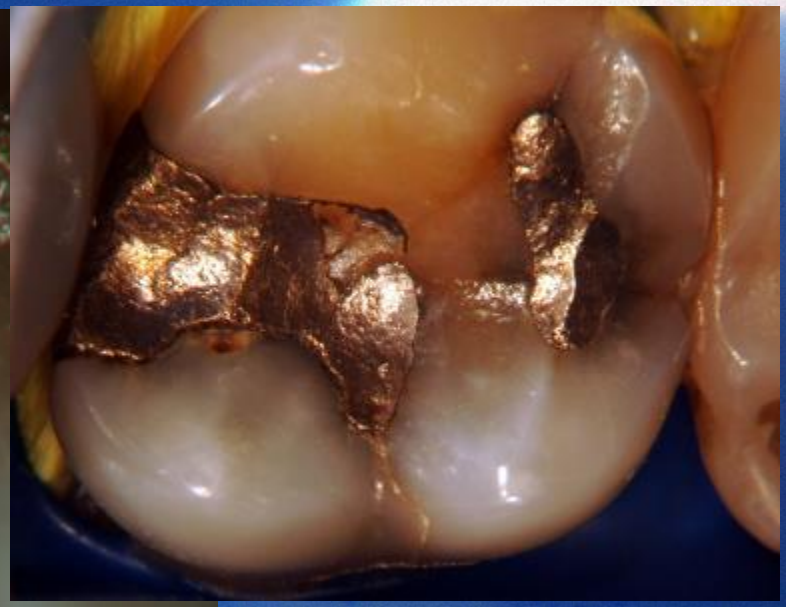

C. Nonlinear cracks that detour from or do not follow natural anatomic grooves

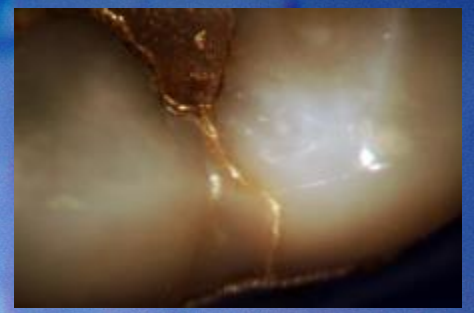
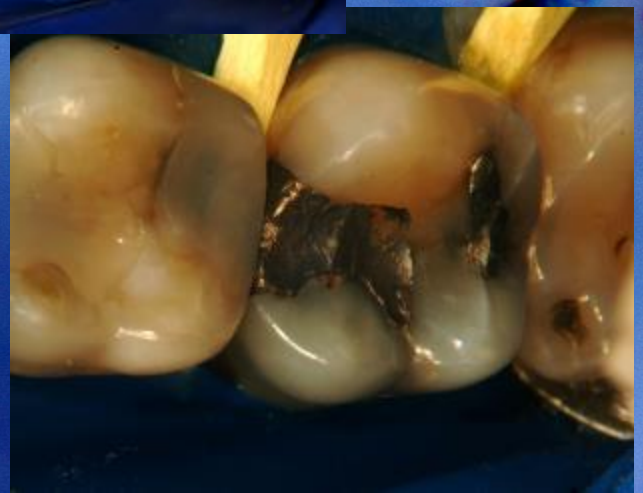
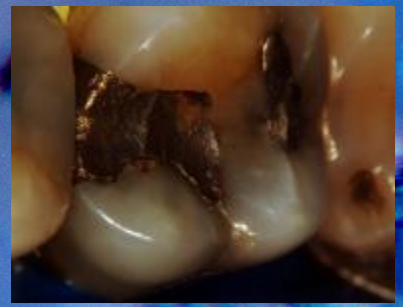
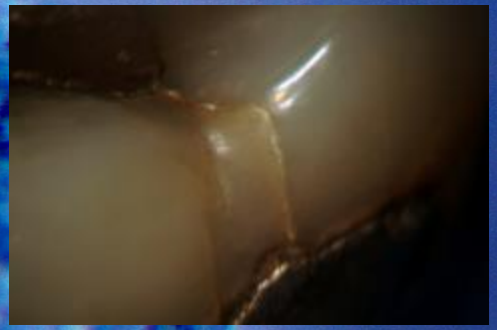


Exercise 1
24X





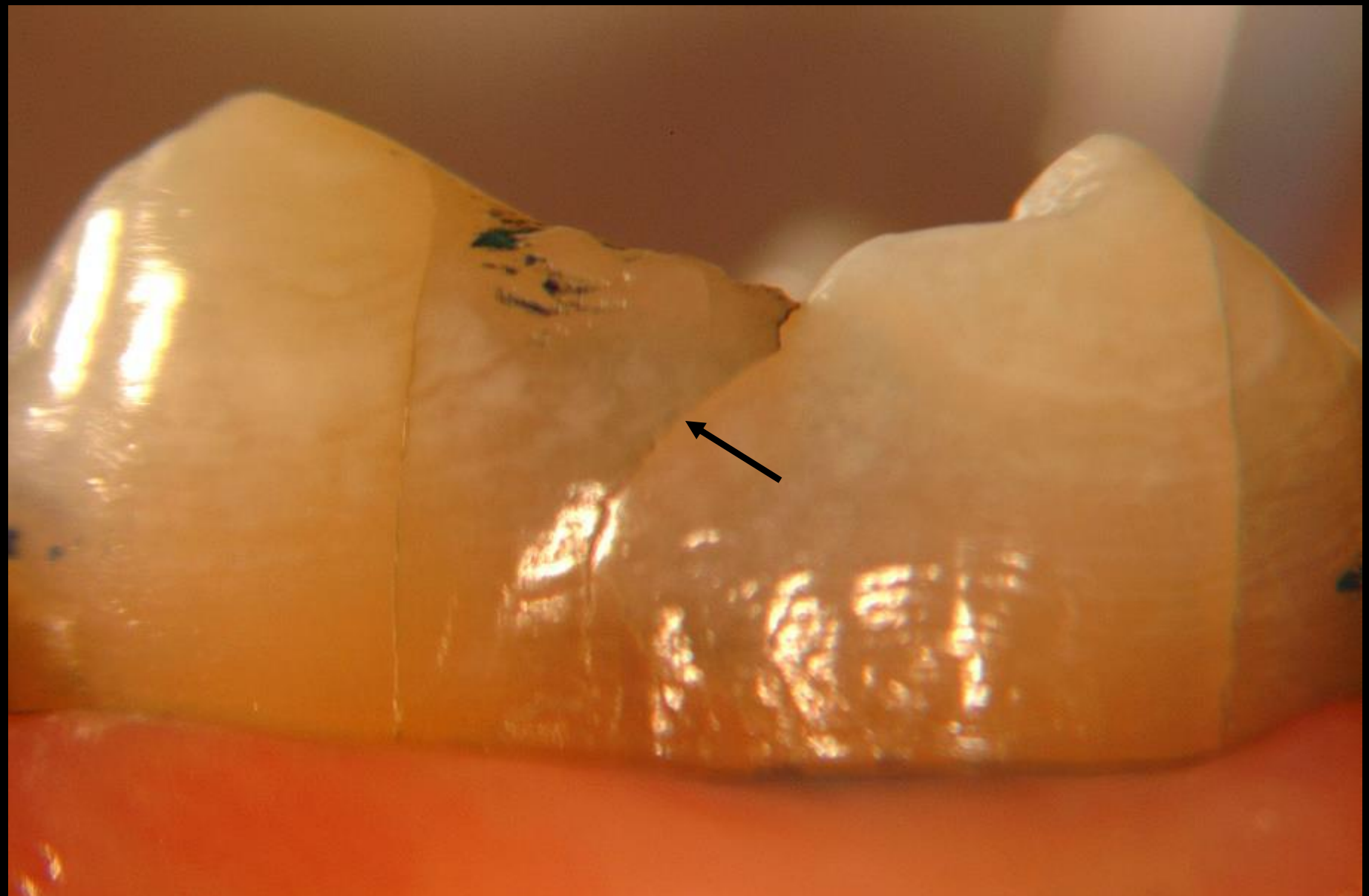



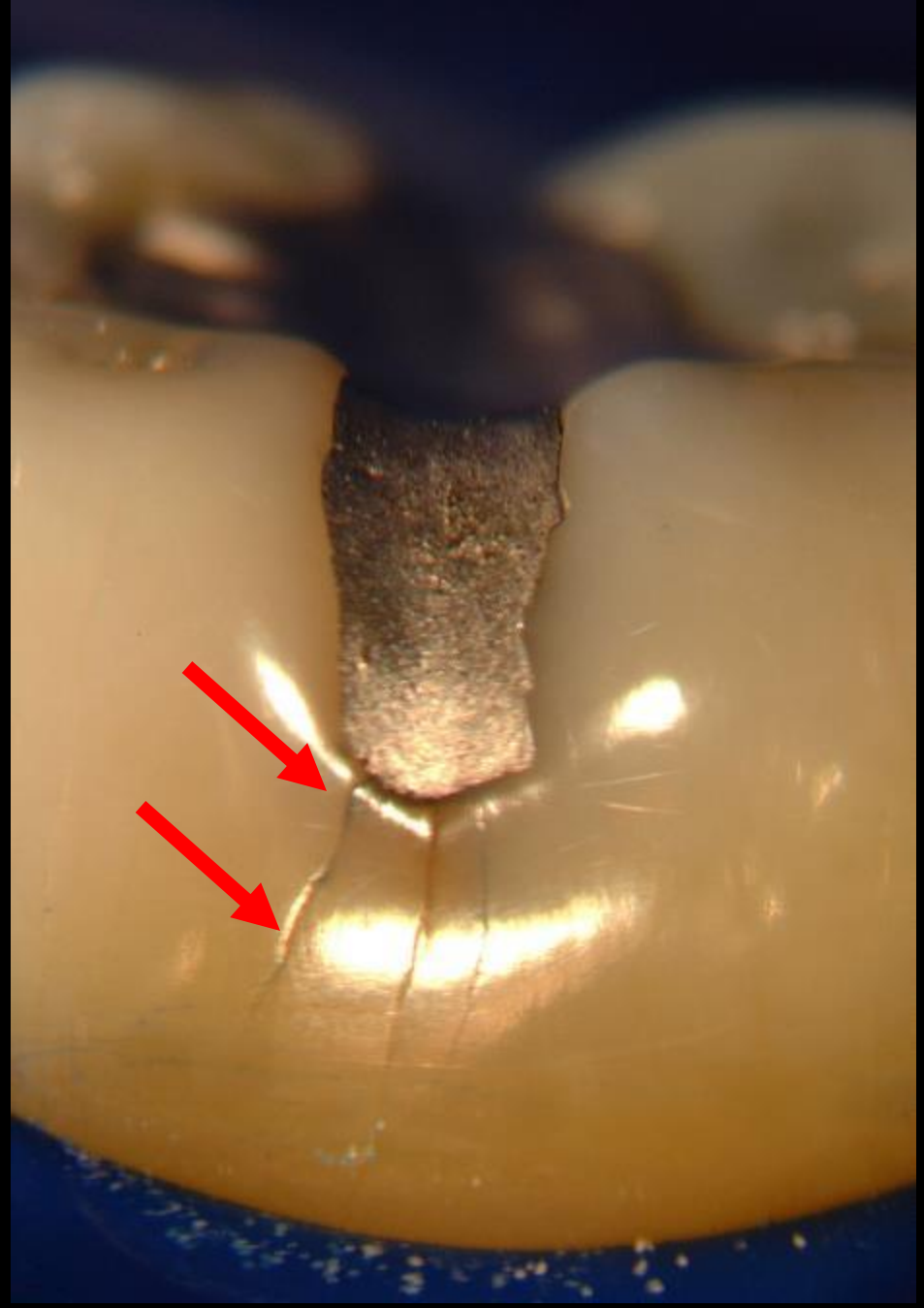
Type III: Have high risk of underlying pathology

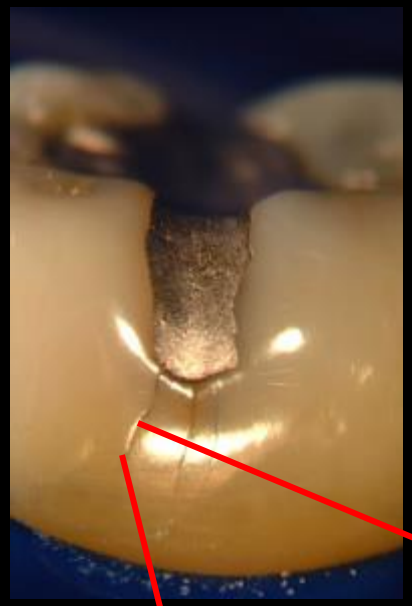
- A) Diagonal cracks branching off a vertical crack
- B) Horizontal or diagonal cracks that emanate from the corner of a restoration
- C) Cracks that house debris
- **D) The tooth looks gray**

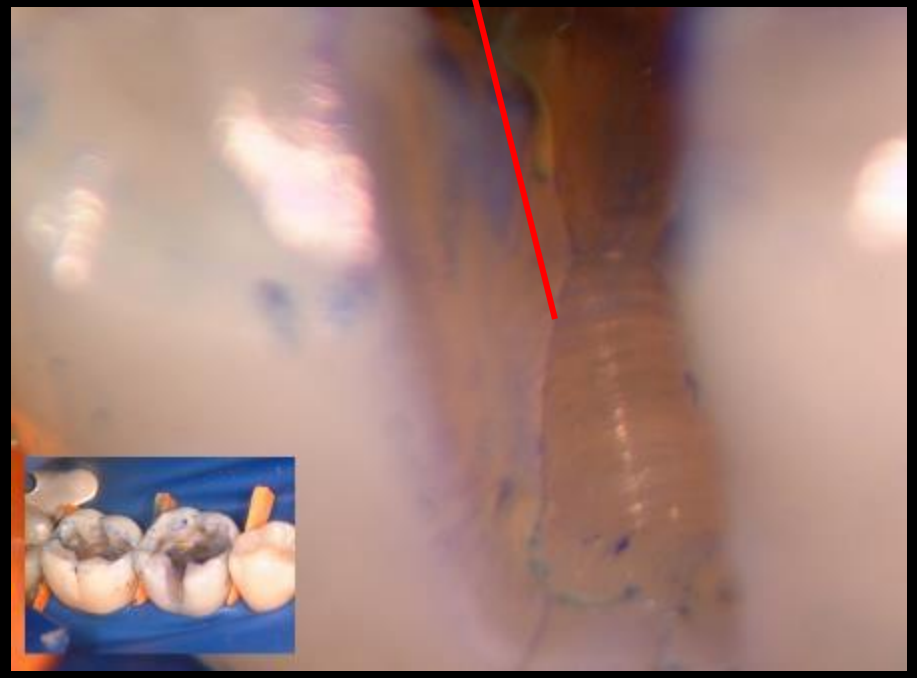
A. Diagonal cracks

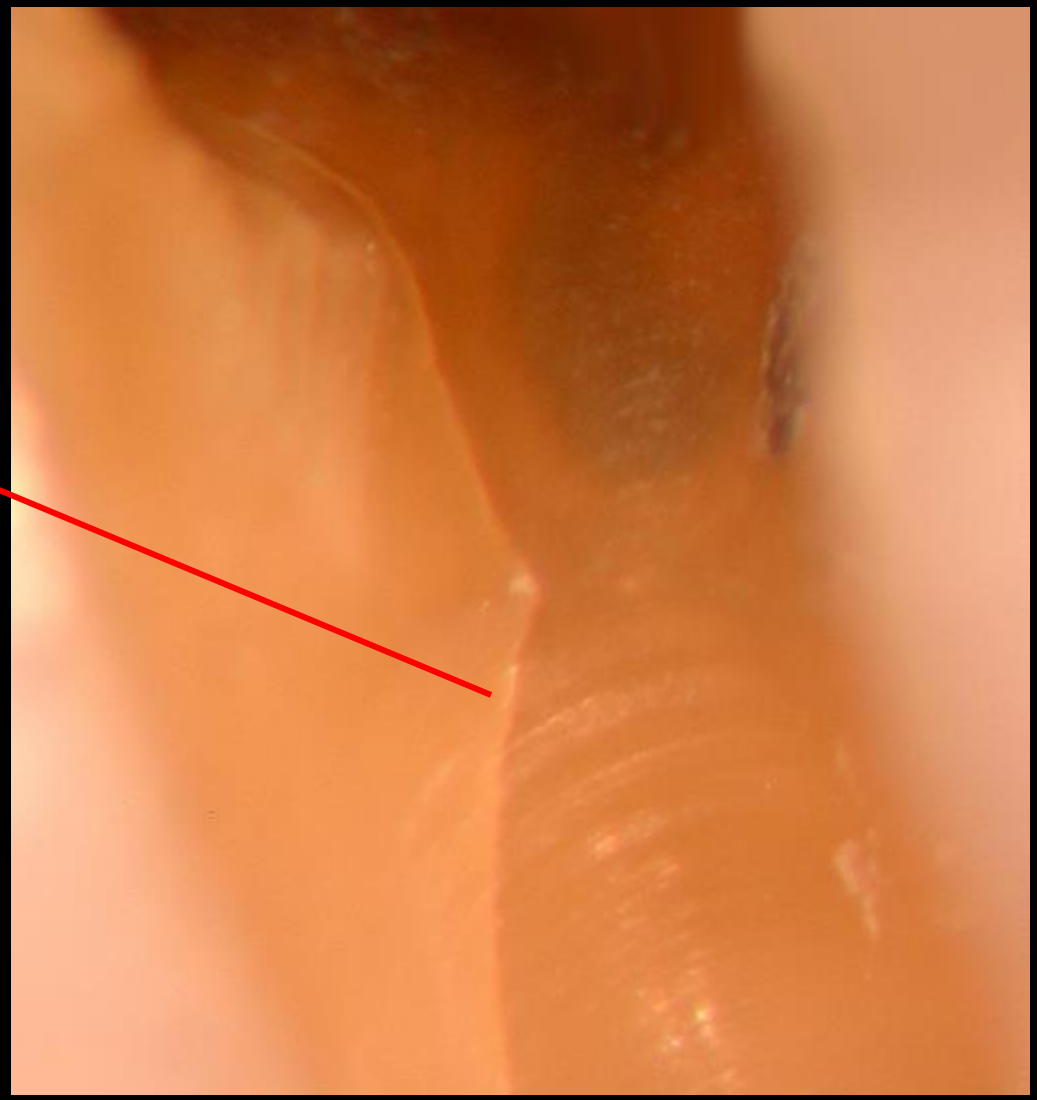


B. Diagonal cracks that emanate from the corner of a restoration



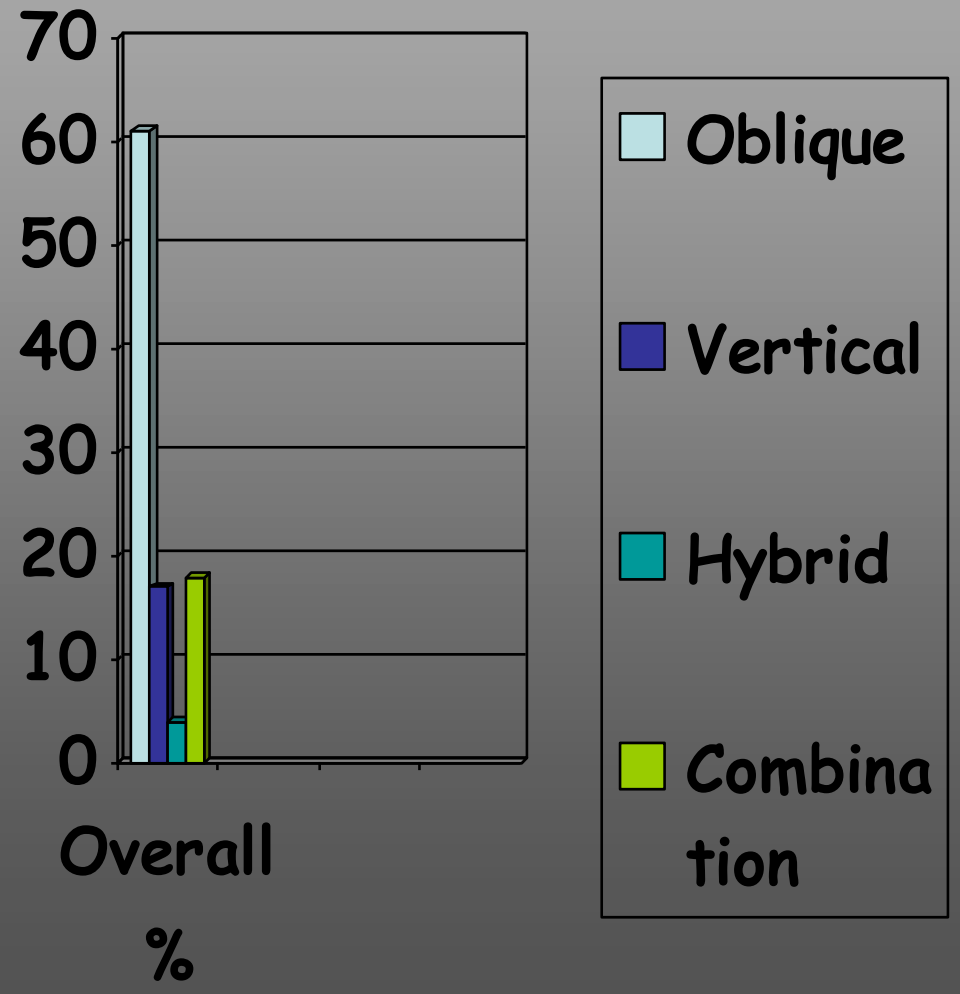






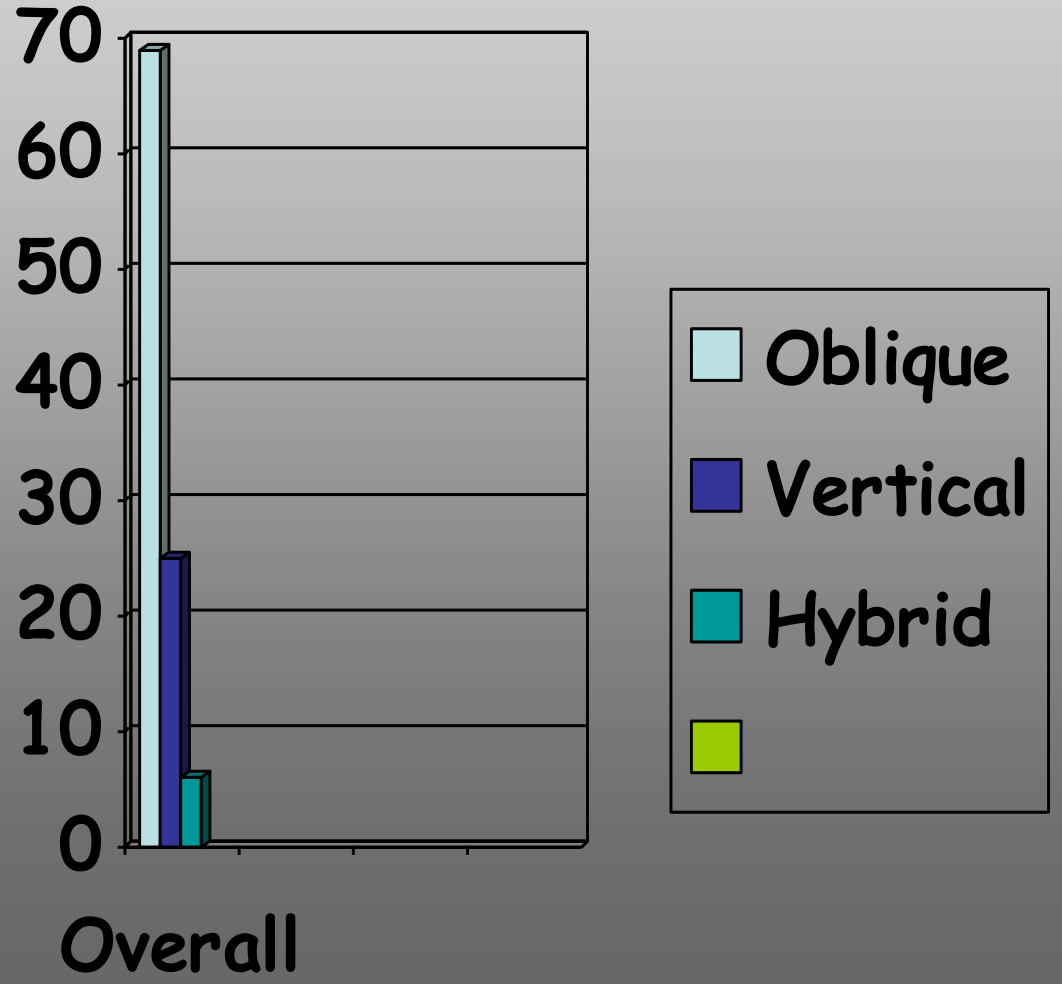
A Two Year Study 2001-2003

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

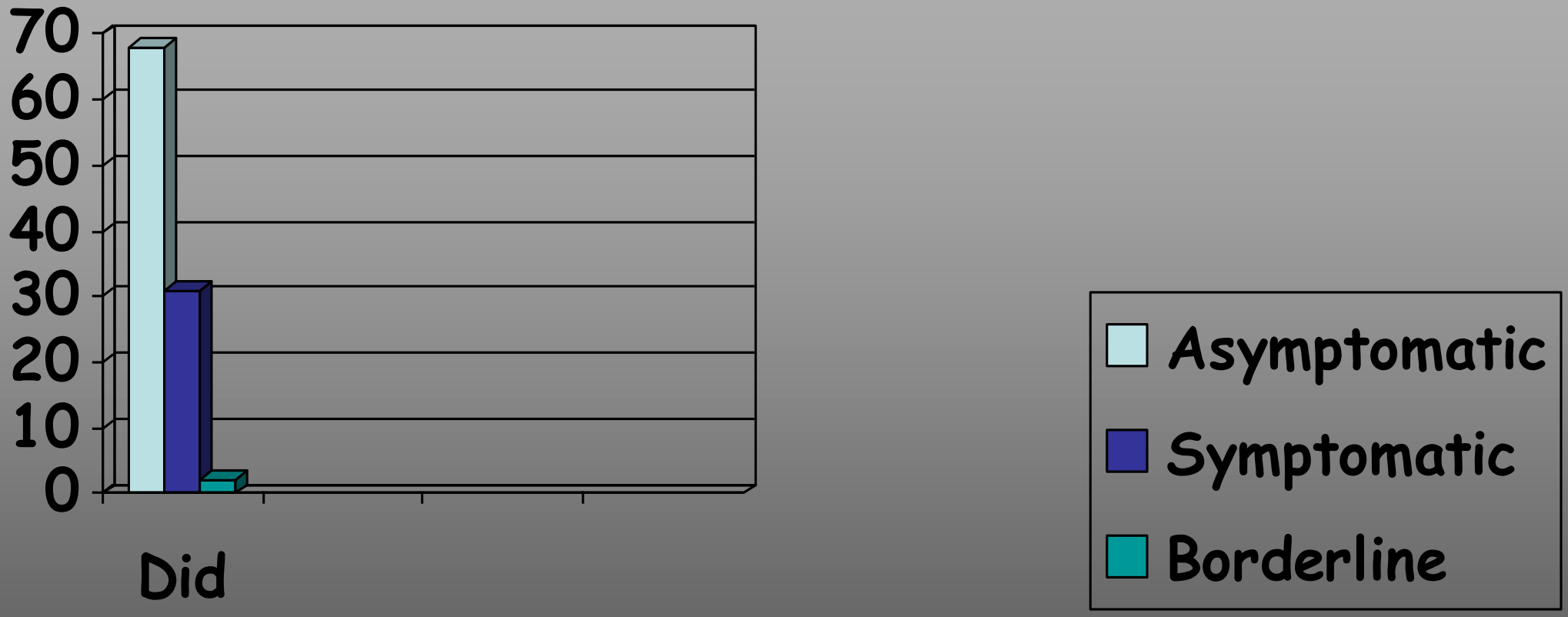


A Two Year Study

- 120 Teeth
- 188 Dentin Cracks (Incomplete Fractures)

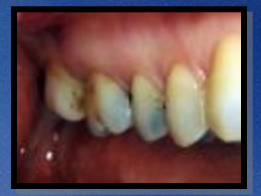


A Two Year Study



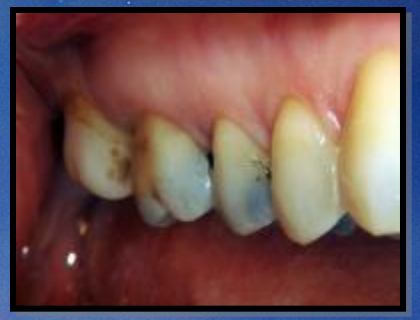
- The third leading cause of tooth loss today is from splits/fractures. (Lynch CD McCinnel RJ. The cracked tooth Syndrome. J Dent Assoc Sept 2002; 68(8):470-475)
- Crack initiation and progression should not be labeled a “syndrome”
- Diagnosis and treatment should be similar to approaches we utilize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

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



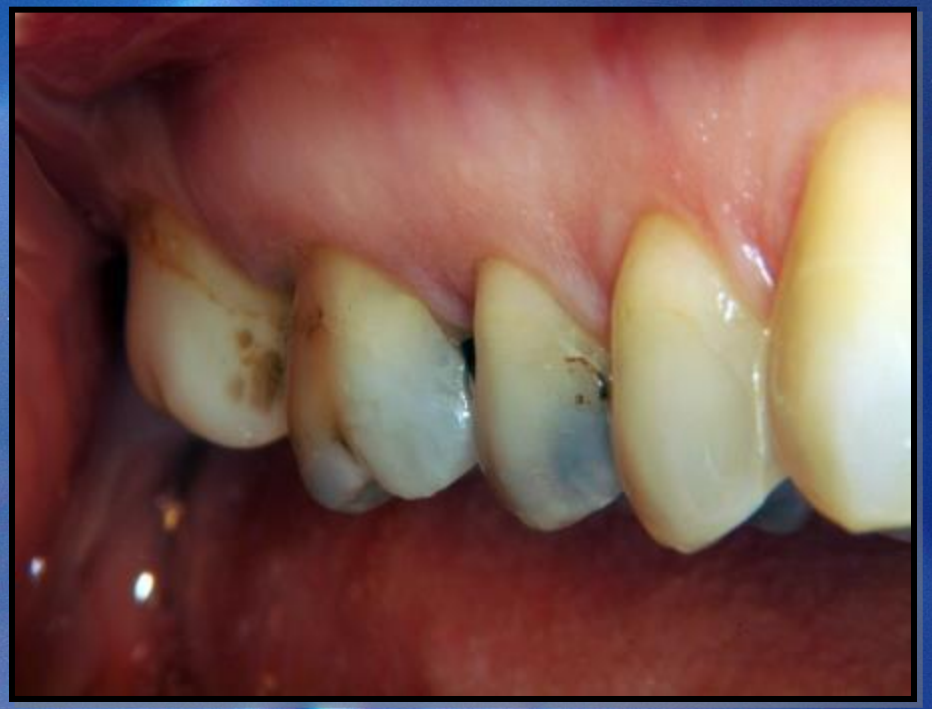
2X

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

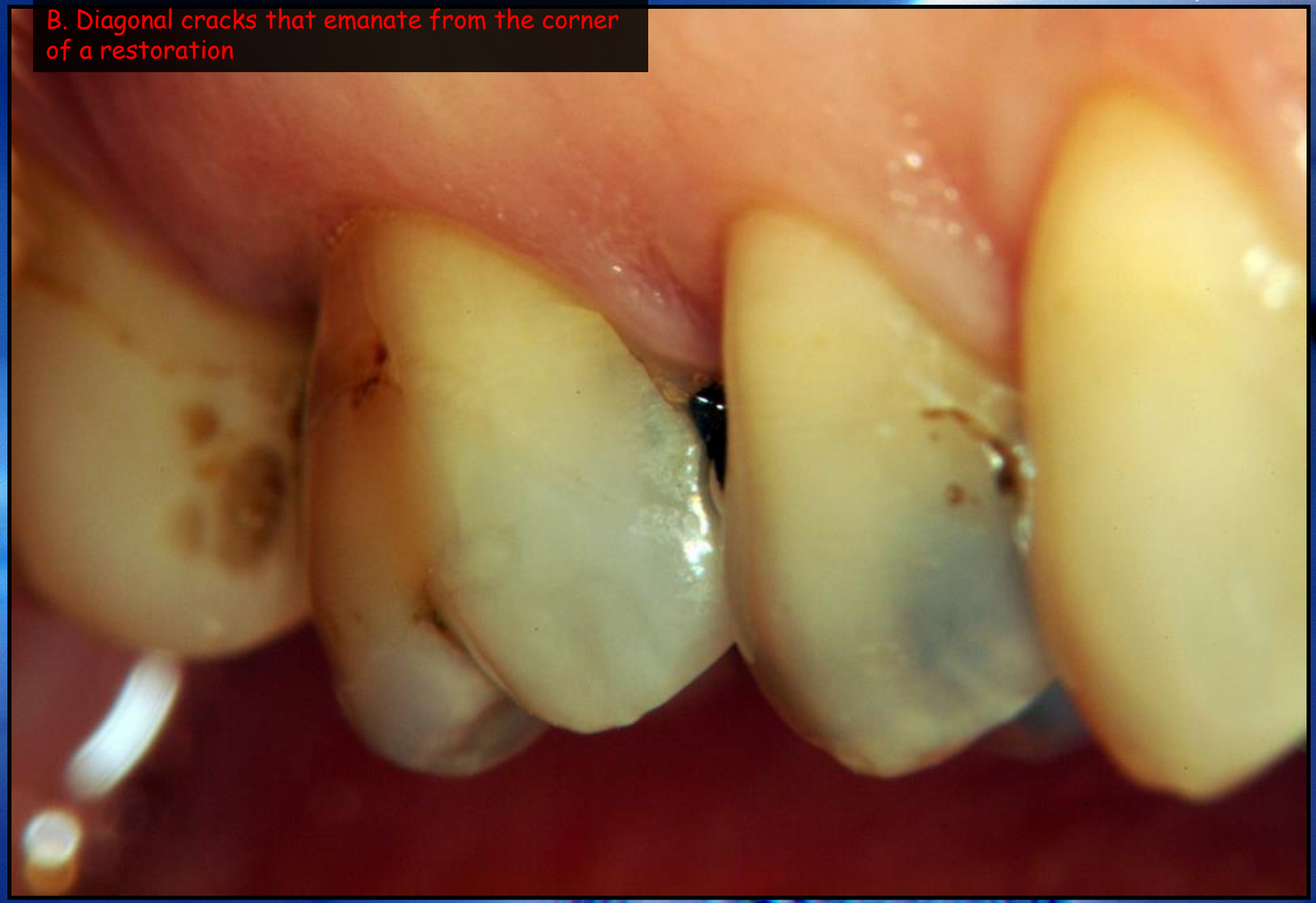


4X

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



8X


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

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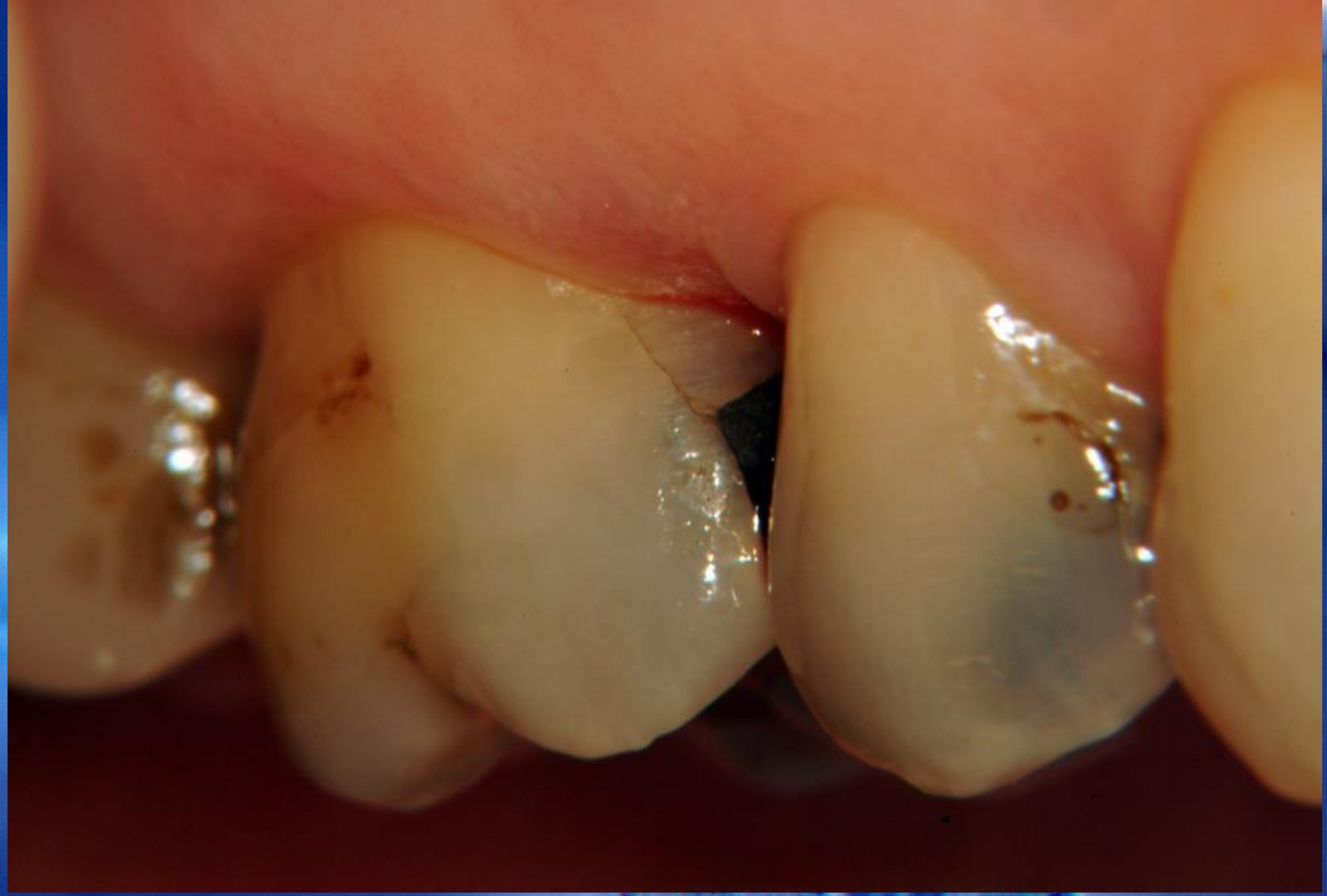
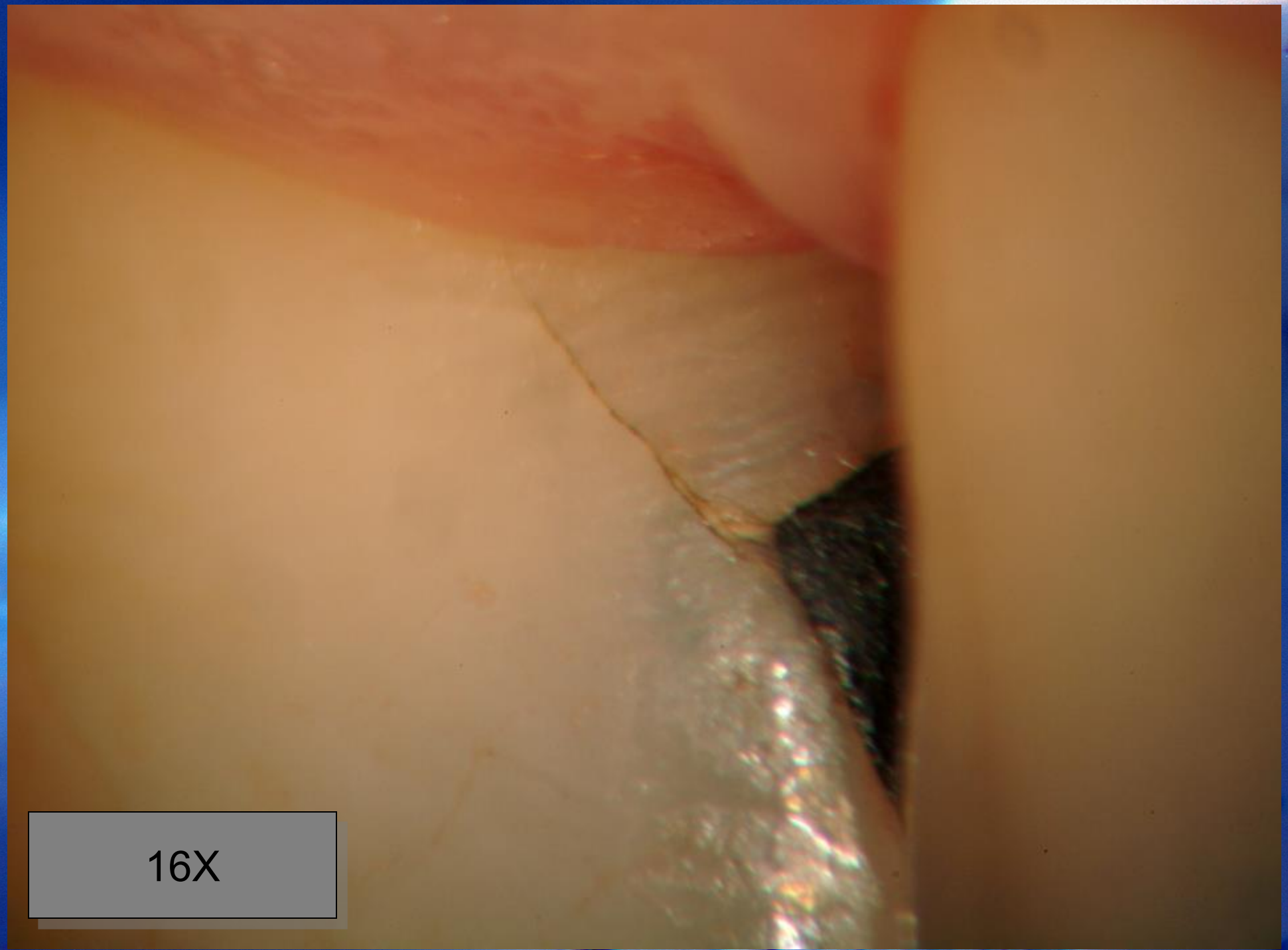
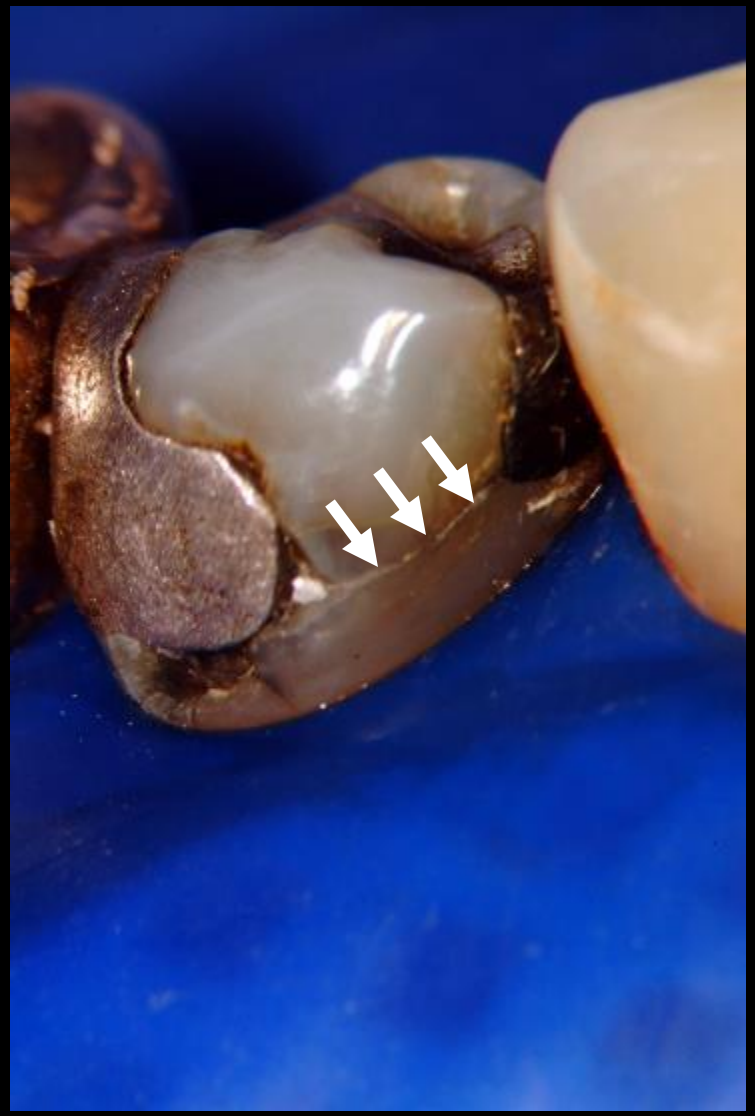
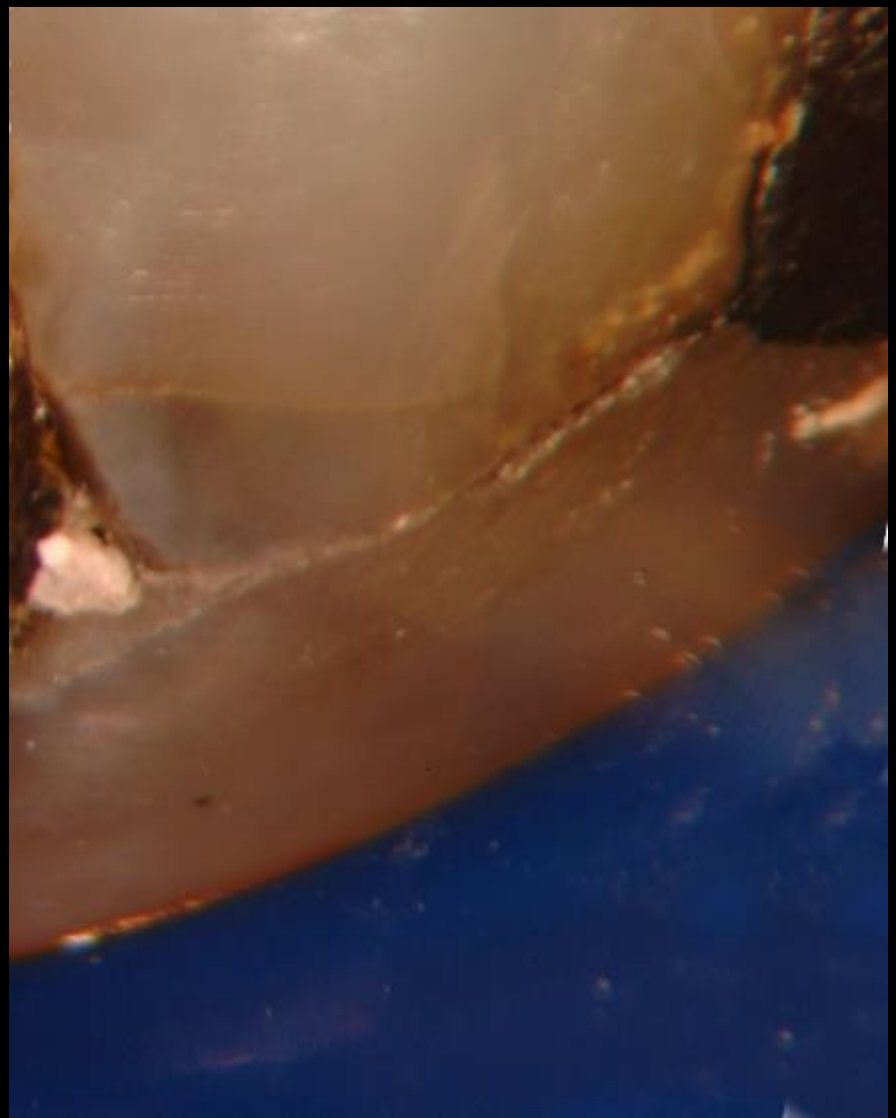


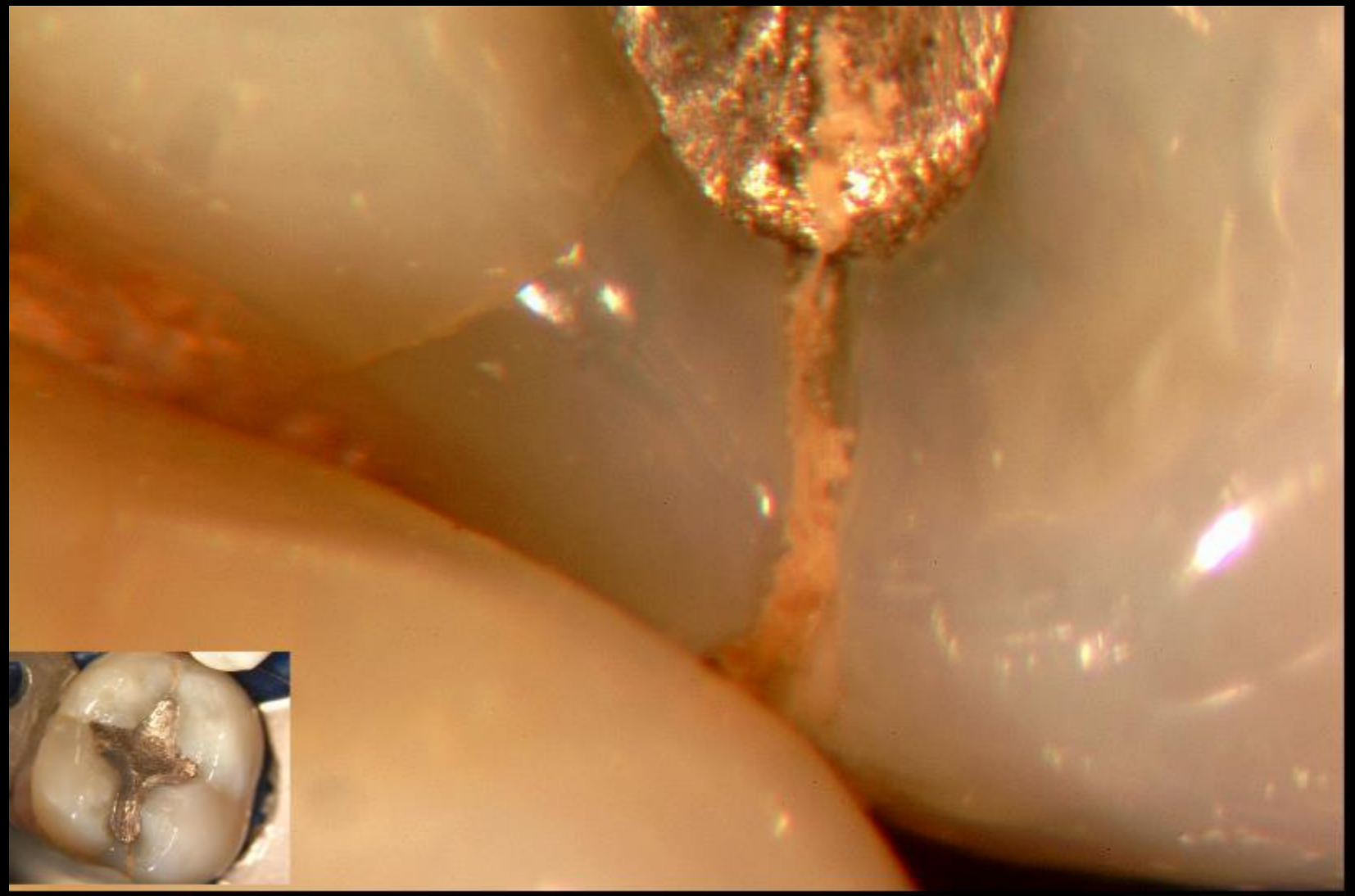

16X

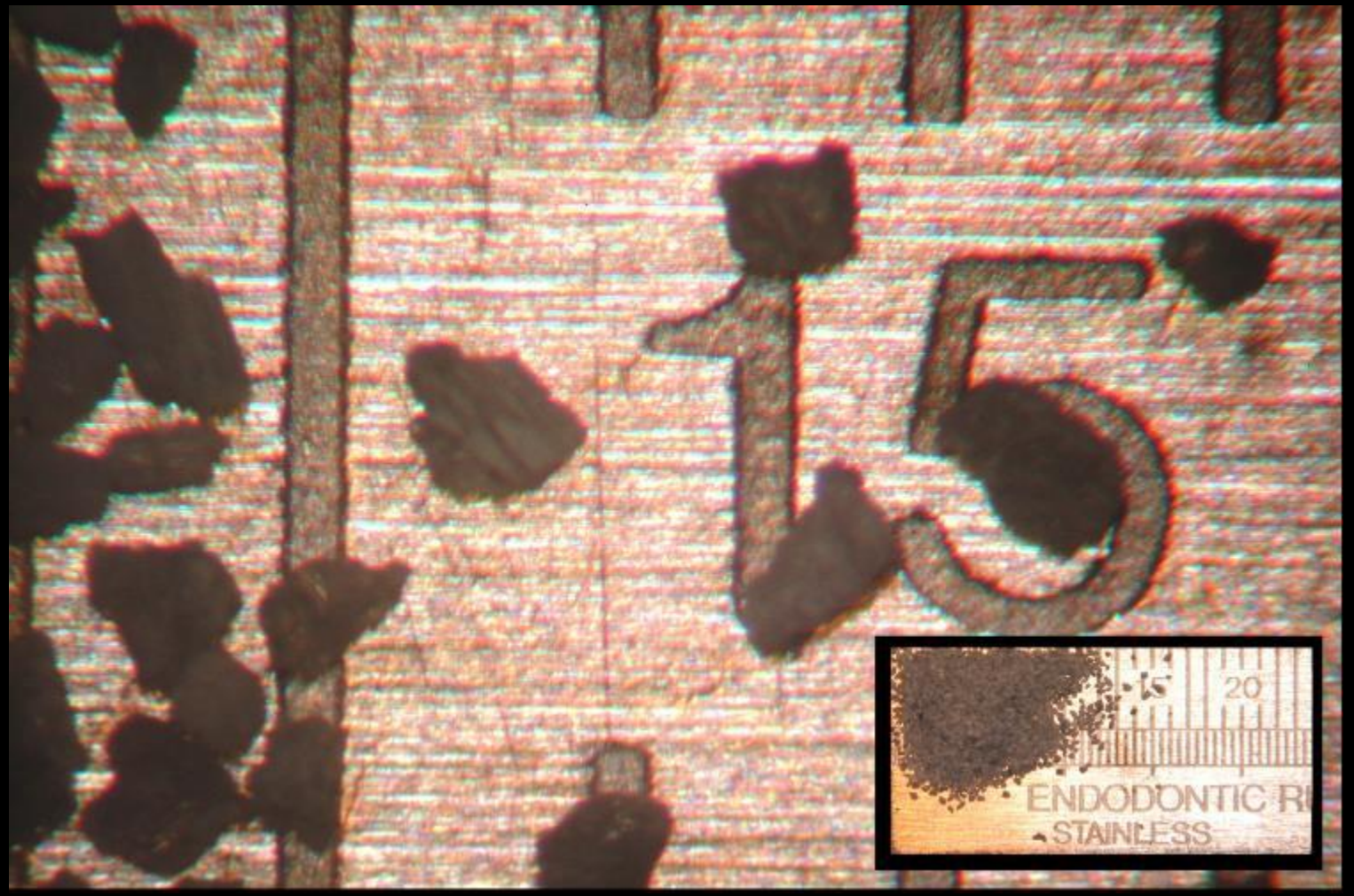
B. Horizontal cracks





C. Crack that houses debris

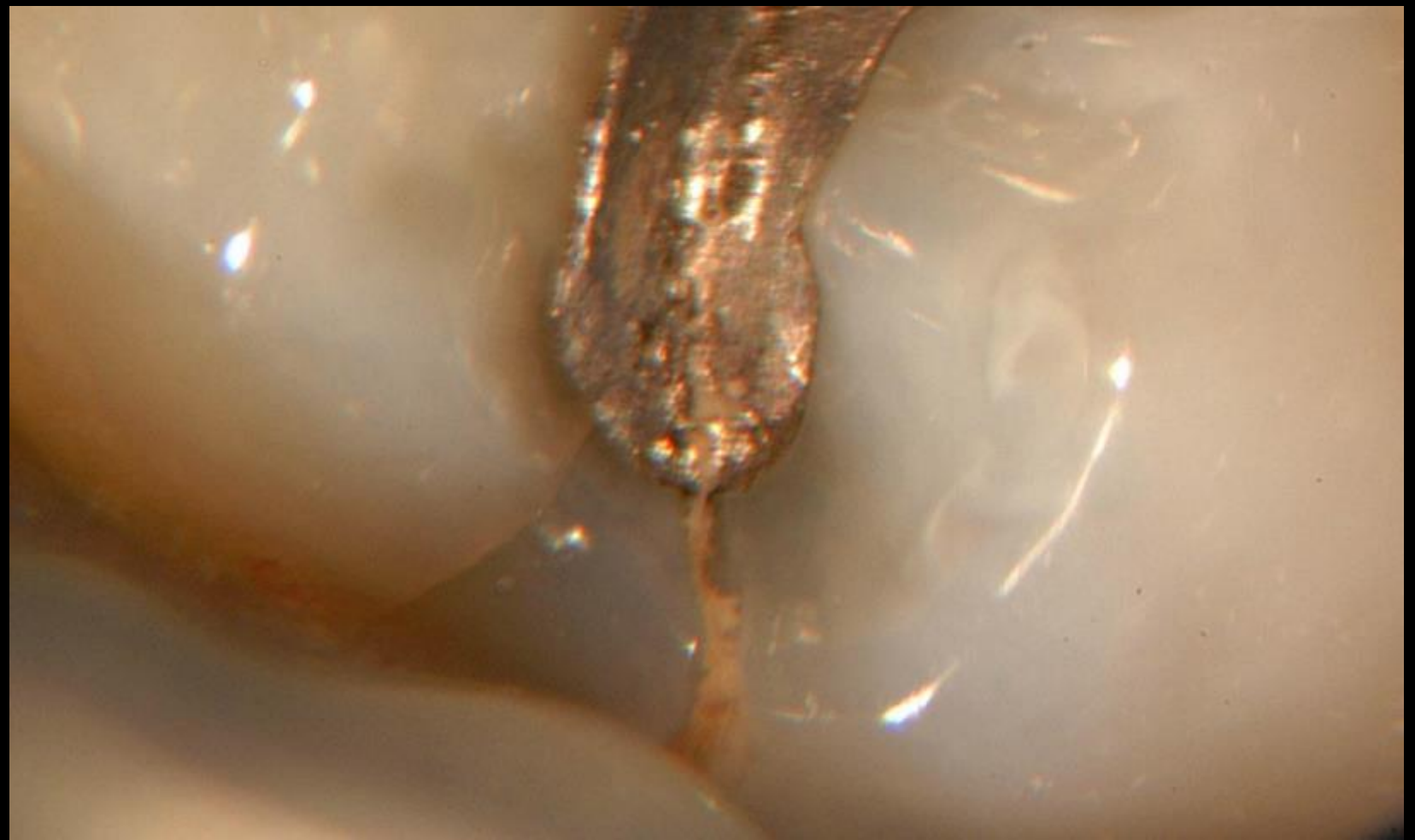



20
ENDODONTIC R
STAINLESS

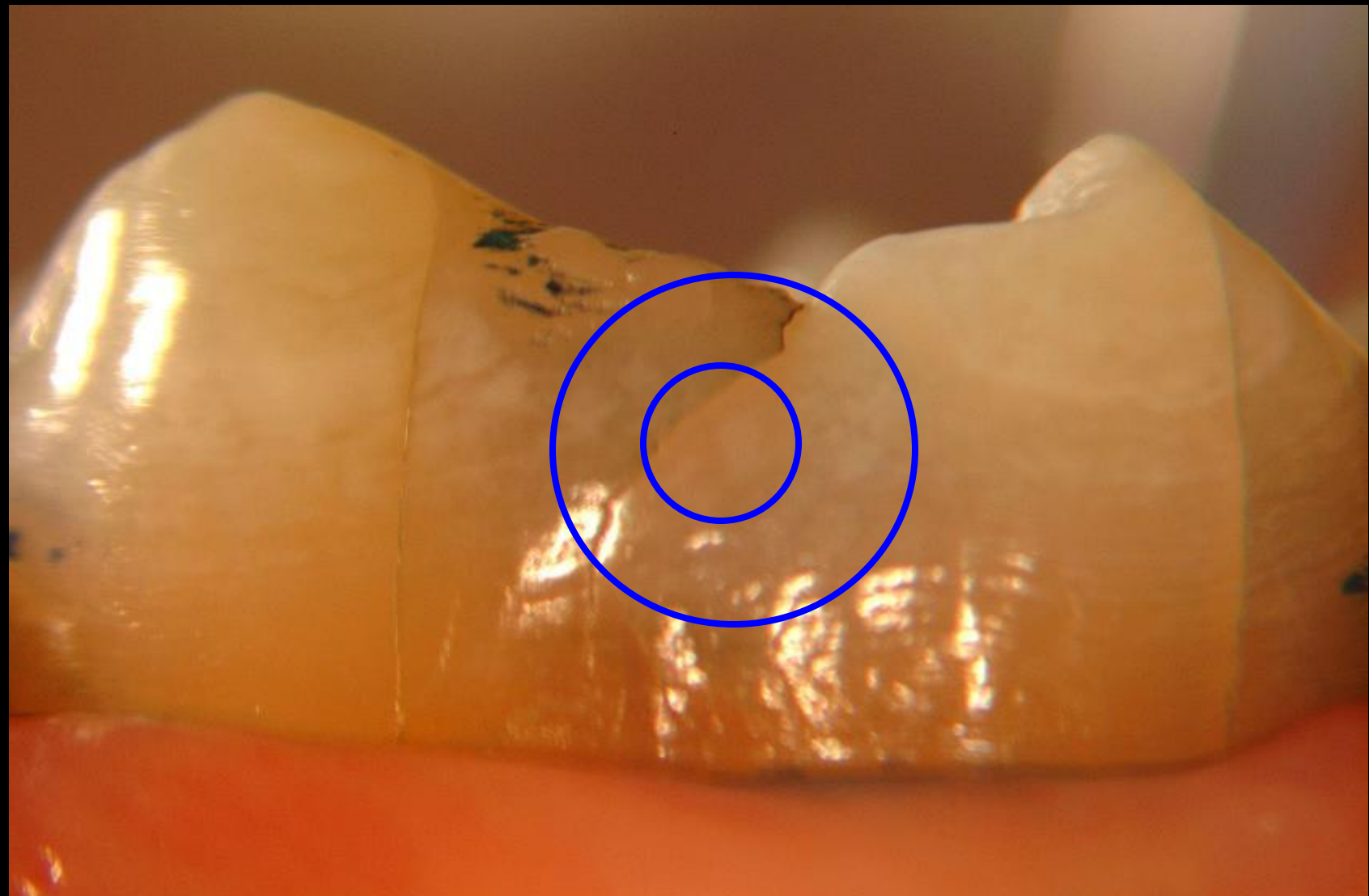
Type III: Have high risk of underlying pathology

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

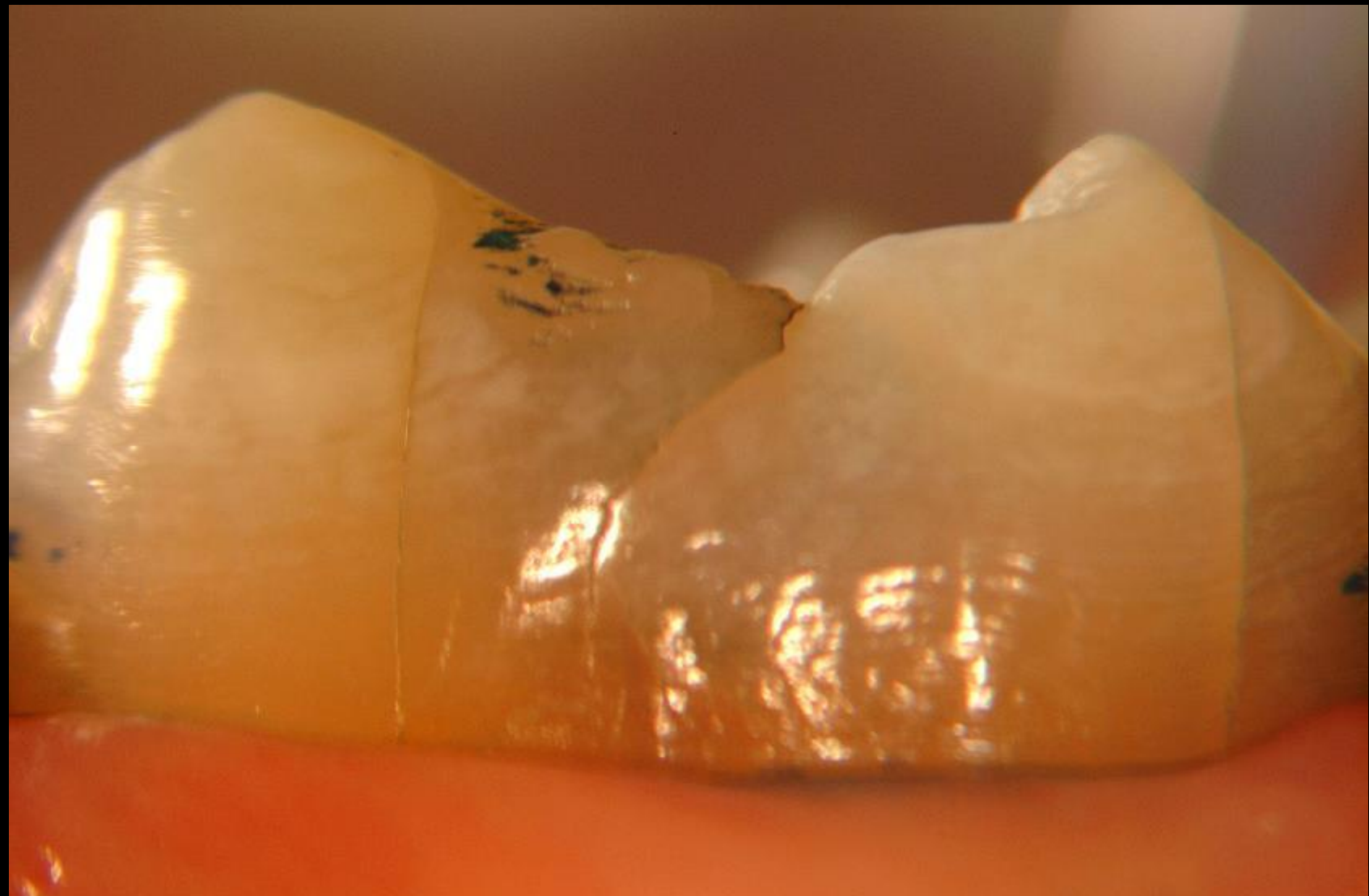
D. Pair of cracks that outline an area (cusp or marginal ridge) of discolored enamel



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

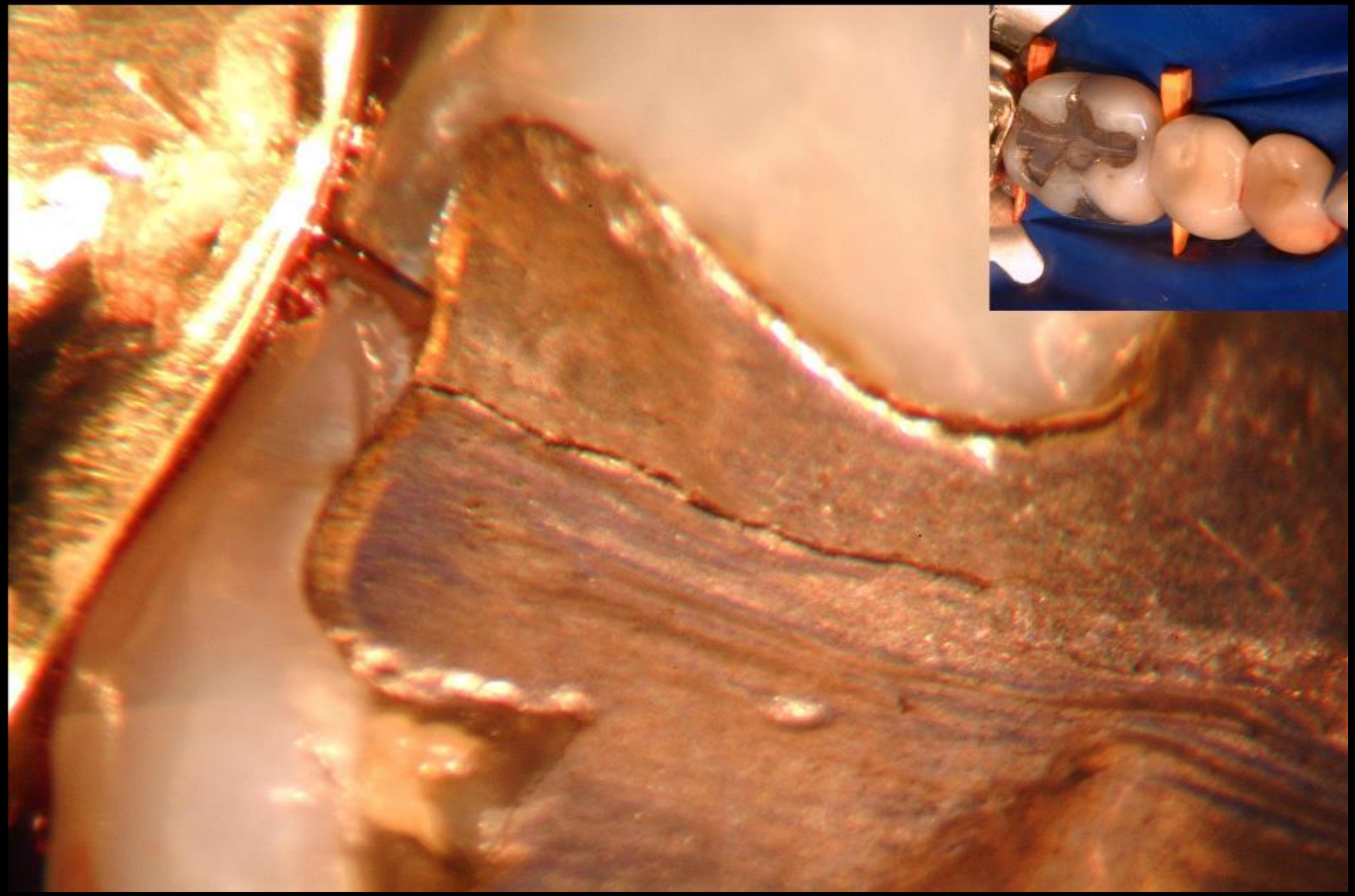


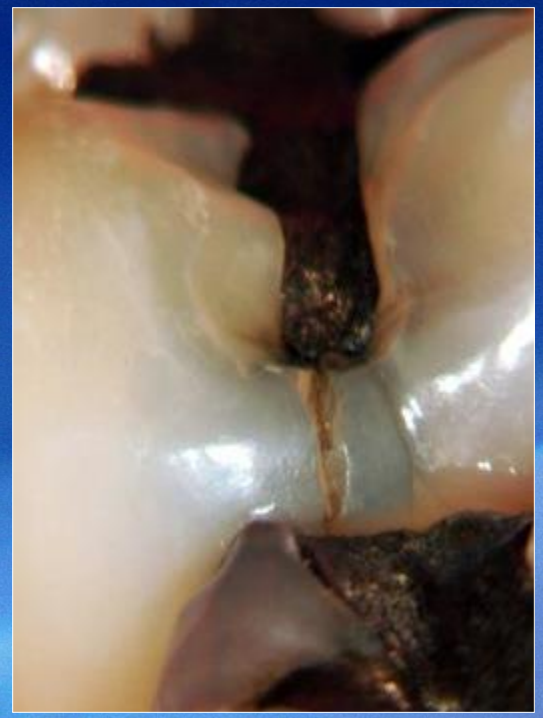
E. Crack with corresponding halo of brown, grey or white centered on crack

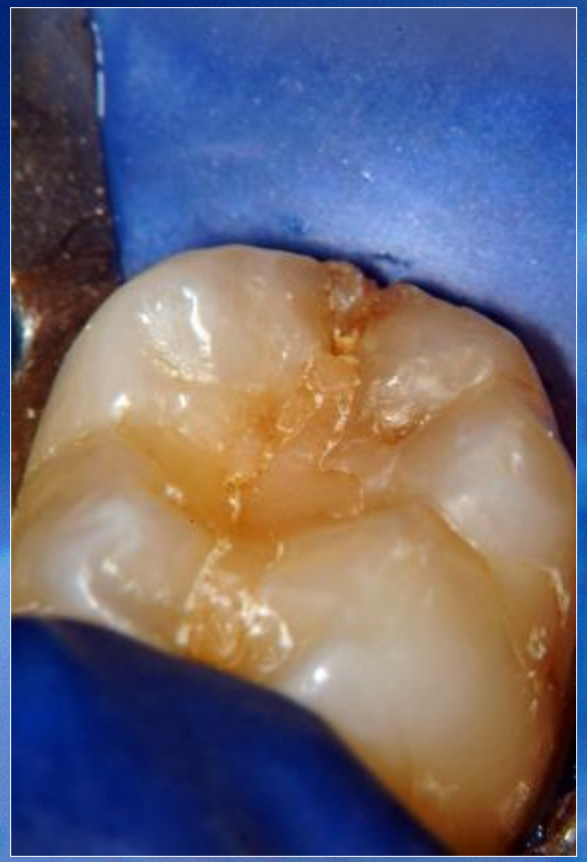


Other Microscopic Findings That Can Indicate a Lack of Coronal Structural Integrity

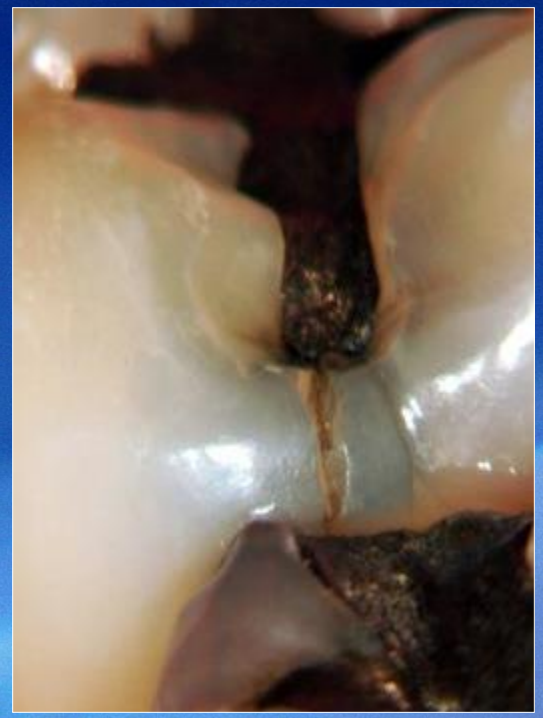
- Unusual or asymmetric gapping of filling material
- Crack in Filling material
- Gray discoloration of a cusp or cusps



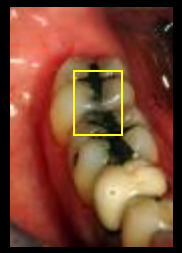


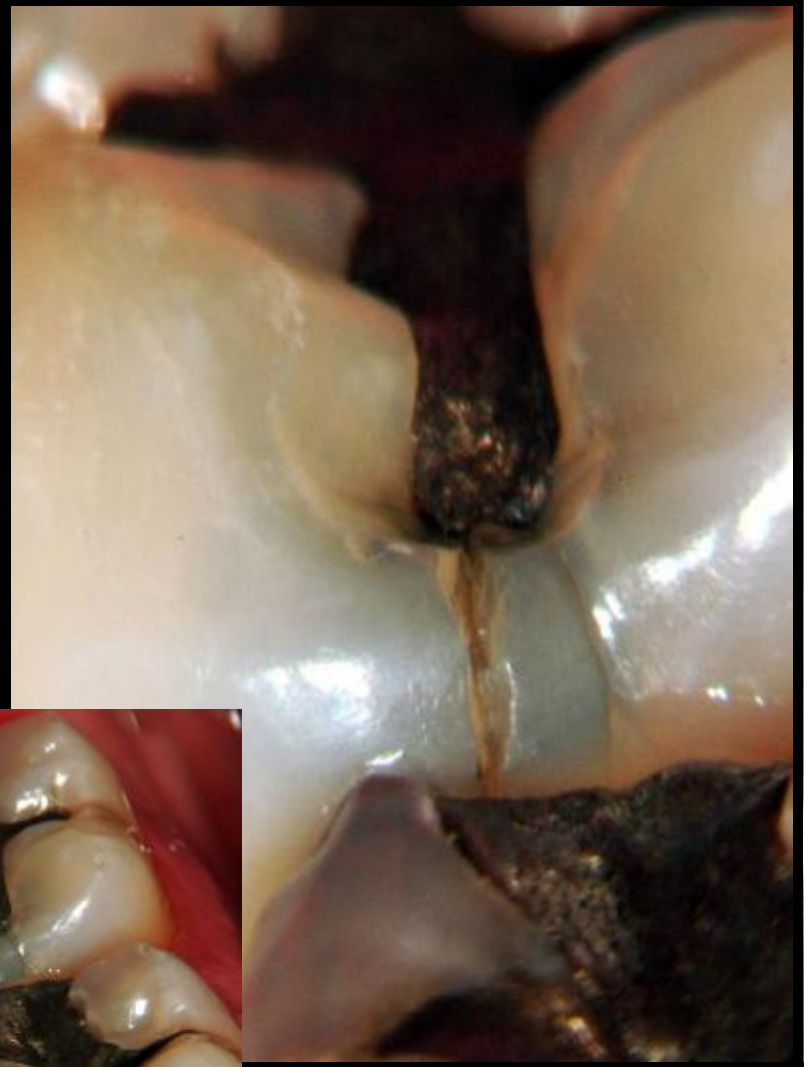


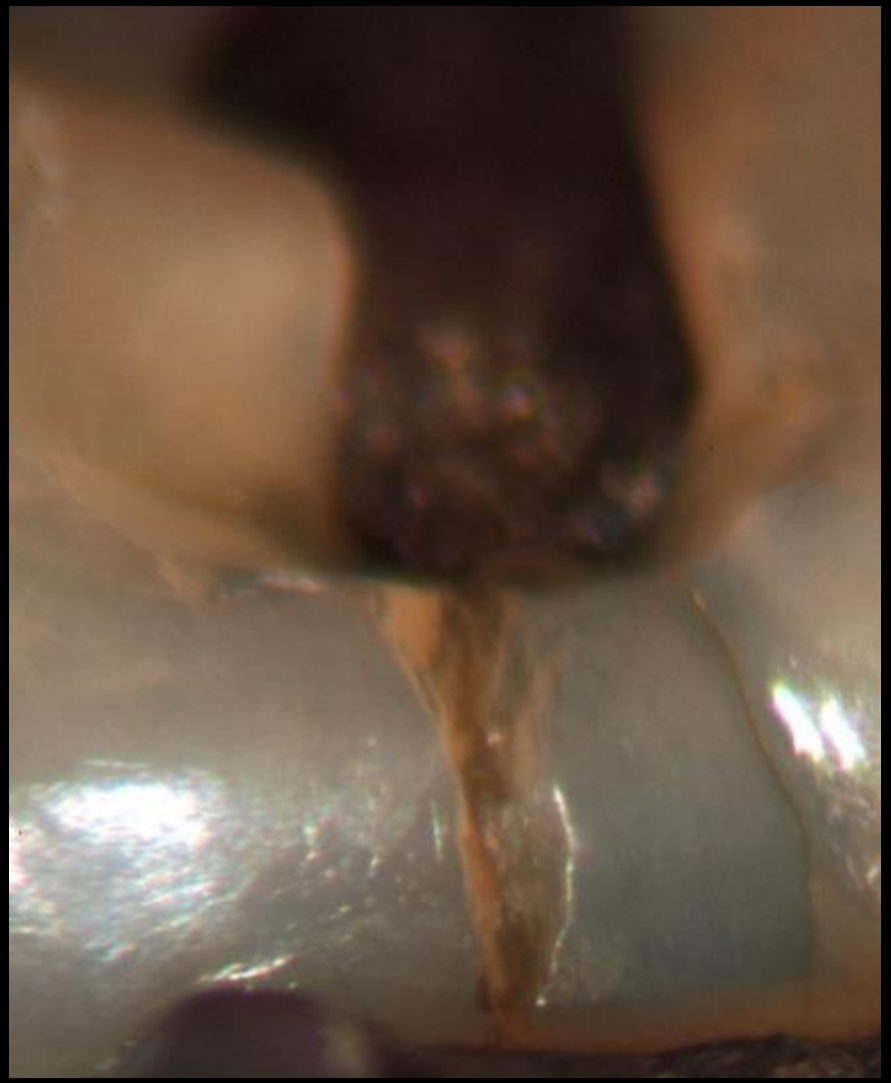
A Tale of Three Marginal Ridges

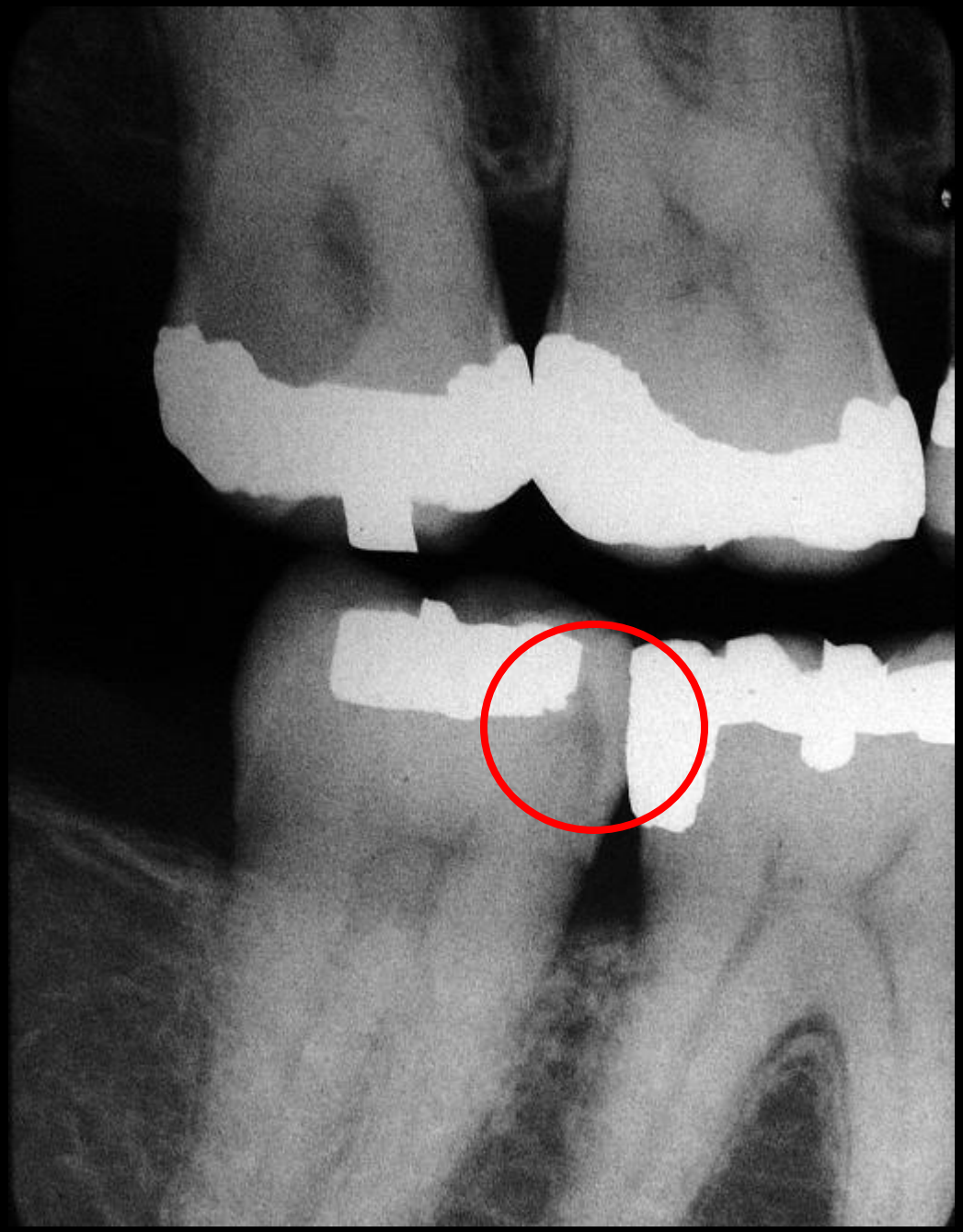


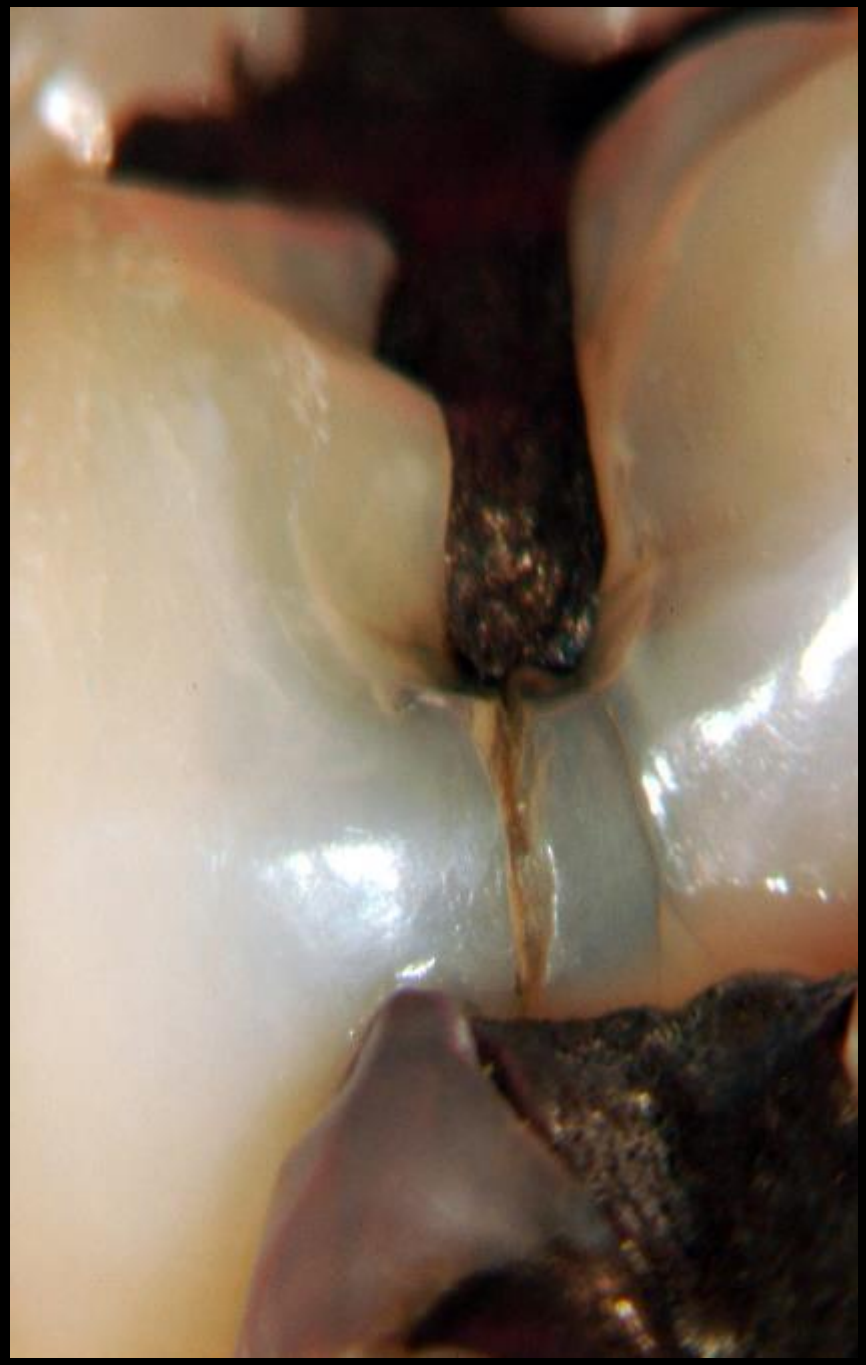
A Tale of Three Marginal Ridges

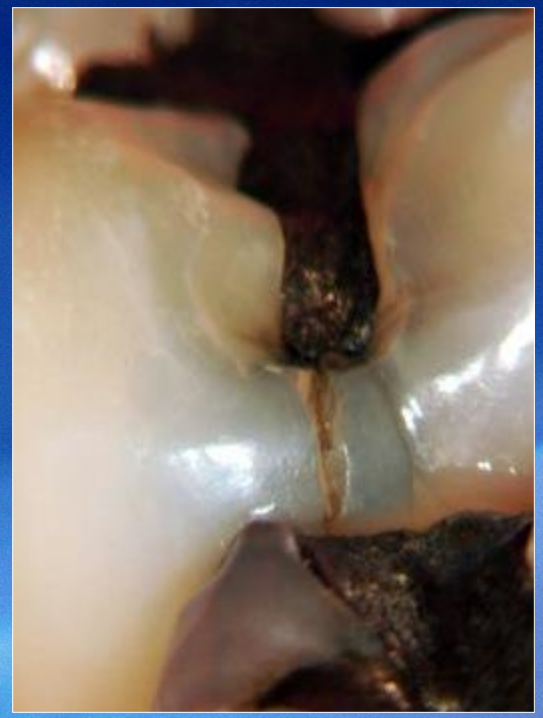


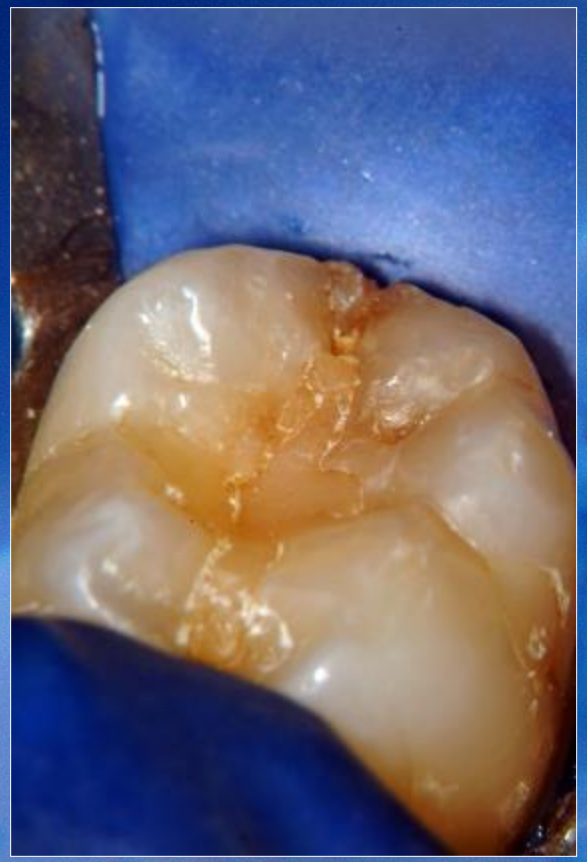






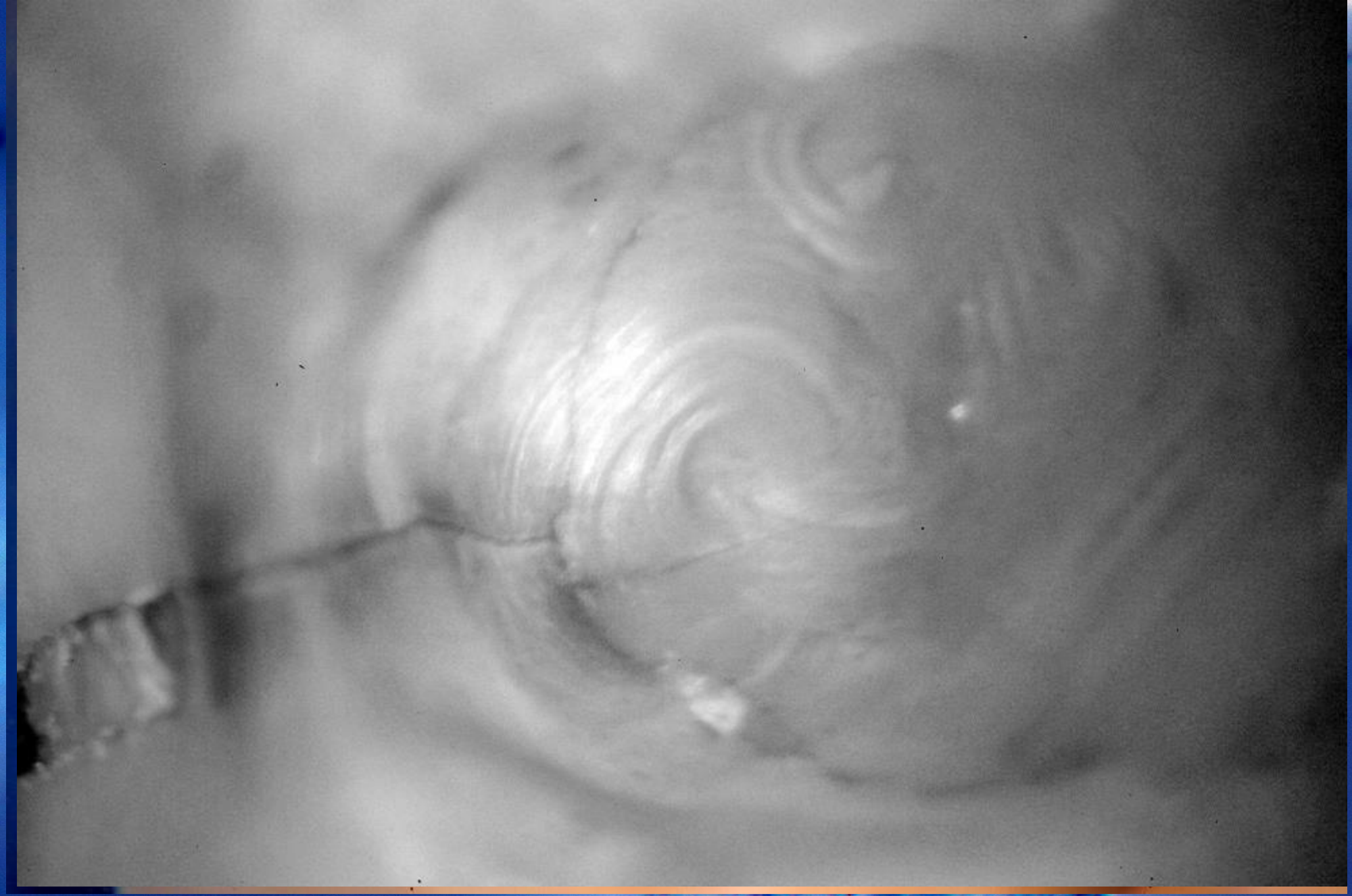


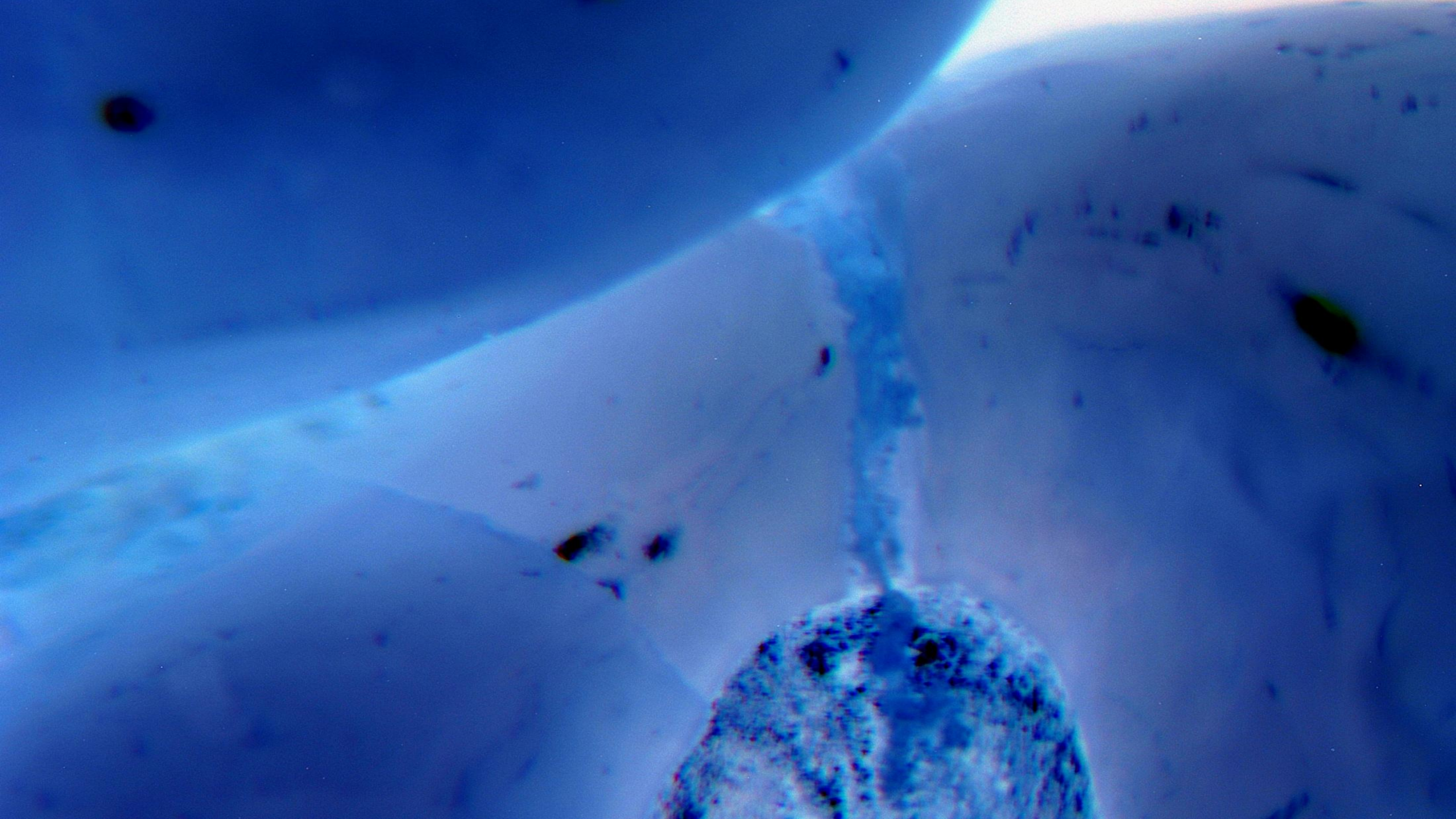


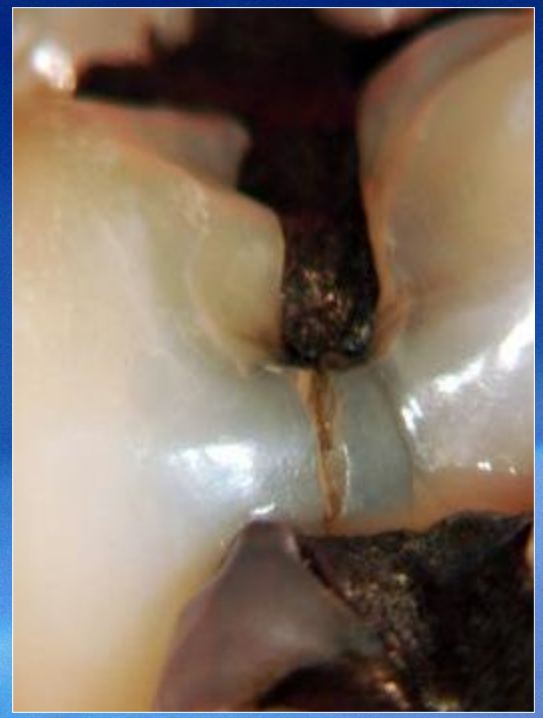


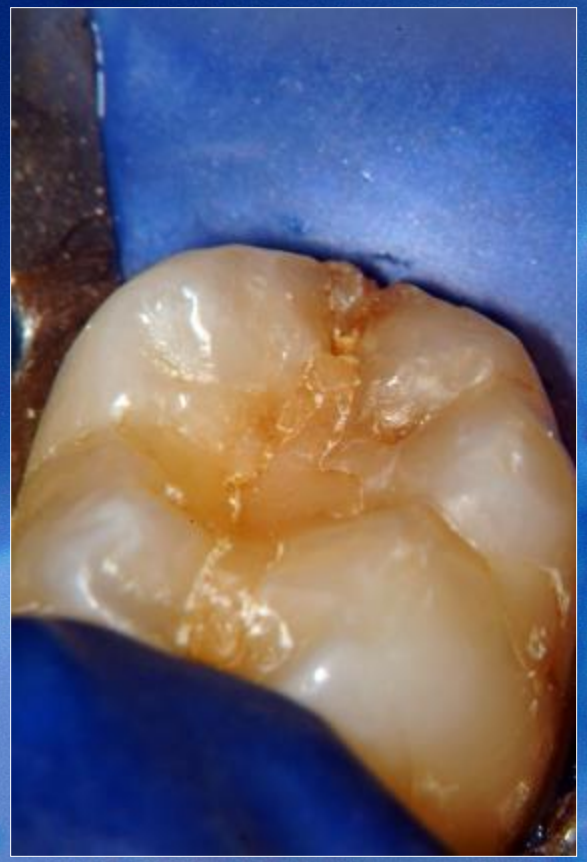
A Tale of Three Marginal Ridges

A Tale of Three Marginal Ridges

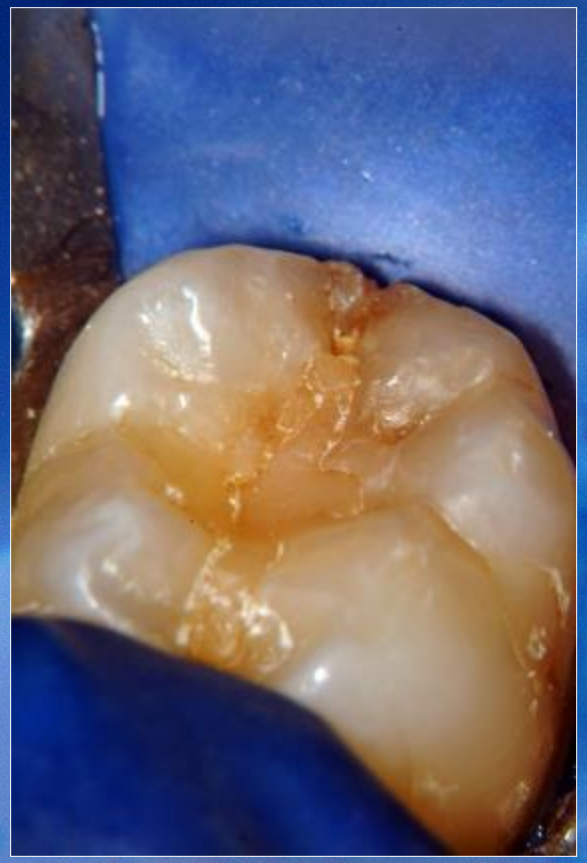




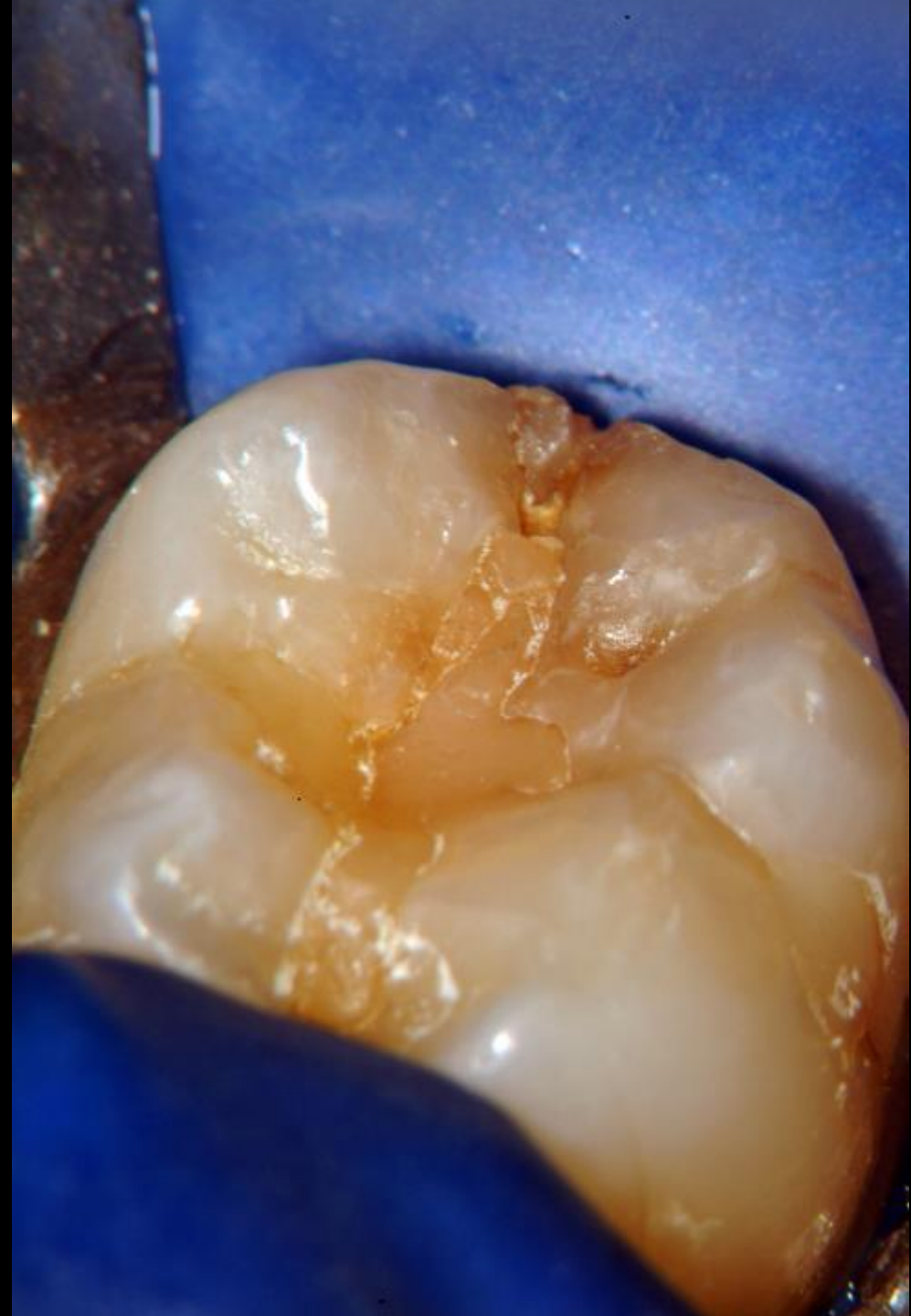


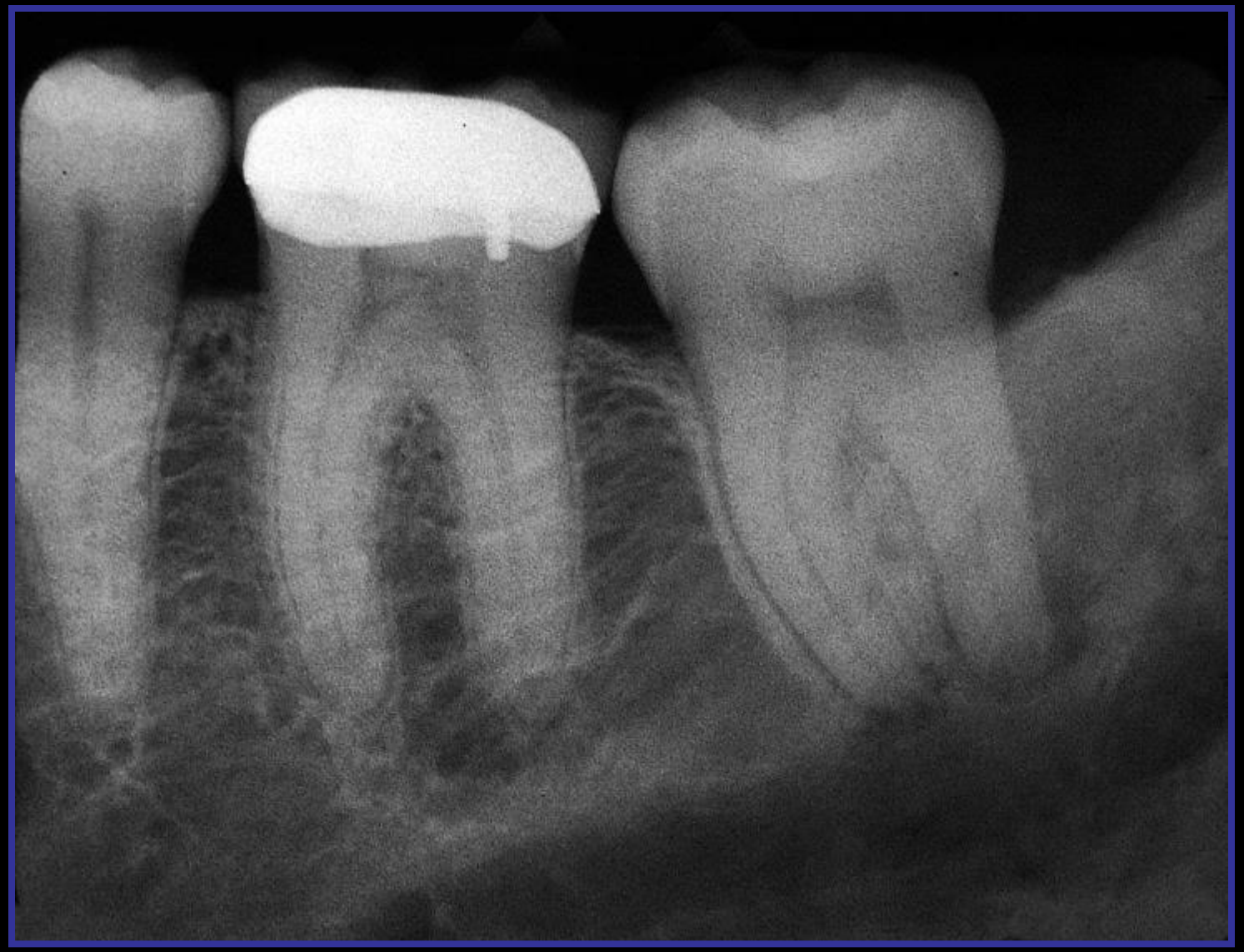


A Tale of Three Marginal Ridges

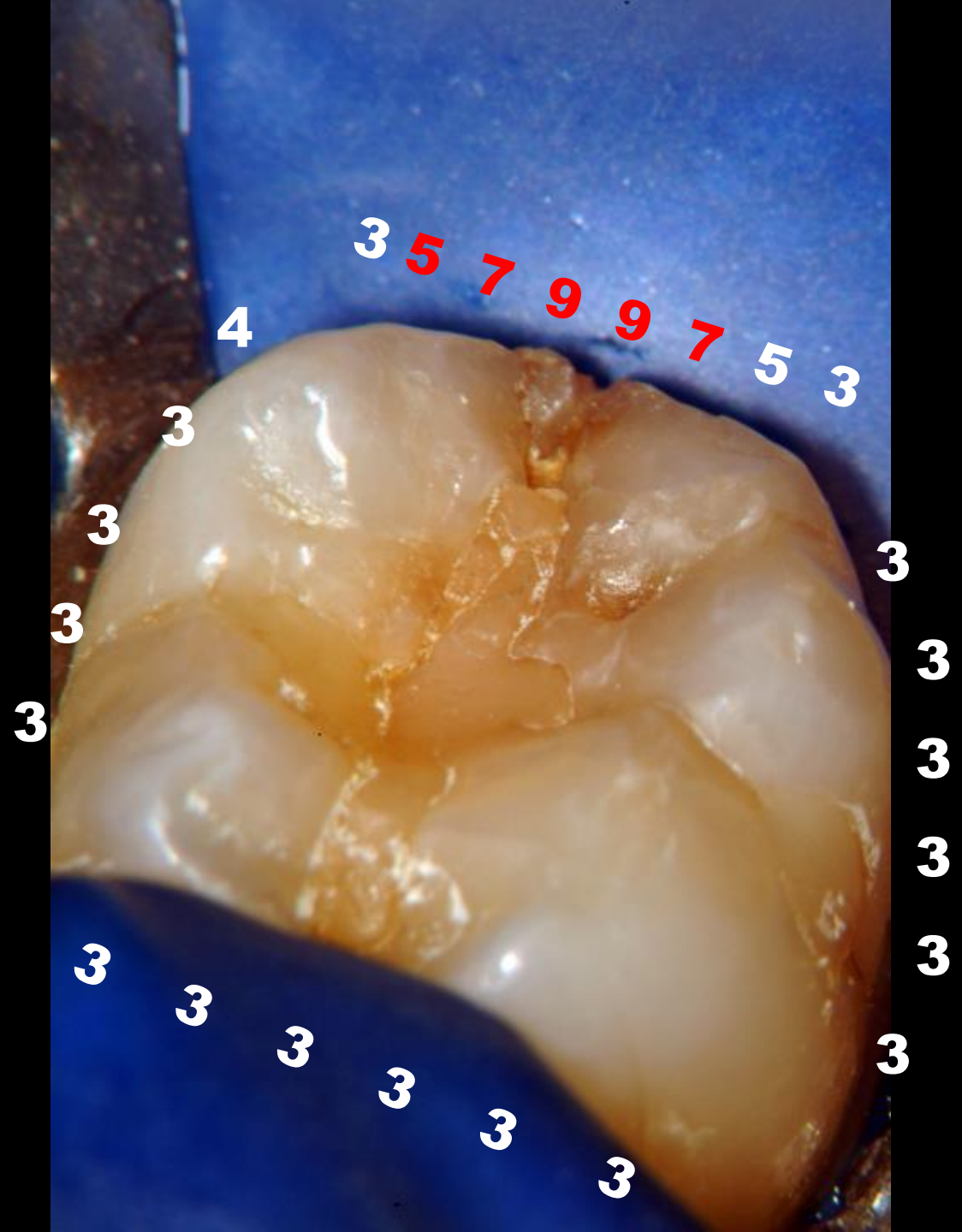


A Tale of Three Marginal Ridges

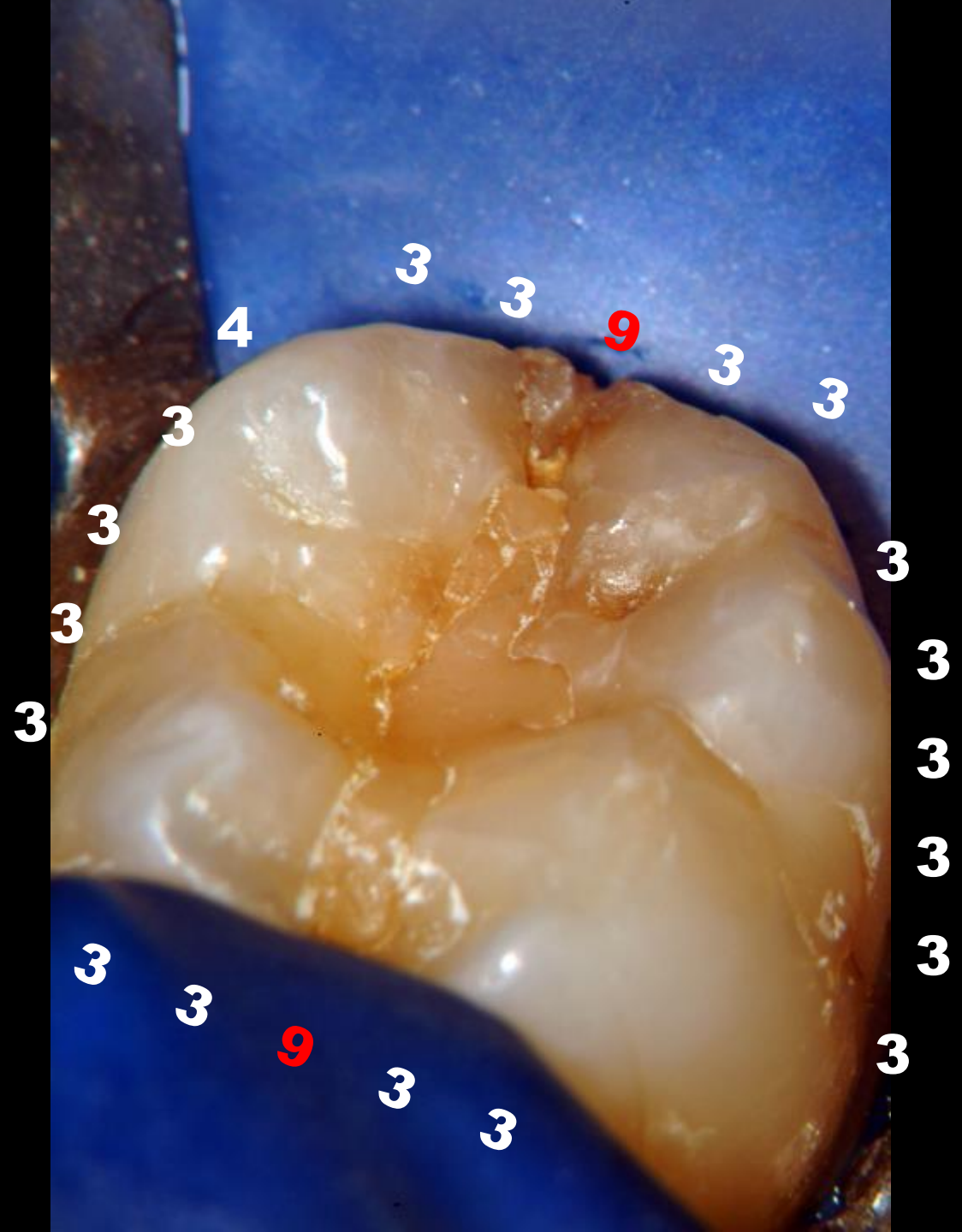




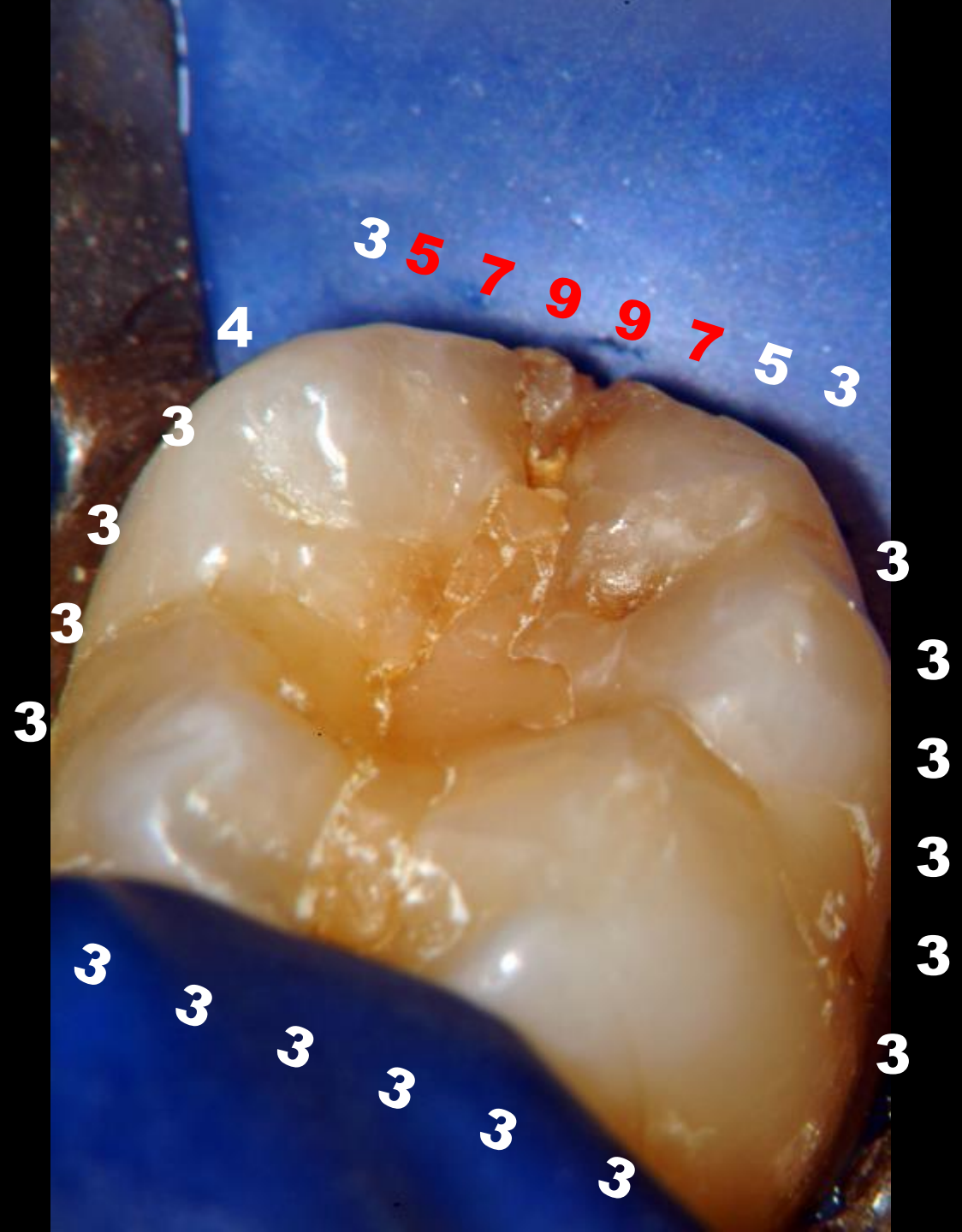
What we probed

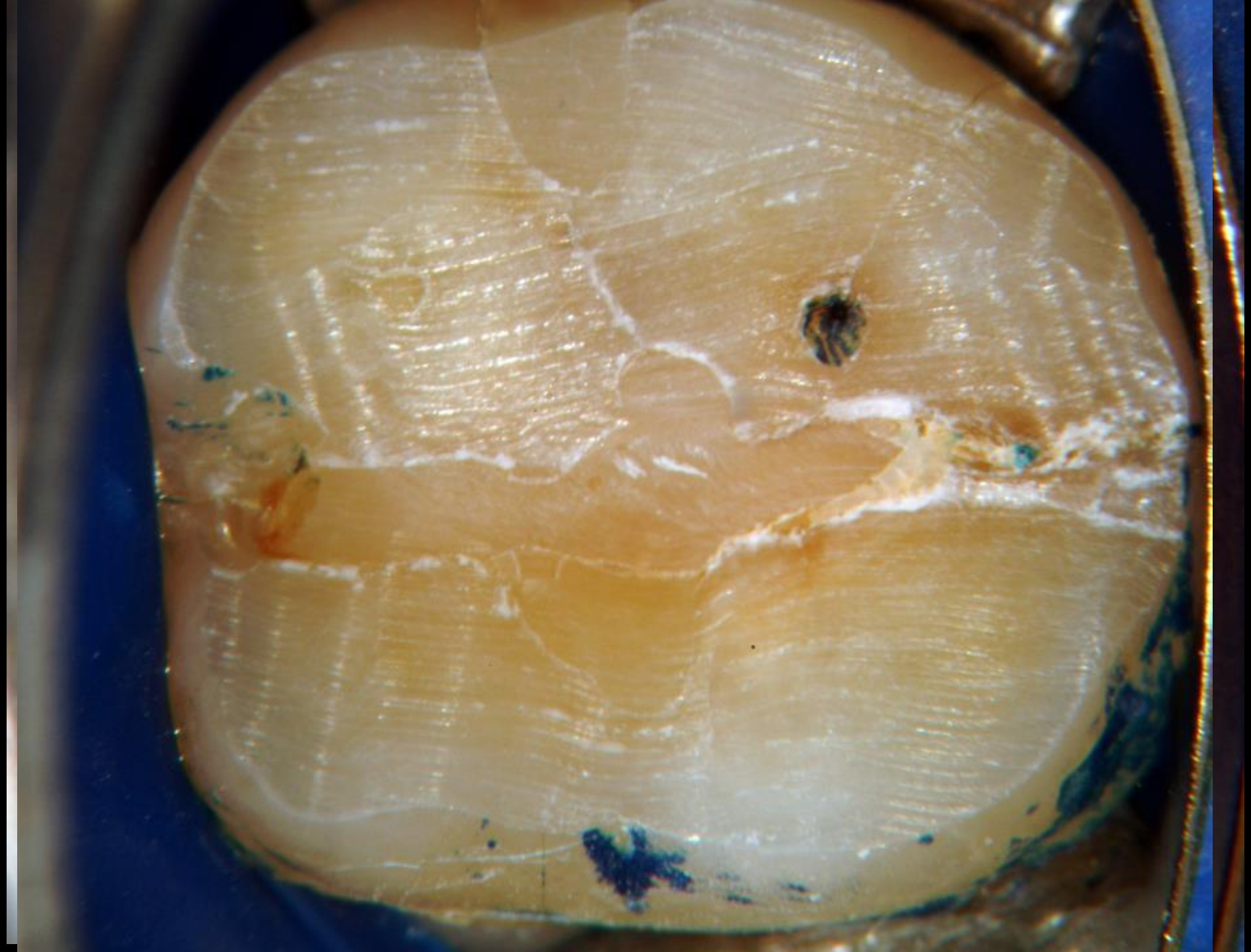


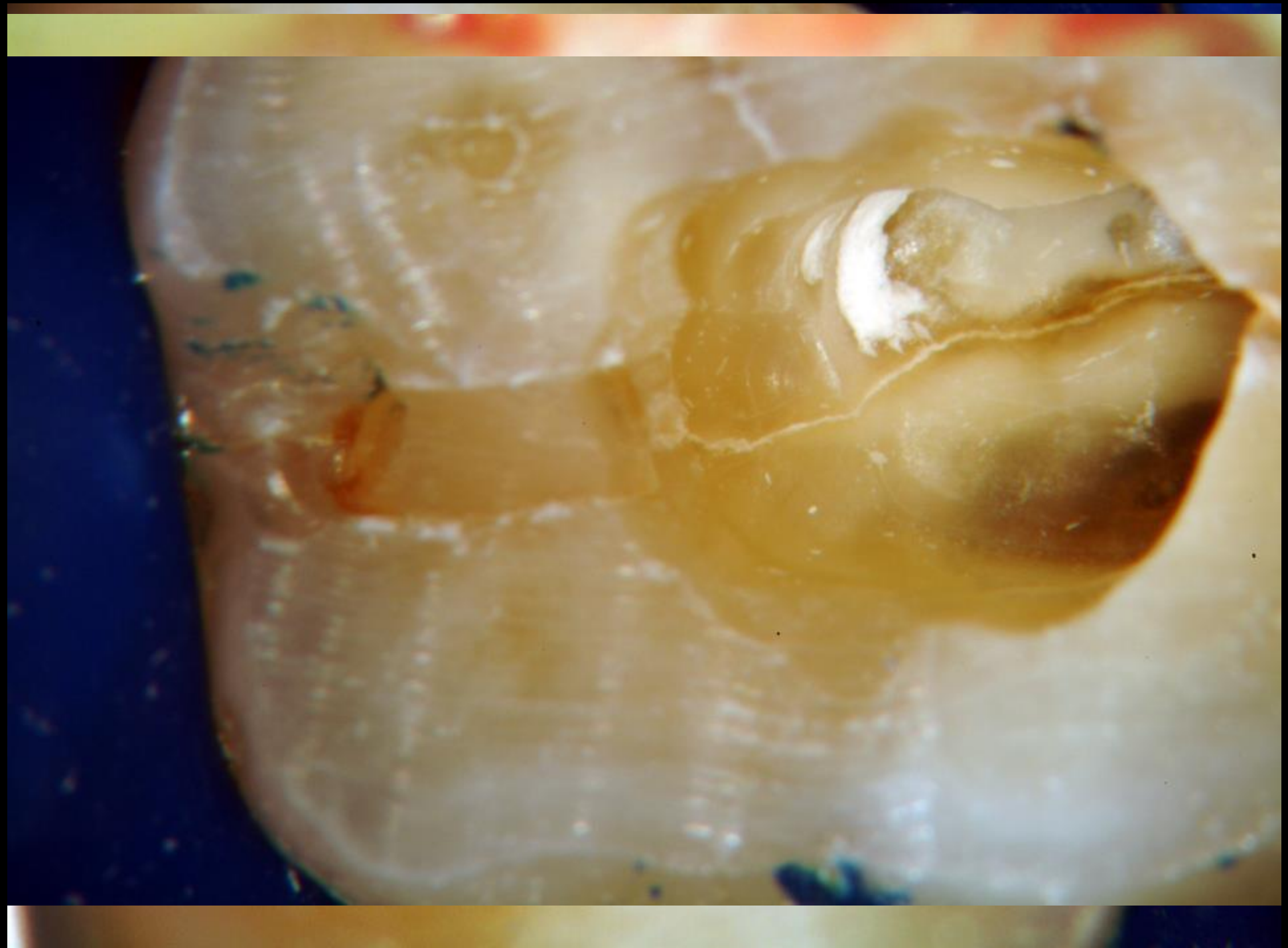
What we expected

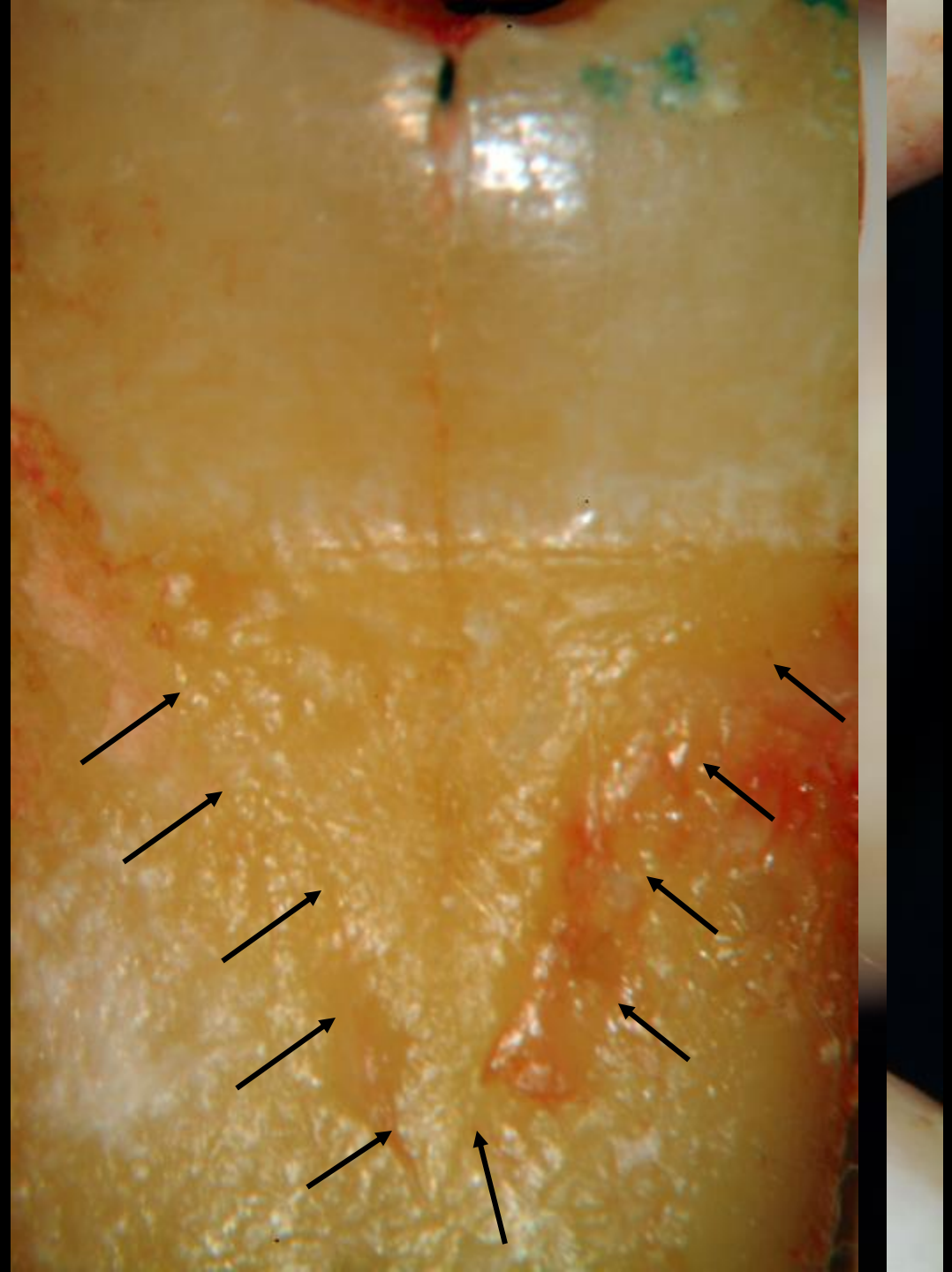


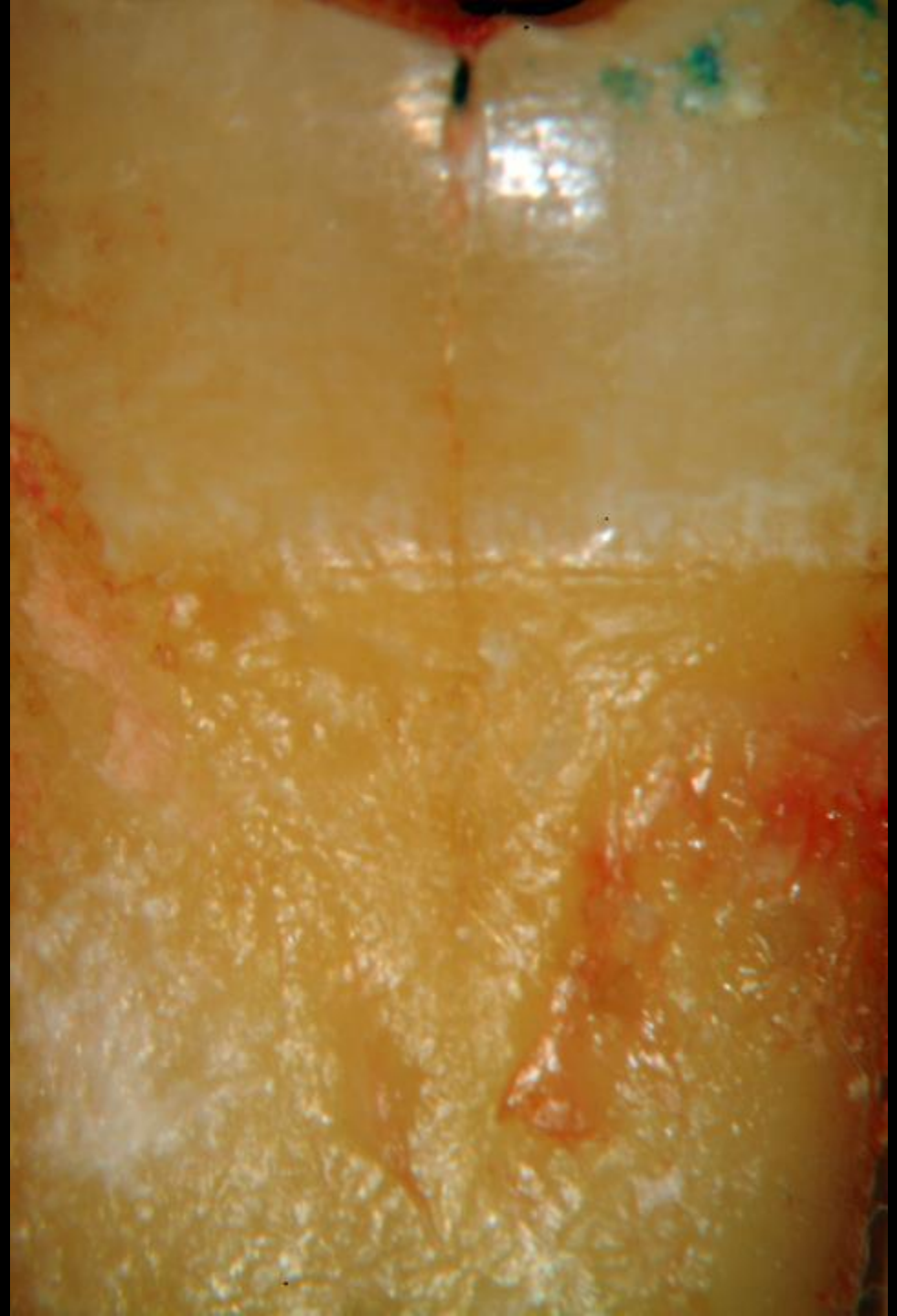
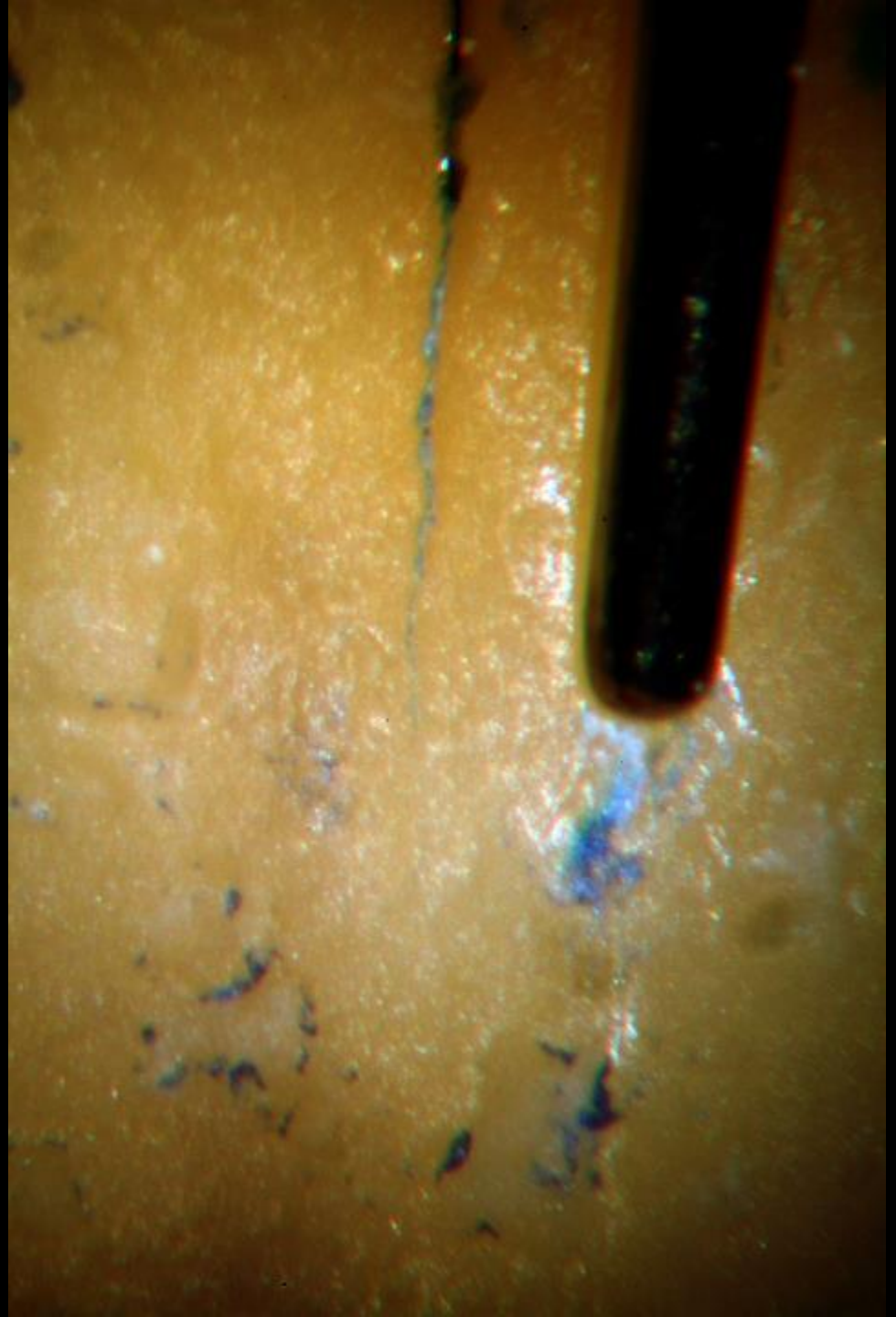
What we probed

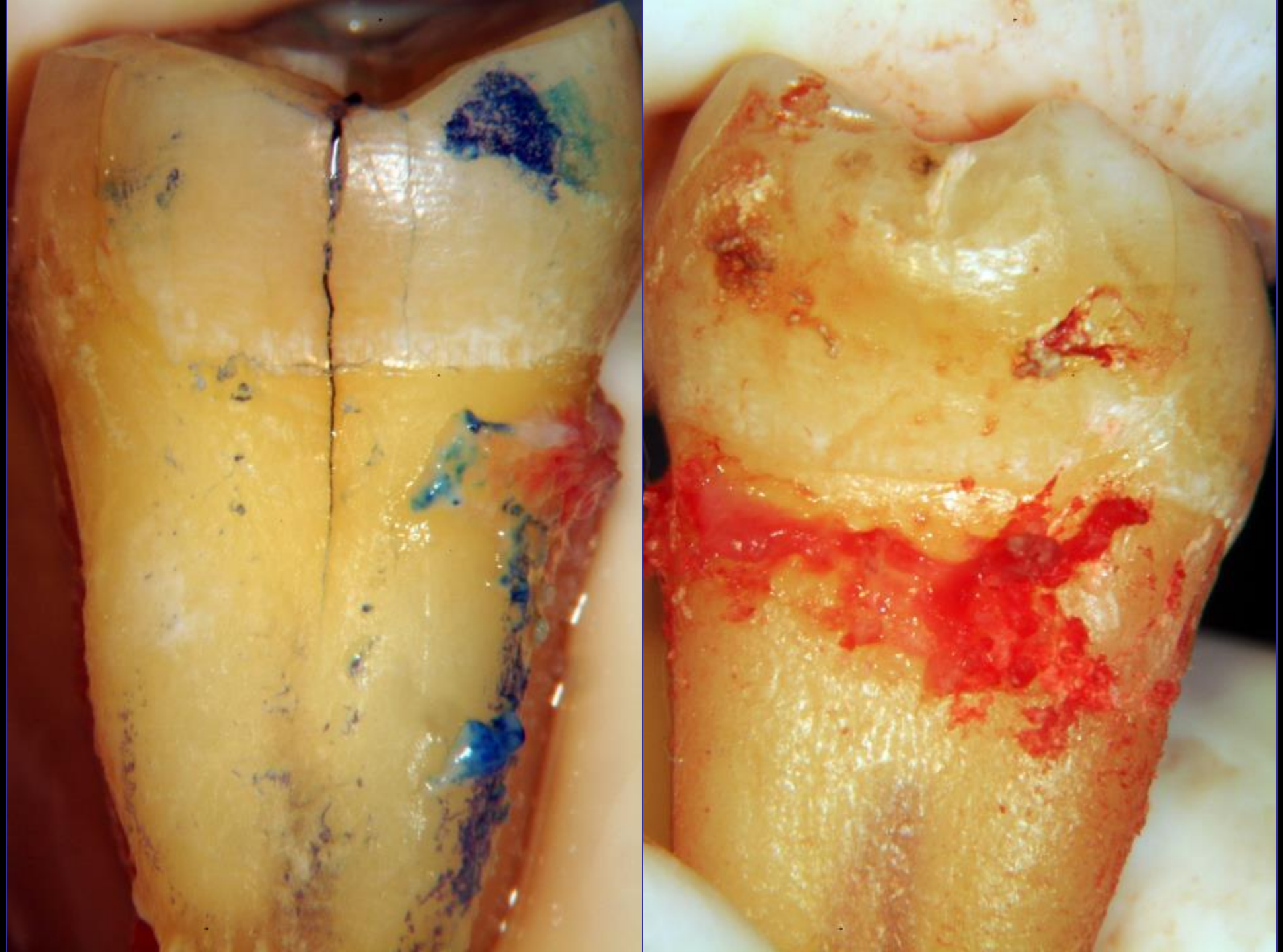


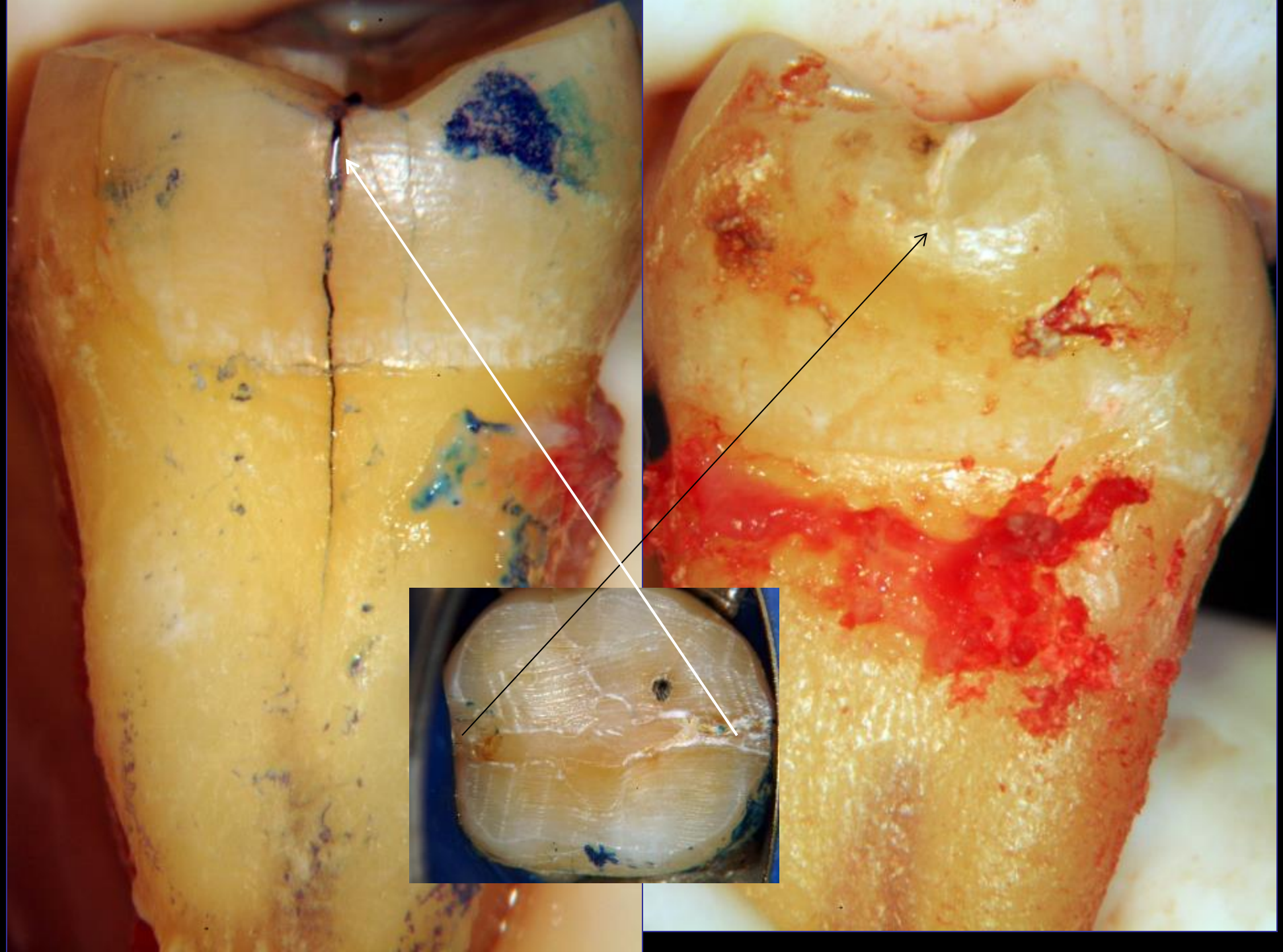




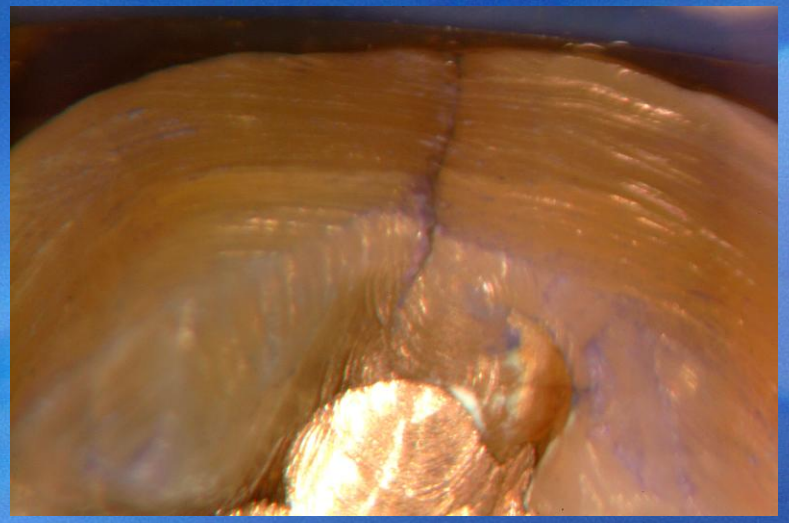




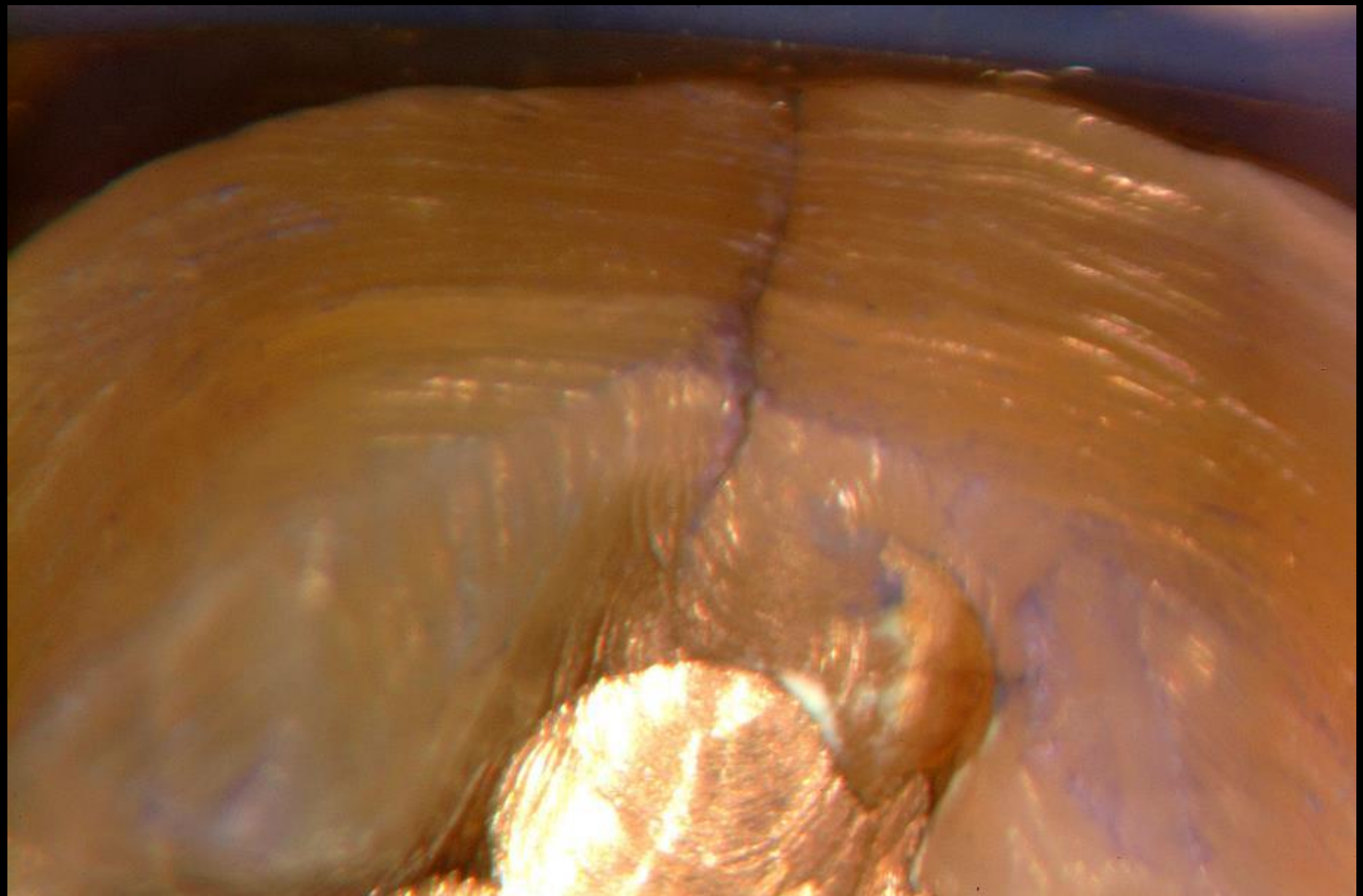


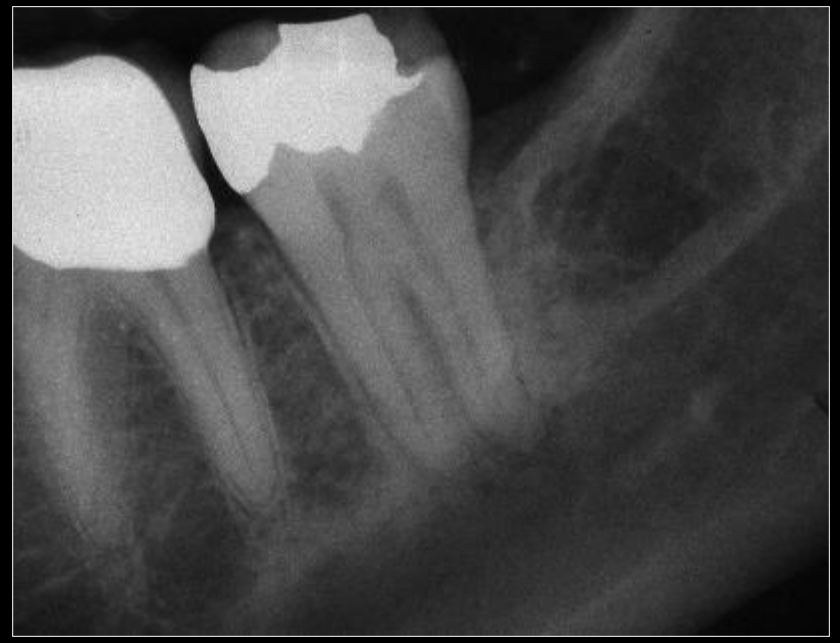
Incomplete and Complete Fractures



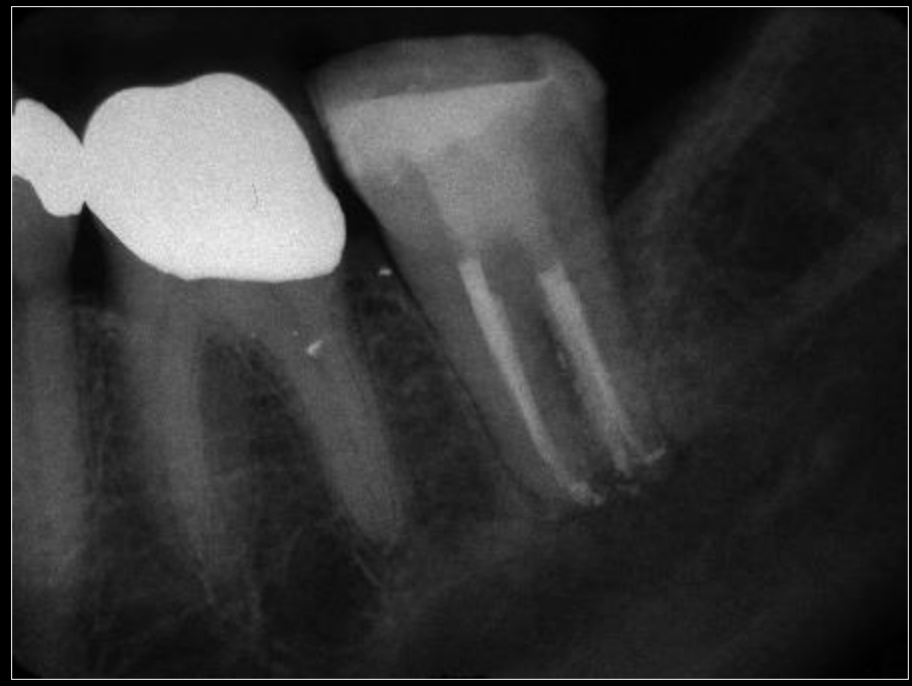
Case Study

Occlusal view of distal

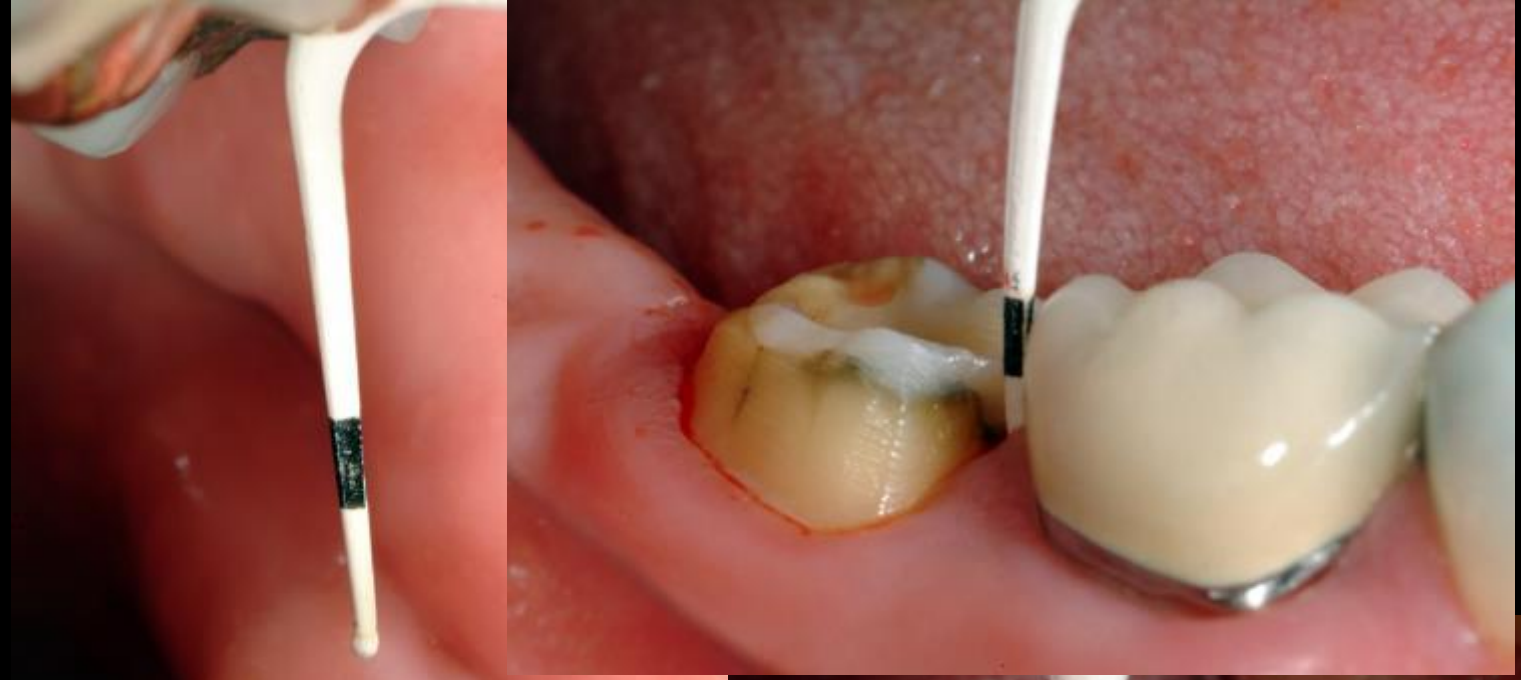


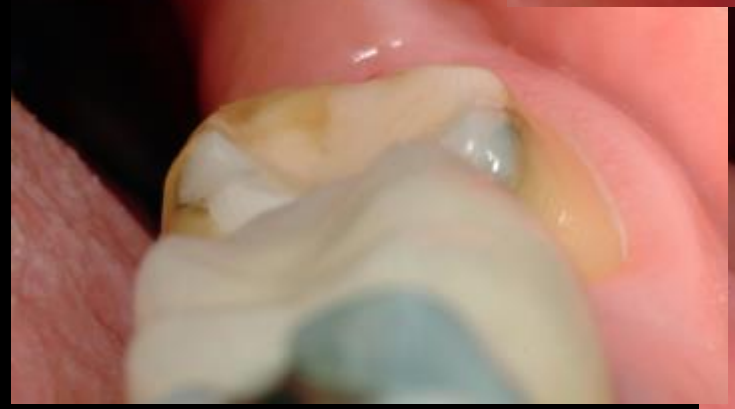


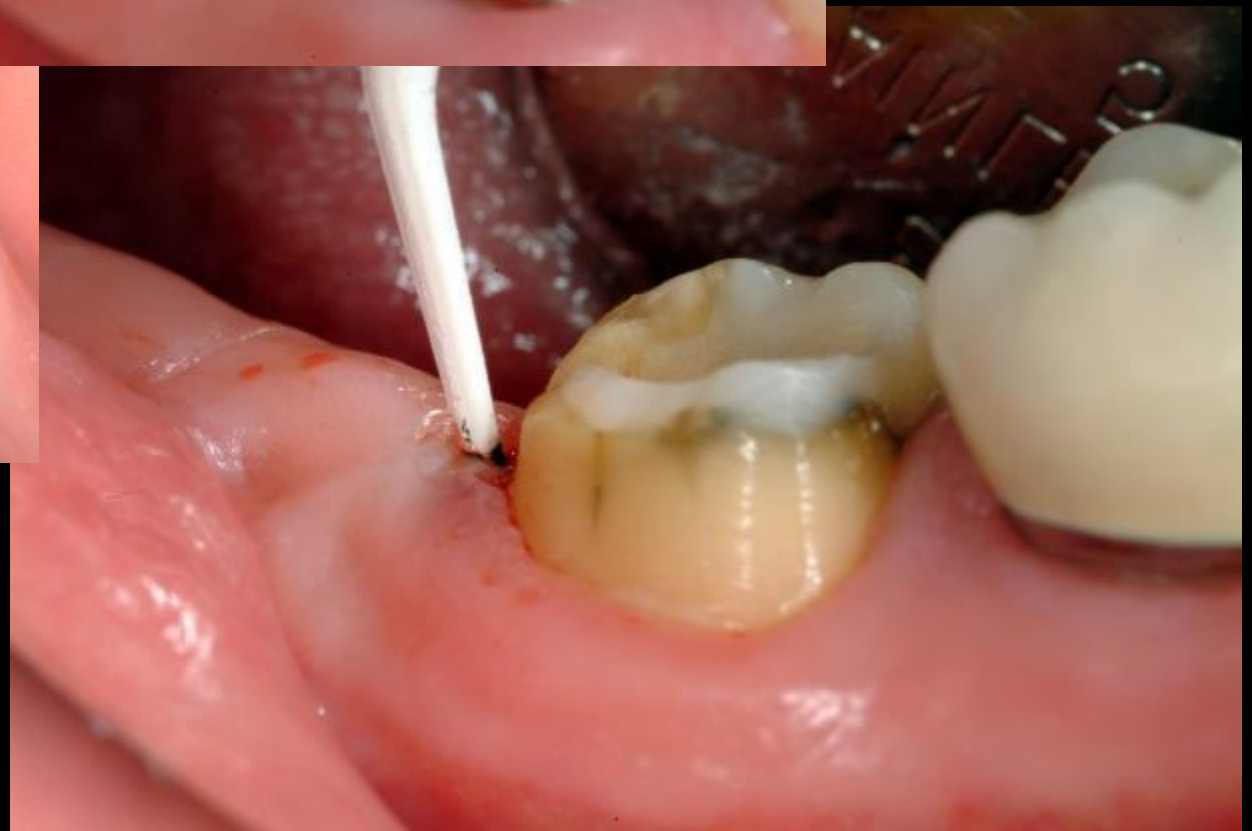
Initial
appointment



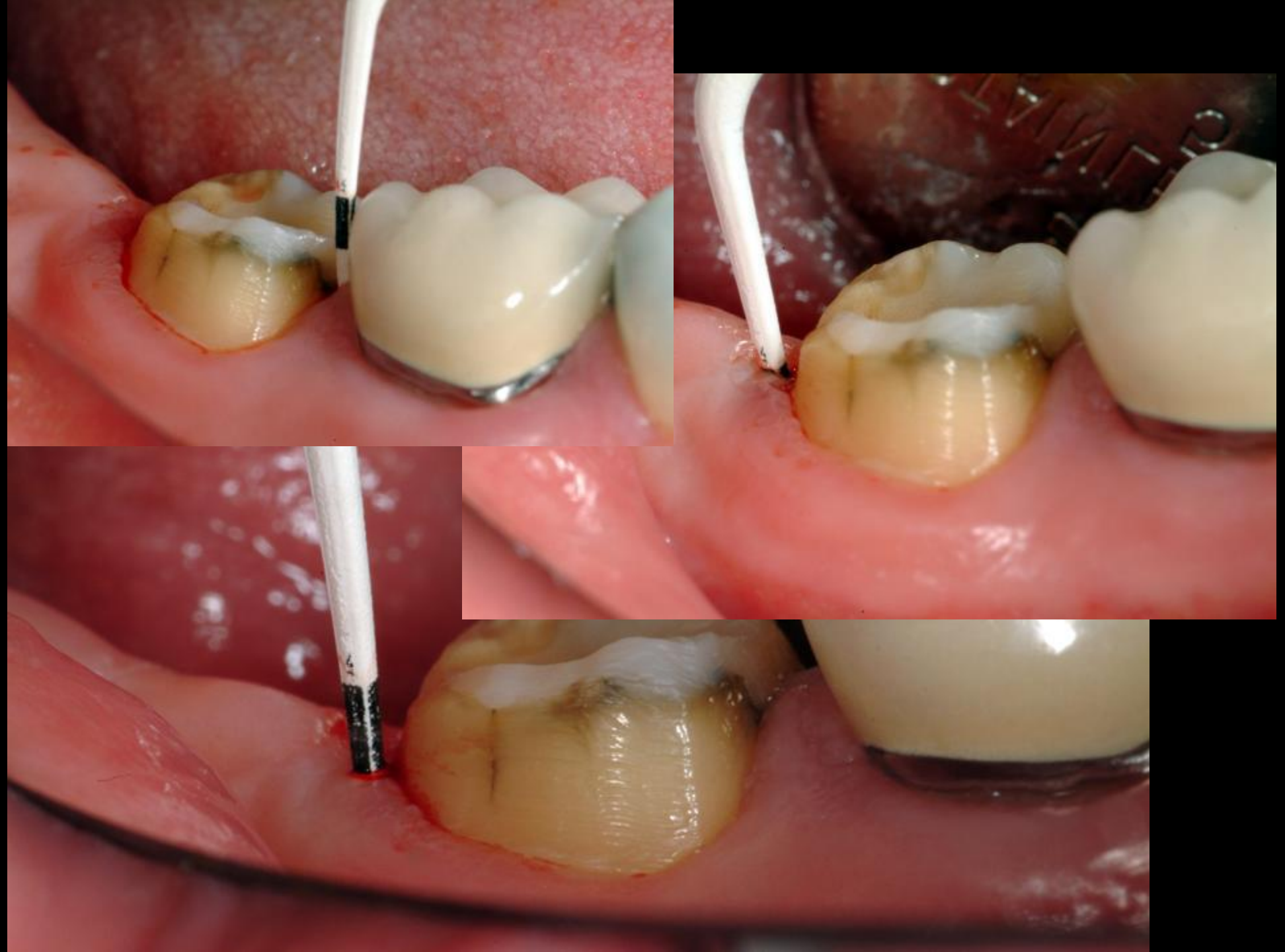
3-6 month
wait with
temp crown







4 month wait



The Old Cracked Tooth Classification System…

Was Based on Symptoms and Conjecture

- Sad
main

FEATURE ARTICLE

WRITTEN BY
Roxanne P. Benison, DMD, MS

Epidemiologic
third most com
countries. This
syndrome is of

Cracked tooth syndrome

Figure 1

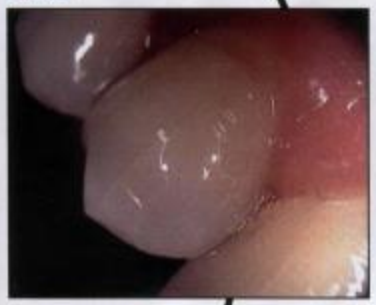
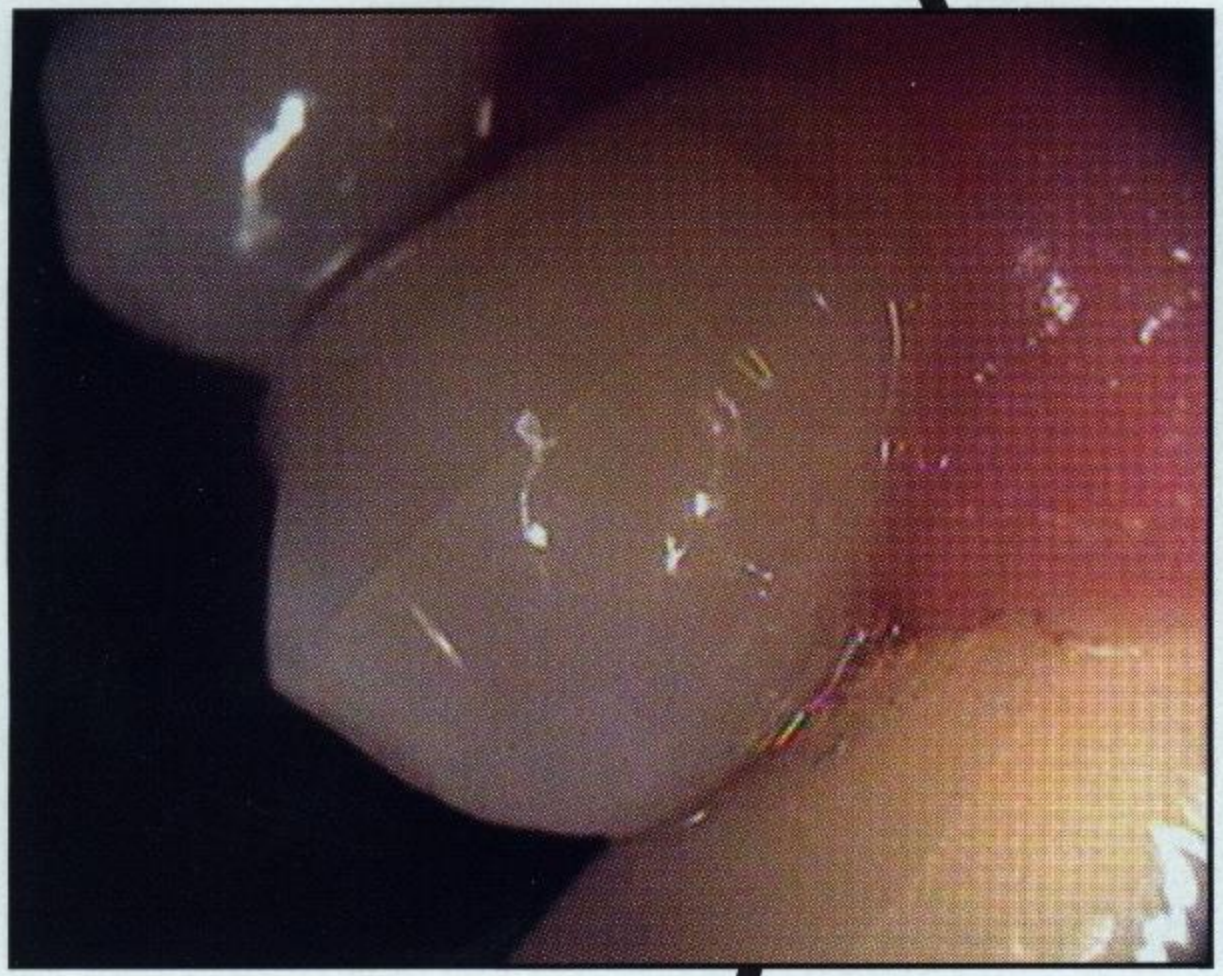
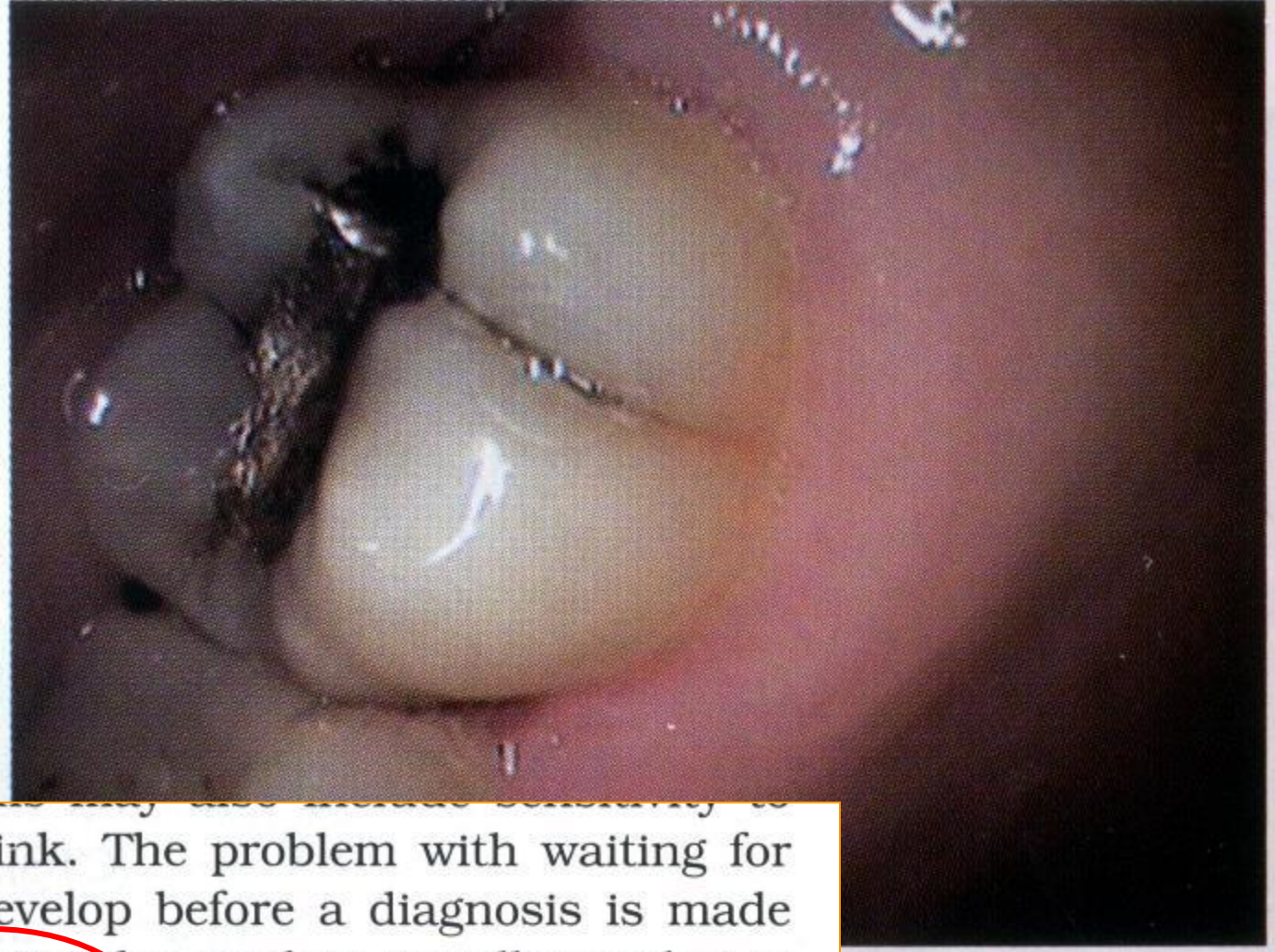


Figure 1





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[5] 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

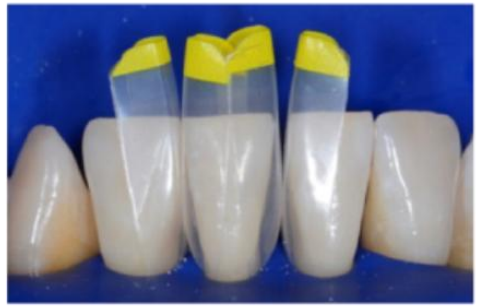
“Build a bridge from buccal to lingual, and the crack(s) becomes dormant.”


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

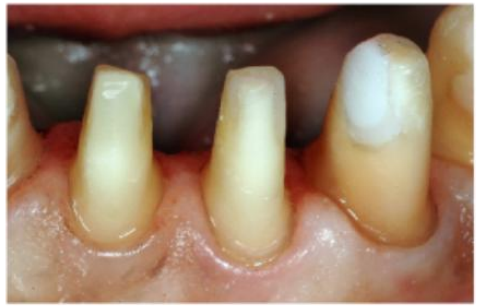
Getting paid to be conservative

BIOCLEAR VS. CROWNS AND VENEERS

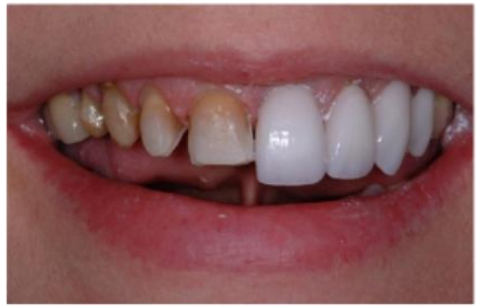
Bioclear is an alternative to traditio
for enhancing a smile. Rather than
to prepare for a crown or veneer, th
ensconcing the natural tooth struct
tooth enamel and tooth durability.



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



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

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

Tooth removed

Remaining tooth

BIOCLEAR

Stop by convention booth #14 to…

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

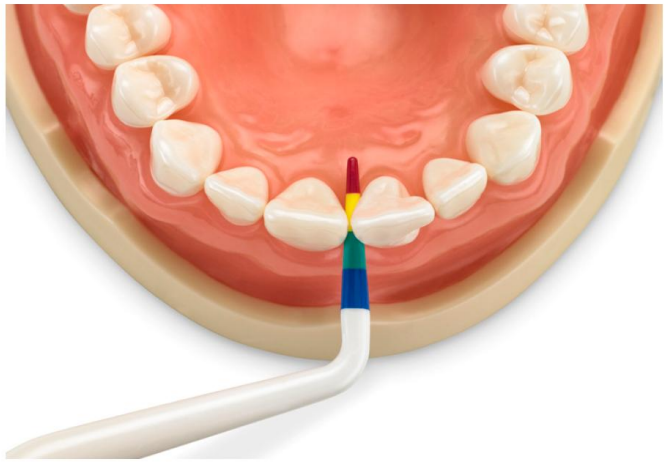
Treat yourself to a weekend with BIOCLEAR

BLACK TRIANGLE

CERTIFICATION COURSE

18 CE CREDITS

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



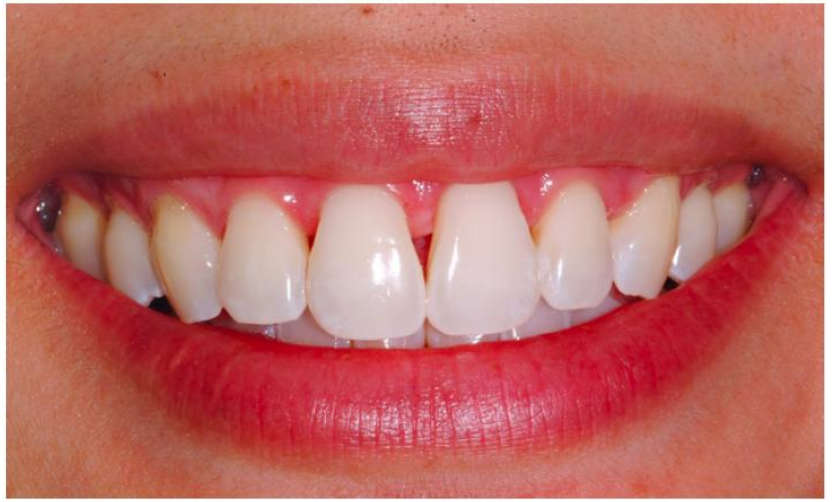
Upcoming Dates:

Denver
October 9th 2026

Walnut Creek
August 21st 2026

Limited spots available!

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



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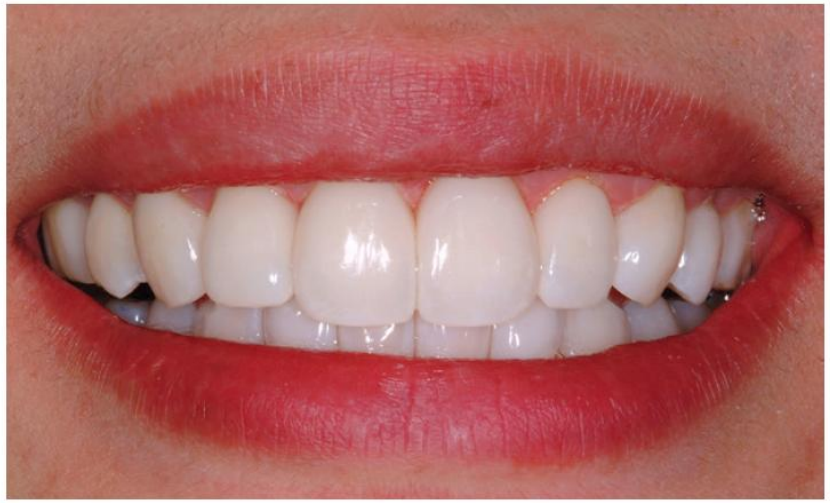

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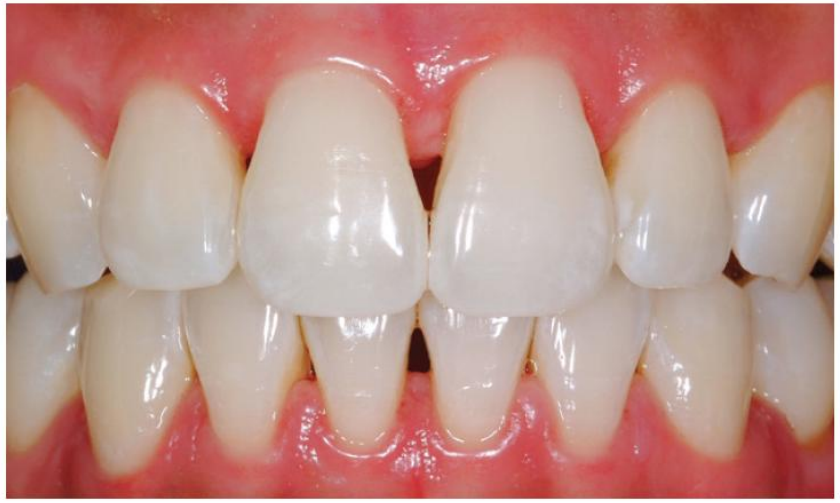

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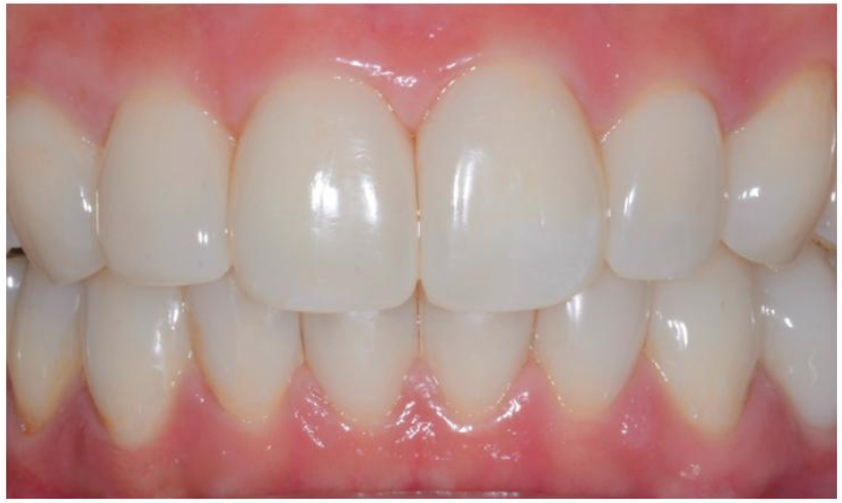


AFTER

OUR MISSION

BIOCLEAR LEARNING CENTER

The Bioclear Learning Center aims to improve restorative outcomes and raise patient expectations of modern composite dental care by providing dentists with continuing education and certification in the practice of the Bioclear Method.

- The Learning Center is equipped with exclusive, patented Bioclear tools, equipment, and your own operatory setup
- Small class sizes with hands-on, interactive curriculum modules
- Online class options available at the convenience of your practice
- Operate a Tell, Show, Do education model
- Learn and understand the Five Pillars of the Bioclear Method

BIOCLEAR

4-DAY CORE ANTERIOR & POSTERIOR COURSE

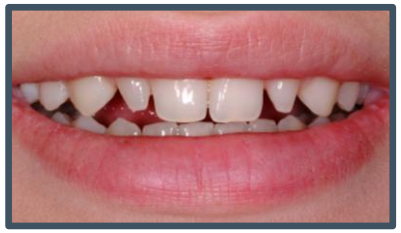
36 CE CREDITS

This course builds a strong foundation in the Bioclear Method and an understanding of Bioclear products. The focus of the course is indirect methods on adult dentitions as an alternative procedure to porcelain crowns and veneers.

Students will learn the foundation of posterior and anterior restorations and are introduced to the engineering principles involved in the design of the new non-retentive compression-based preps. Students collaboratively practice all applications of the Bioclear Method during intensive, hands-on exercises that simulate posterior and anterior restorations.

LEARN MORE

BEFORE



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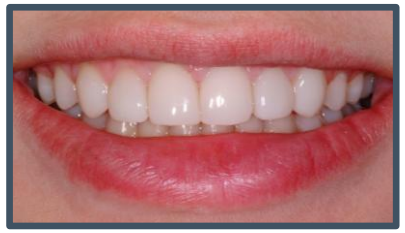

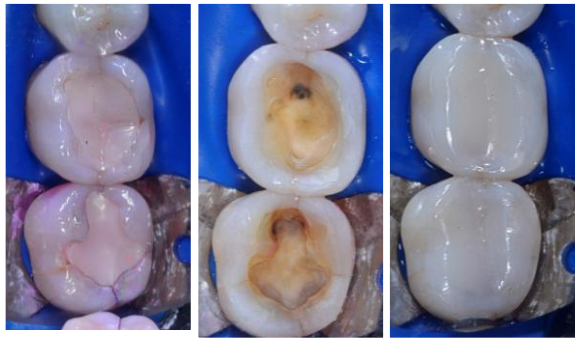

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GLOBAL
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EXIT


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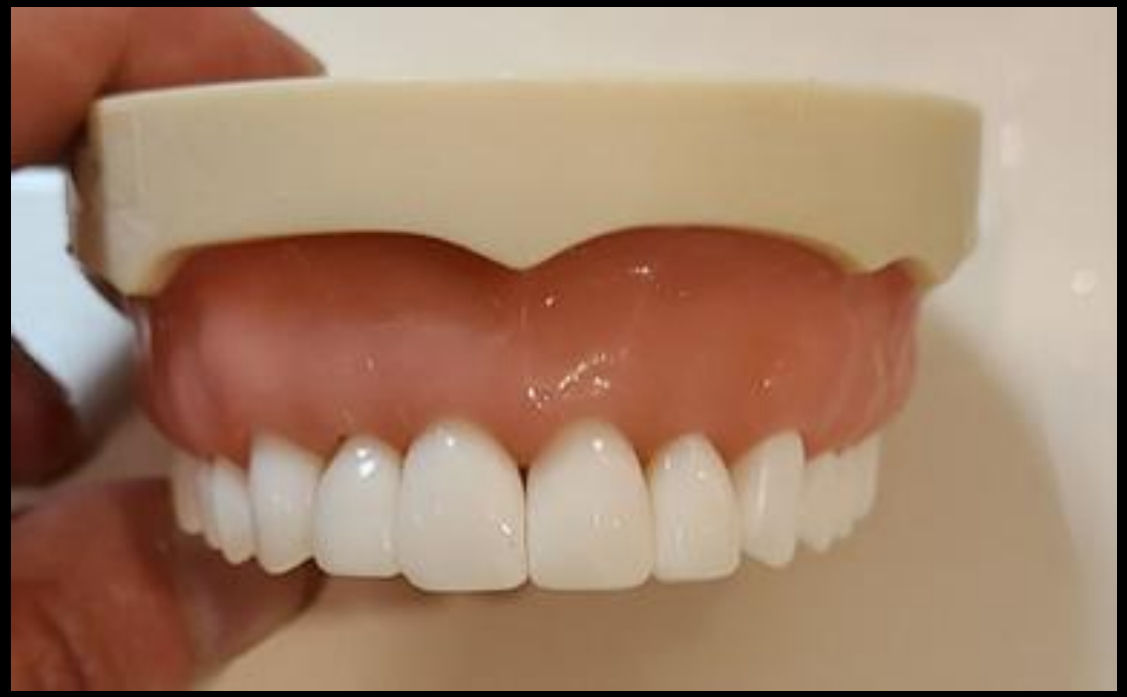
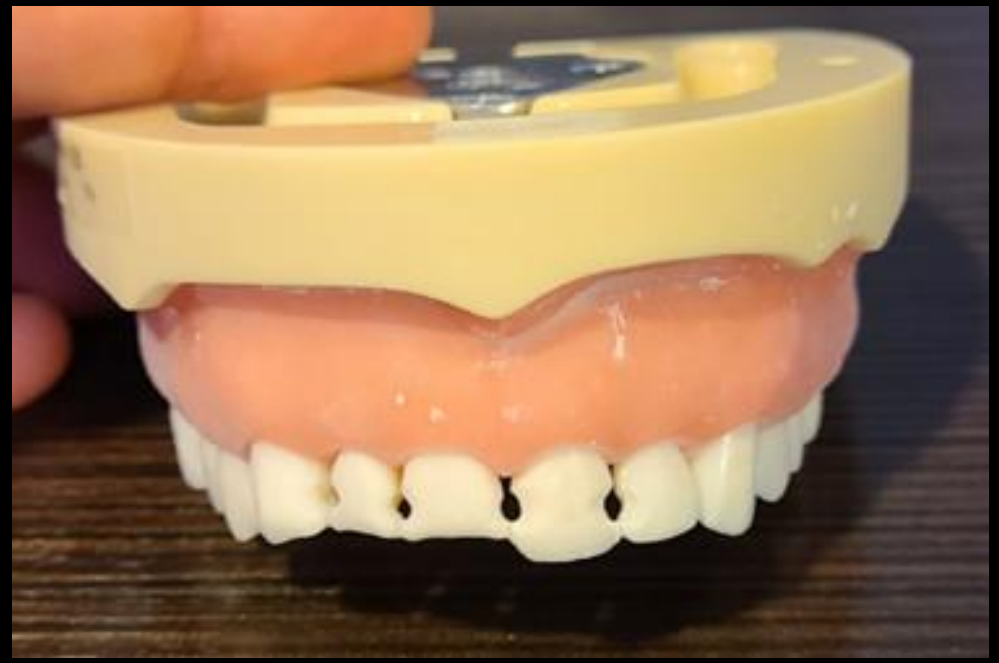
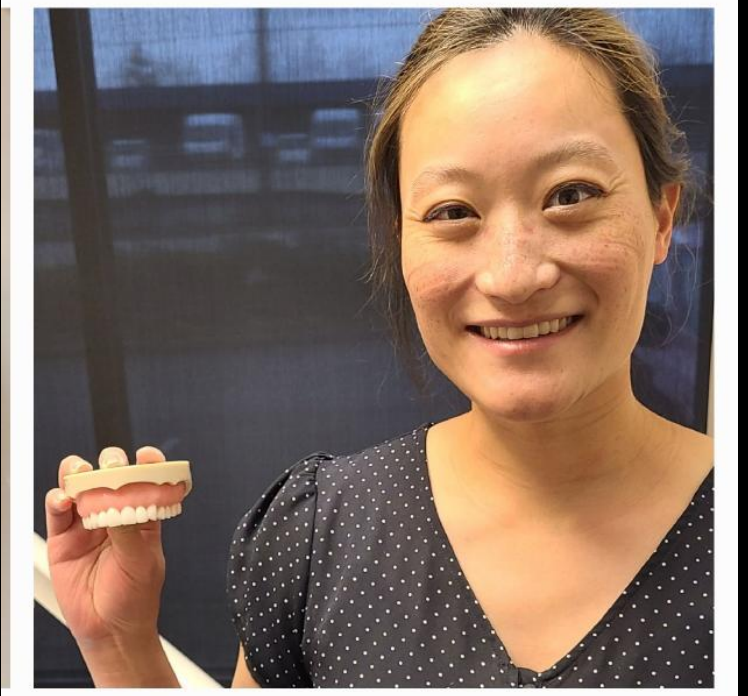
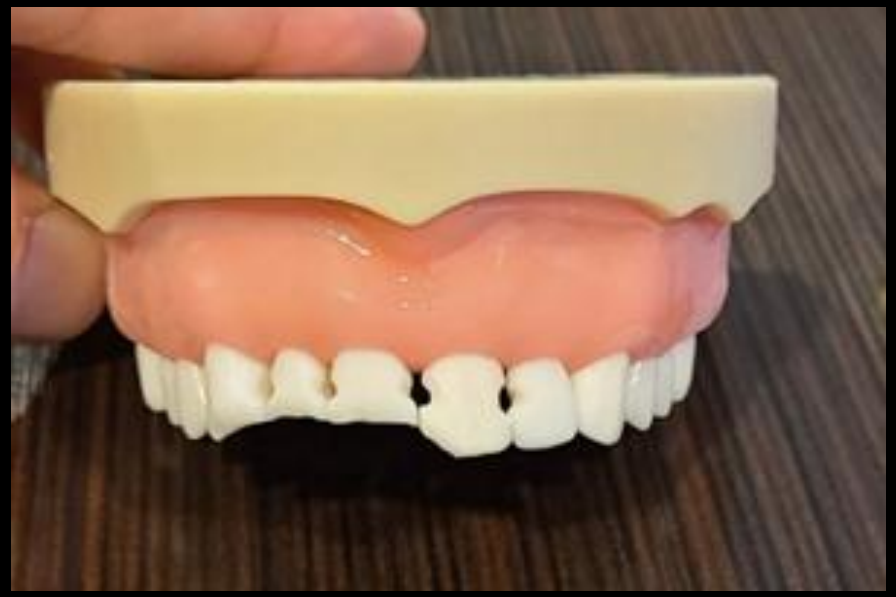
Welcome
BIOCLEAR
5:00 PM
Next slide
Bioclear Method for Composite Restorations

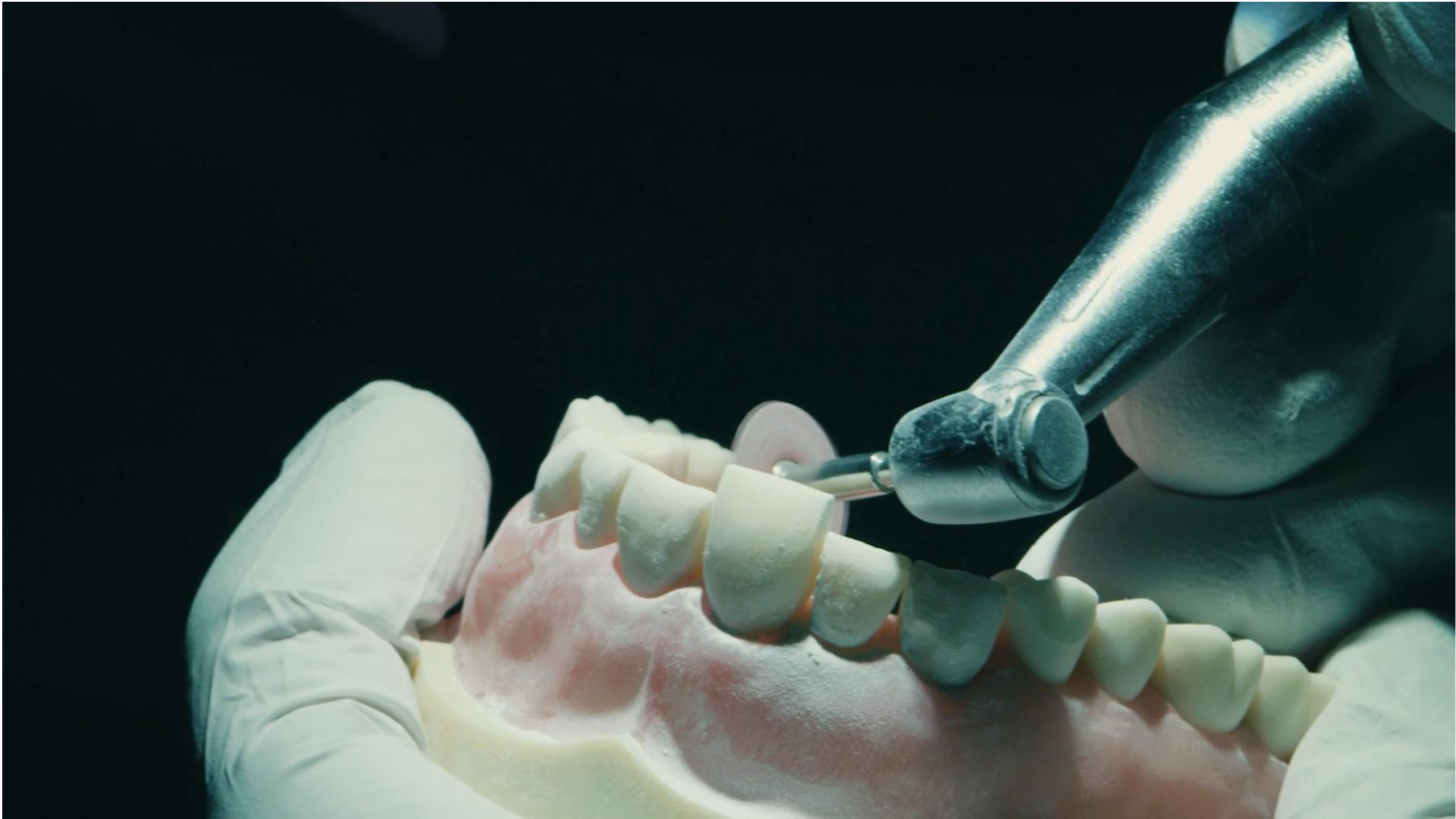








Last week’s attendees at the certification course



2026 Certification Courses

BIOCLEAR LEARNING CENTER

- 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
8	9	10	11	12	13	14
15	16	17	18	19	20	21
22	23	24	25	26	27	28
29	30	31				

April

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		

May

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						

June

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				

July

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	

August

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					

September

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			

October

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

November

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					

December

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		

2027 Certification Courses

BIOCLEAR LEARNING CENTER

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

JANUARY

S	M	T	W	T	F	S
					01	02
03	04	05	06	07	08	09
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
	01	02	03	04	05	06
07	08	09	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
	01	02	03	04	05	06
07	08	09	10	11	12	13
14	15	16	17	18	19	20
21	22	23	24	25	26	27
28	29	30	31			

APRIL

S	M	T	W	T	F	S
				01	02	03
04	05	06	07	08	09	10
11	12	13	14	15	16	17
18	19	20	21	22	23	24
25	26	27	28	29	30	

MAY

S	M	T	W	T	F	S
						01
02	03	04	05	06	07	08
09	10	11	12	13	14	15
16	17	18	19	20	21	22
23	24	25	26	27	28	29
30	31					

JUNE

S	M	T	W	T	F	S
		01	02	03	04	05
06	07	08	09	10	11	12
13	14	15	16	17	18	19
20	21	22	23	24	25	26
27	28	29	30			

JULY

S	M	T	W	T	F	S
				01	02	03
04	05	06	07	08	09	10
11	12	13	14	15	16	17
18	19	20	21	22	23	24
25	26	27	28	29	30	31

AUGUST

S	M	T	W	T	F	S
01	02	03	04	05	06	07
08	09	10	11	12	13	14
15	16	17	18	19	20	21
22	23	24	25	26	27	28
29	30	31				

SEPTEMBER

S	M	T	W	T	F	S
			01	02	03	04
05	06	07	08	09	10	11
12	13	14	15	16	17	18
19	20	21	22	23	24	25
26	27	28	29	30		

OCTOBER

S	M	T	W	T	F	S
					01	02
03	04	05	06	07	08	09
10	11	12	13	14	15	16
17	18	19	20	21	22	23
24	25	26	27	28	29	30
31						

NOVEMBER

S	M	T	W	T	F	S
	01	02	03	04	05	06
07	08	09	10	11	12	13
14	15	16	17	18	19	20
21	22	23	24	25	26	27
28	29	30				

DECEMBER

S	M	T	W	T	F	S
			01	02	03	04
05	06	07	08	09	10	11
12	13	14	15	16	17	18
19	20	21	22	23	24	25
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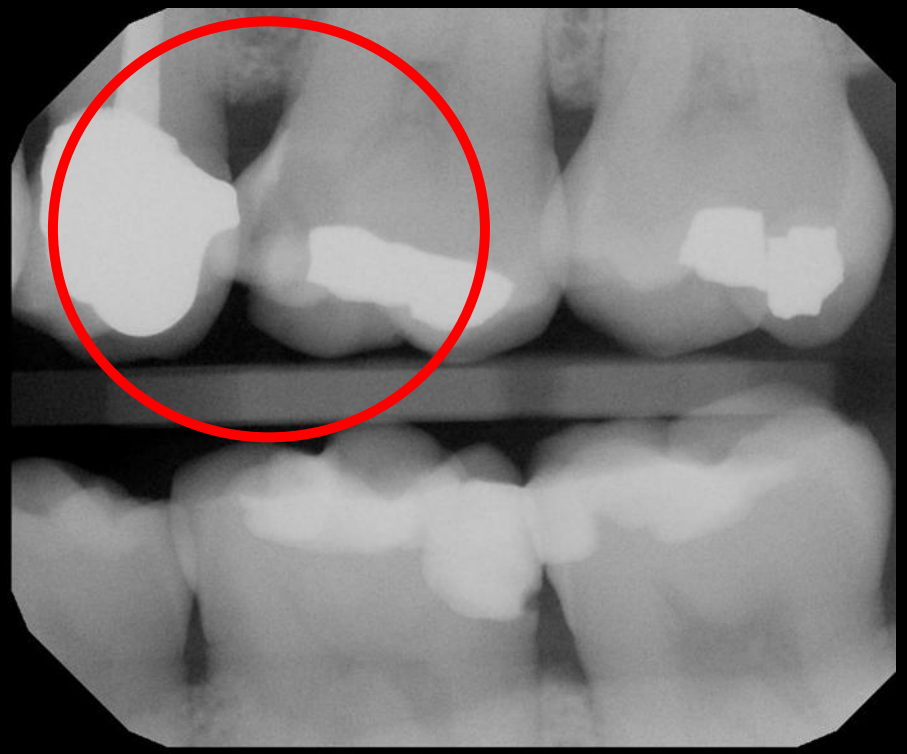
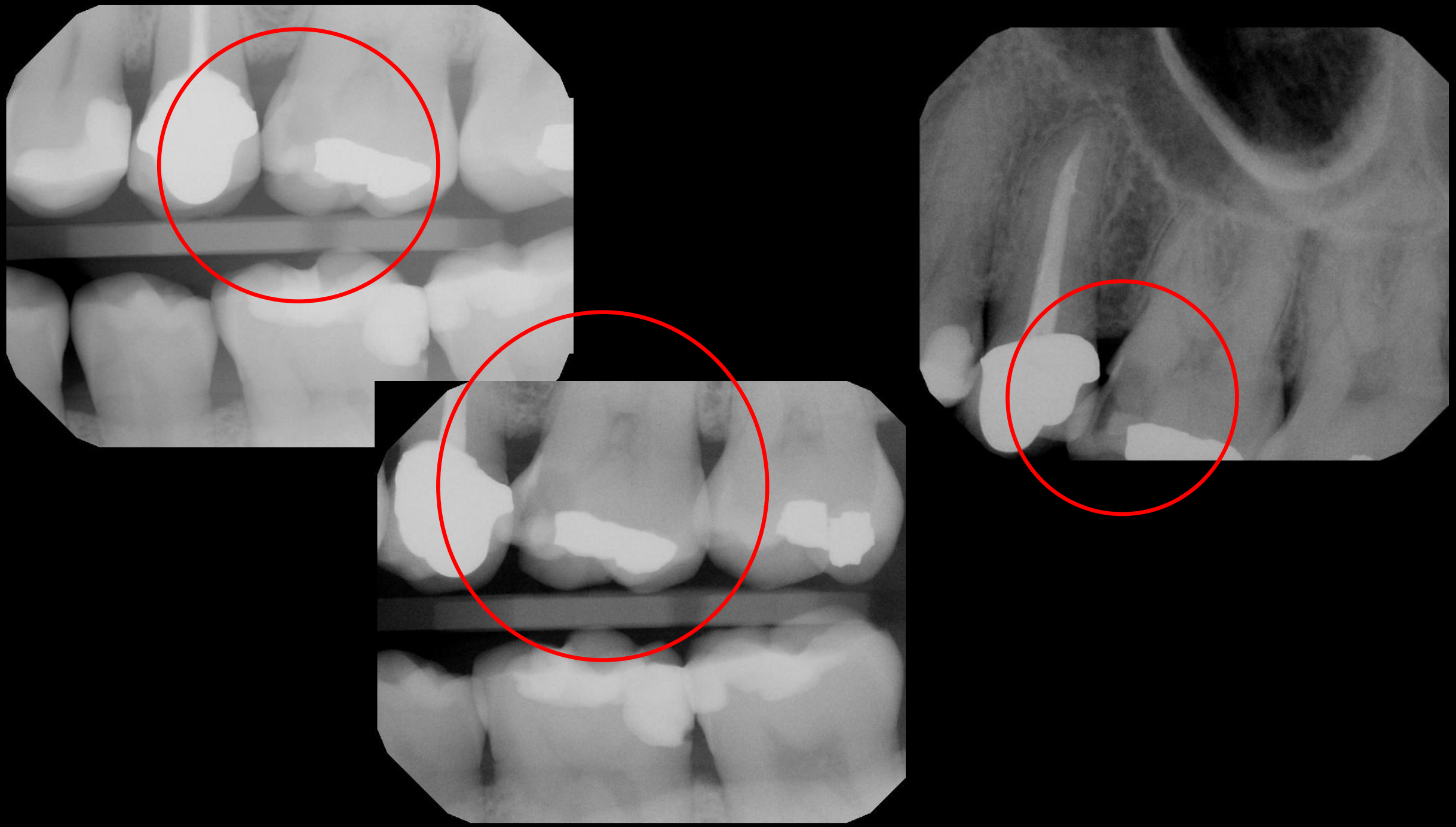
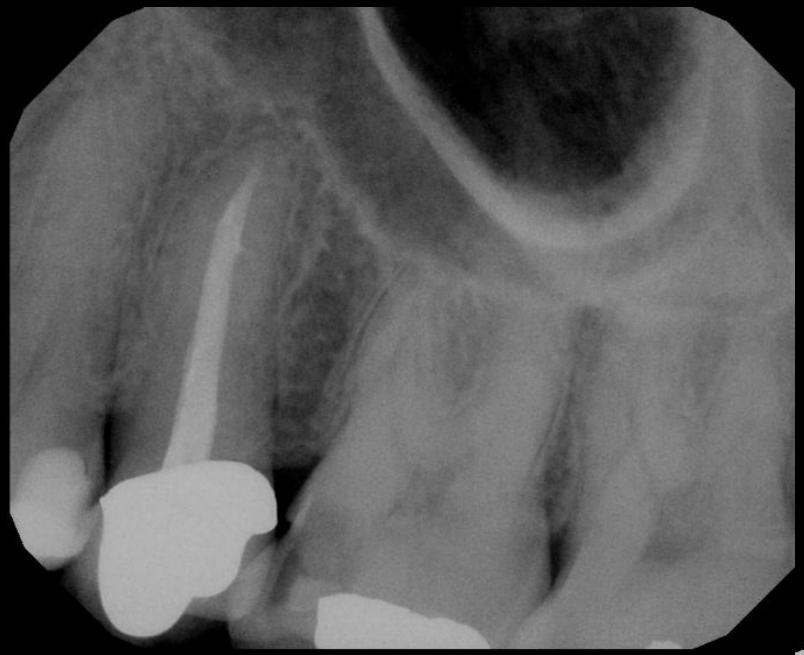
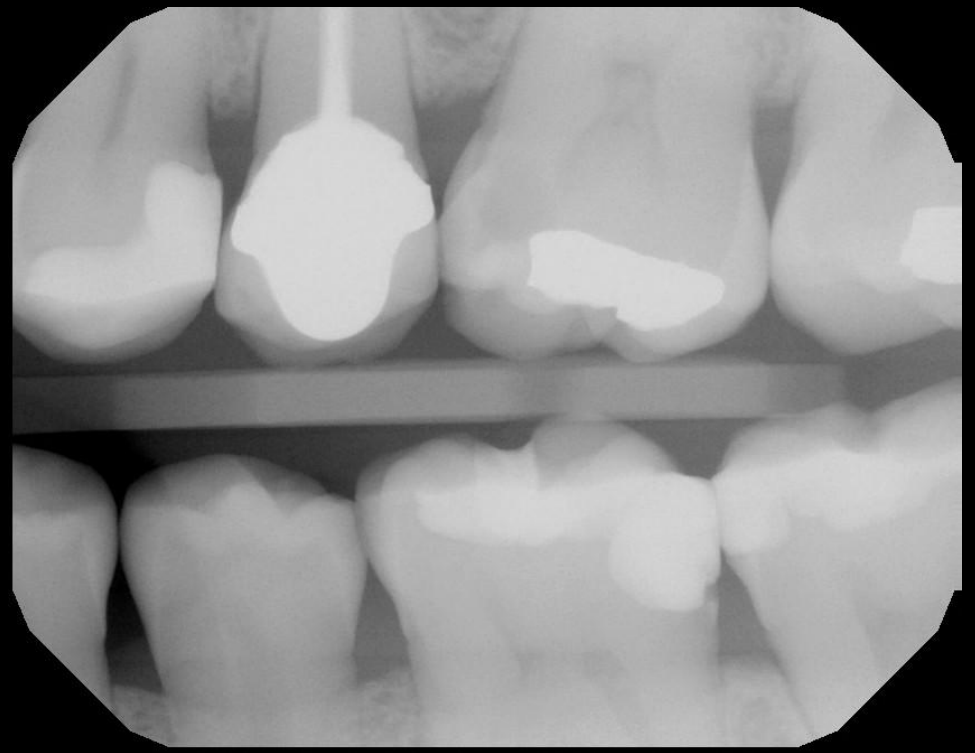
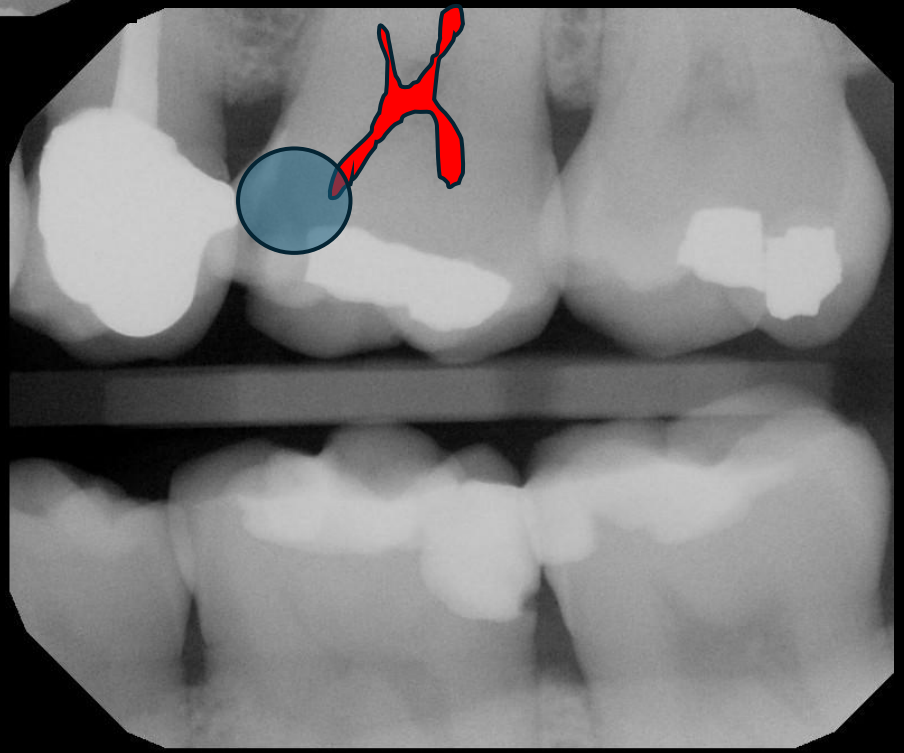


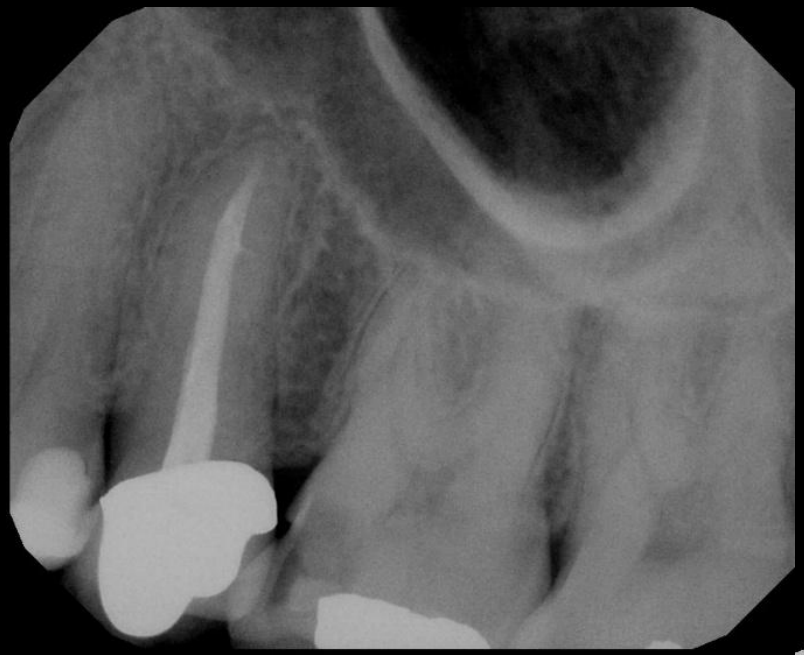
Dr. Rafael Bustamante
Full Faculty at the
Bioclear Learning enter

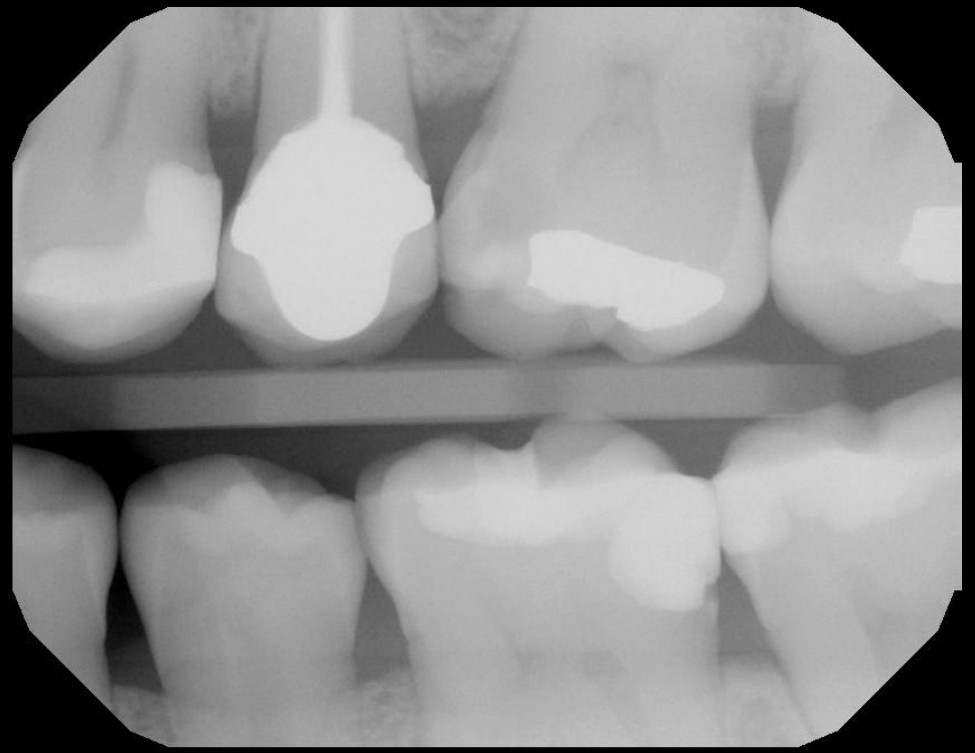


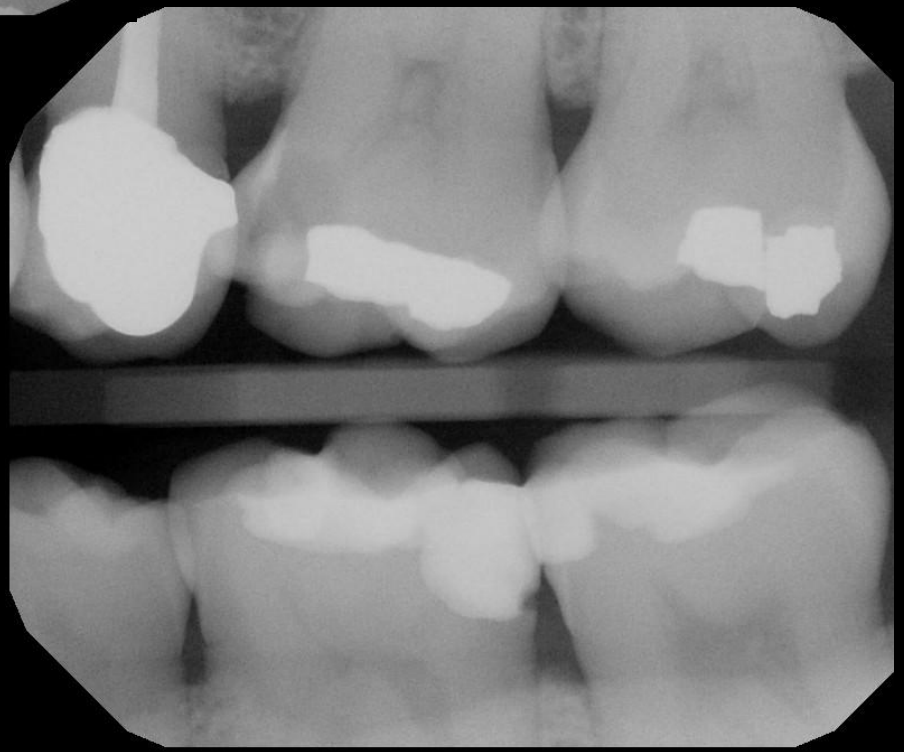




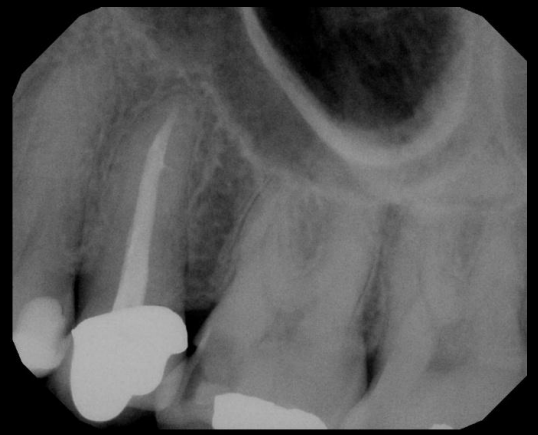


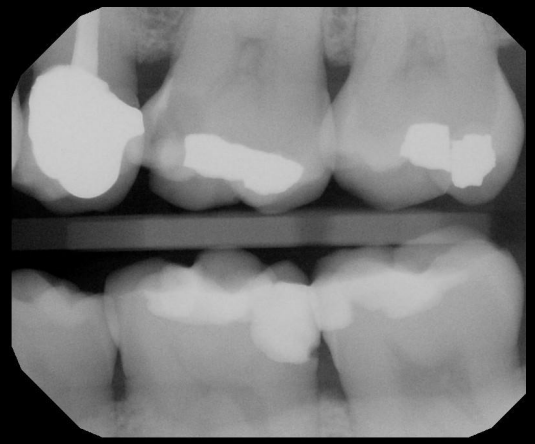


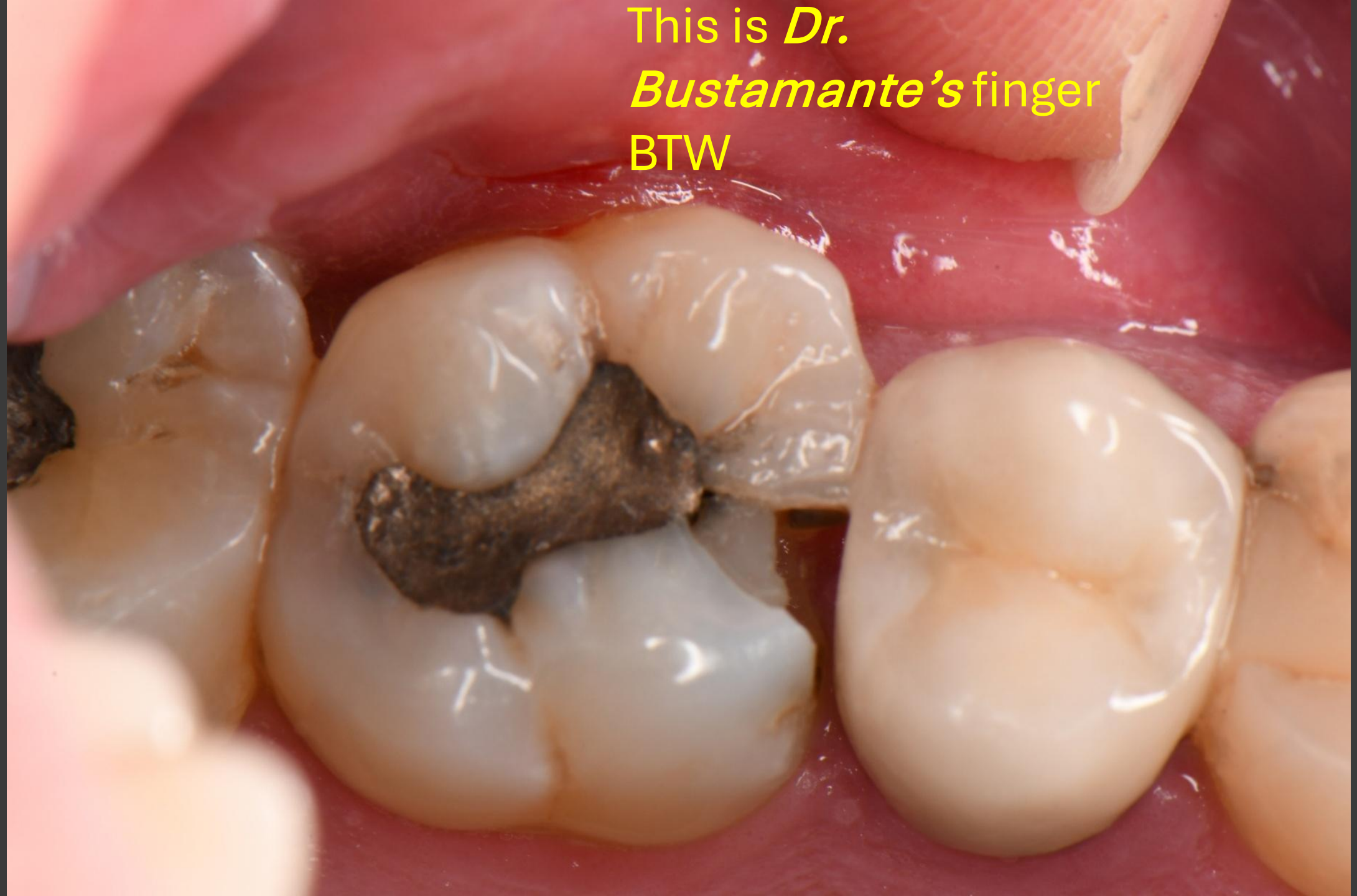


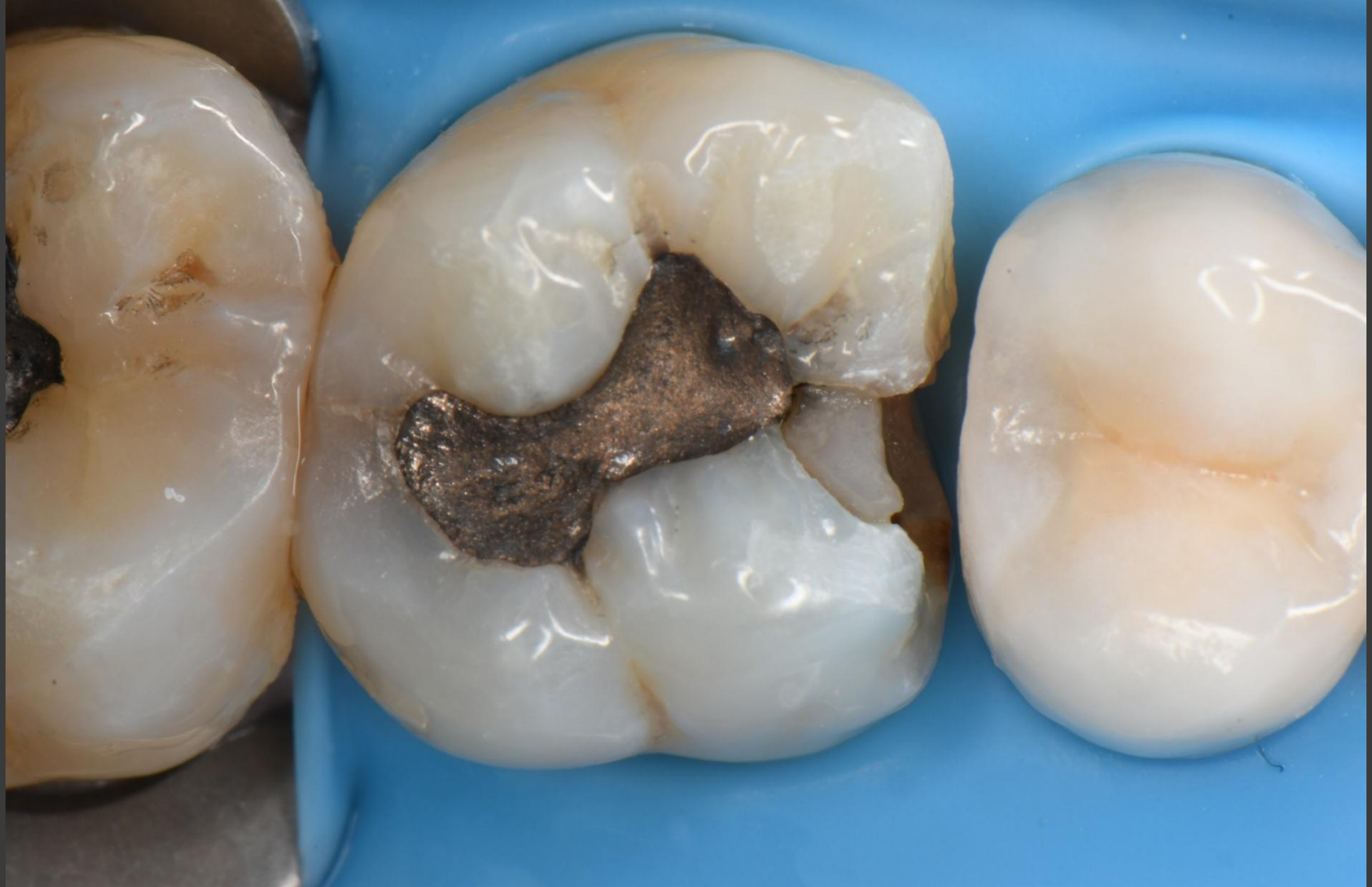


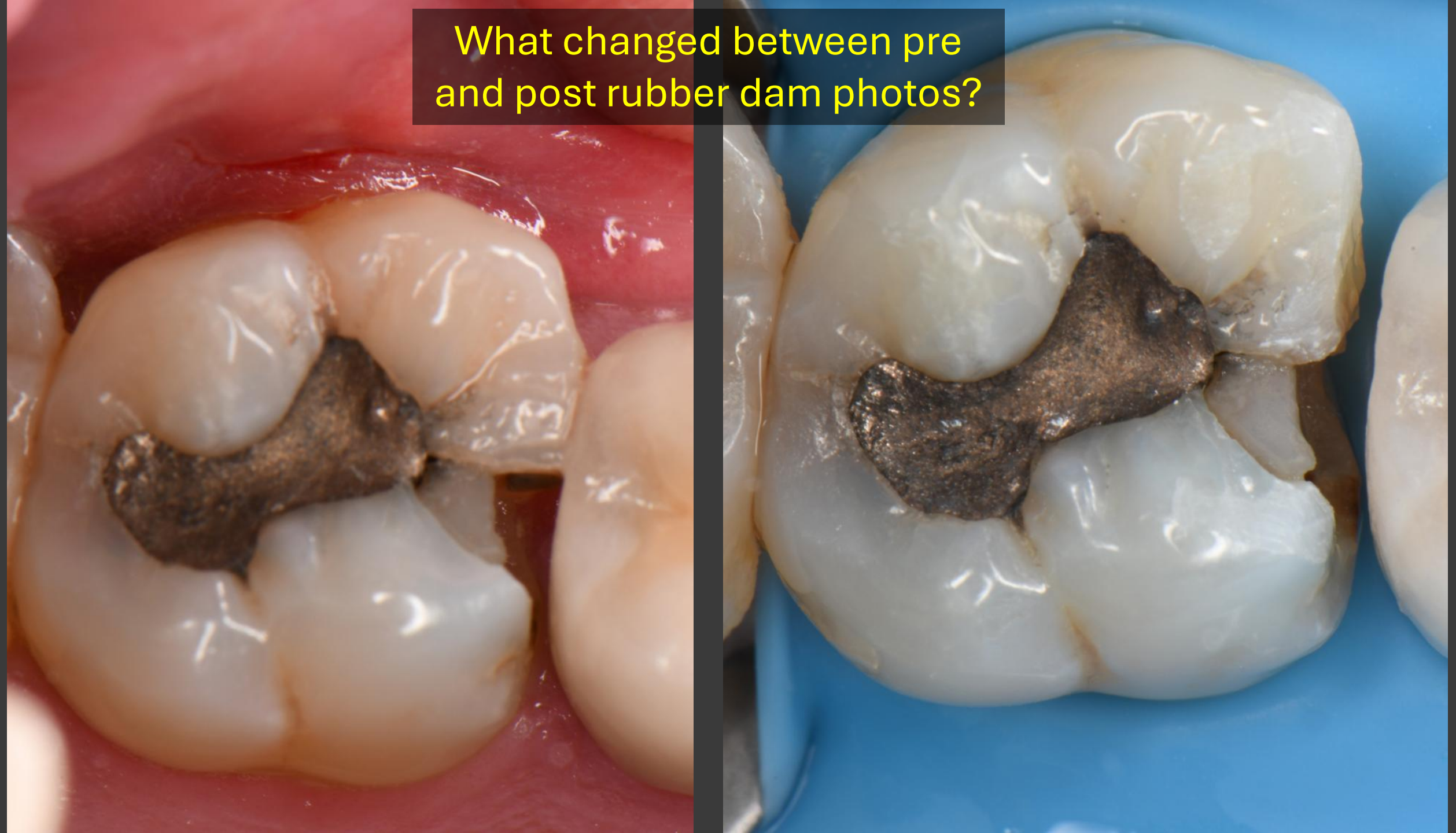
- Selective Caries Removal
- Calla Lilly Compression Based Cavity Preparation for a Cracked Tooth
- Deep Margin Acquisition
- Dealing with a Furcation

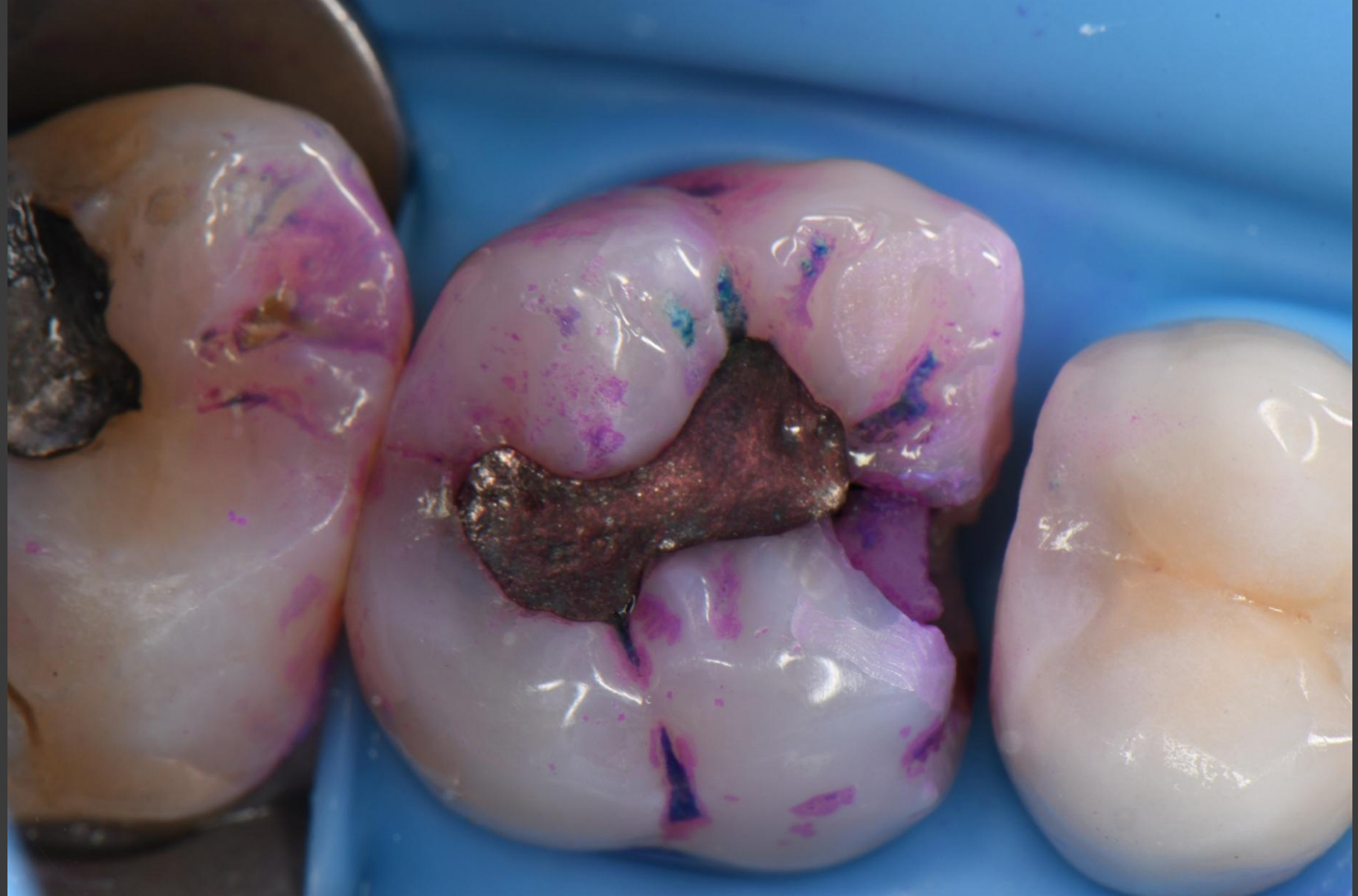


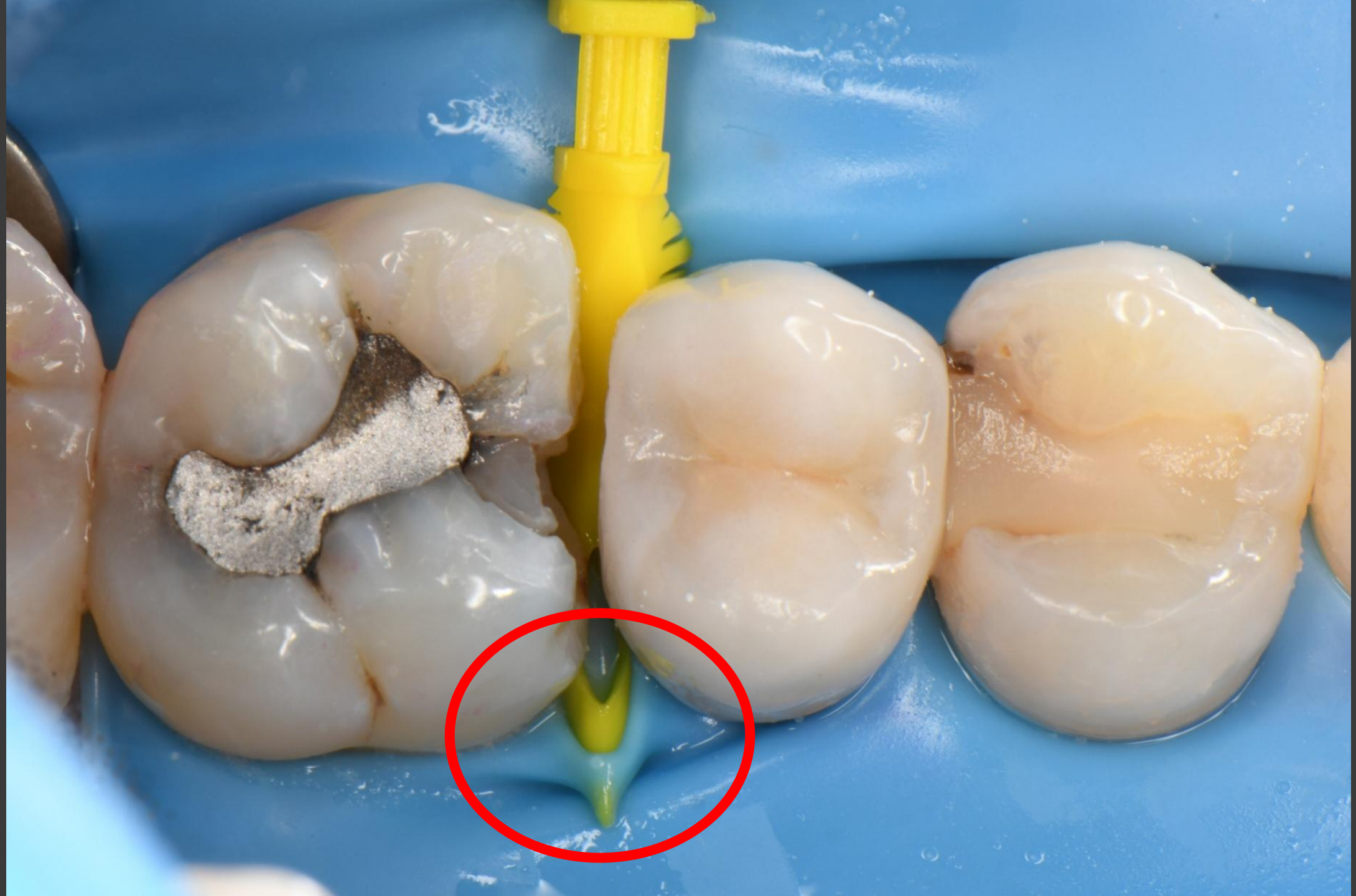


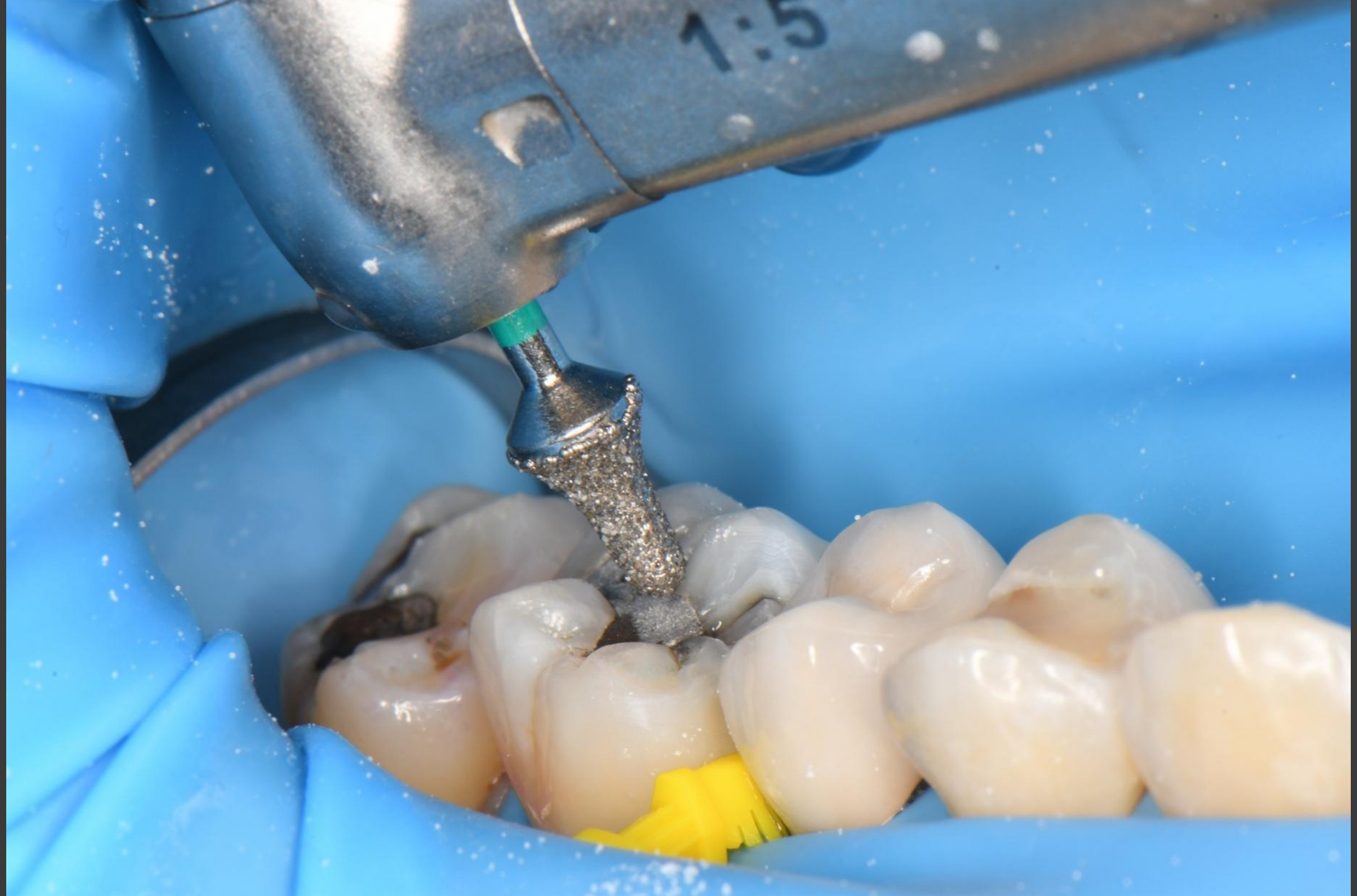

This is *Dr. Bustamante's* finger
BTW




What changed between pre
and post rubber dam photos?



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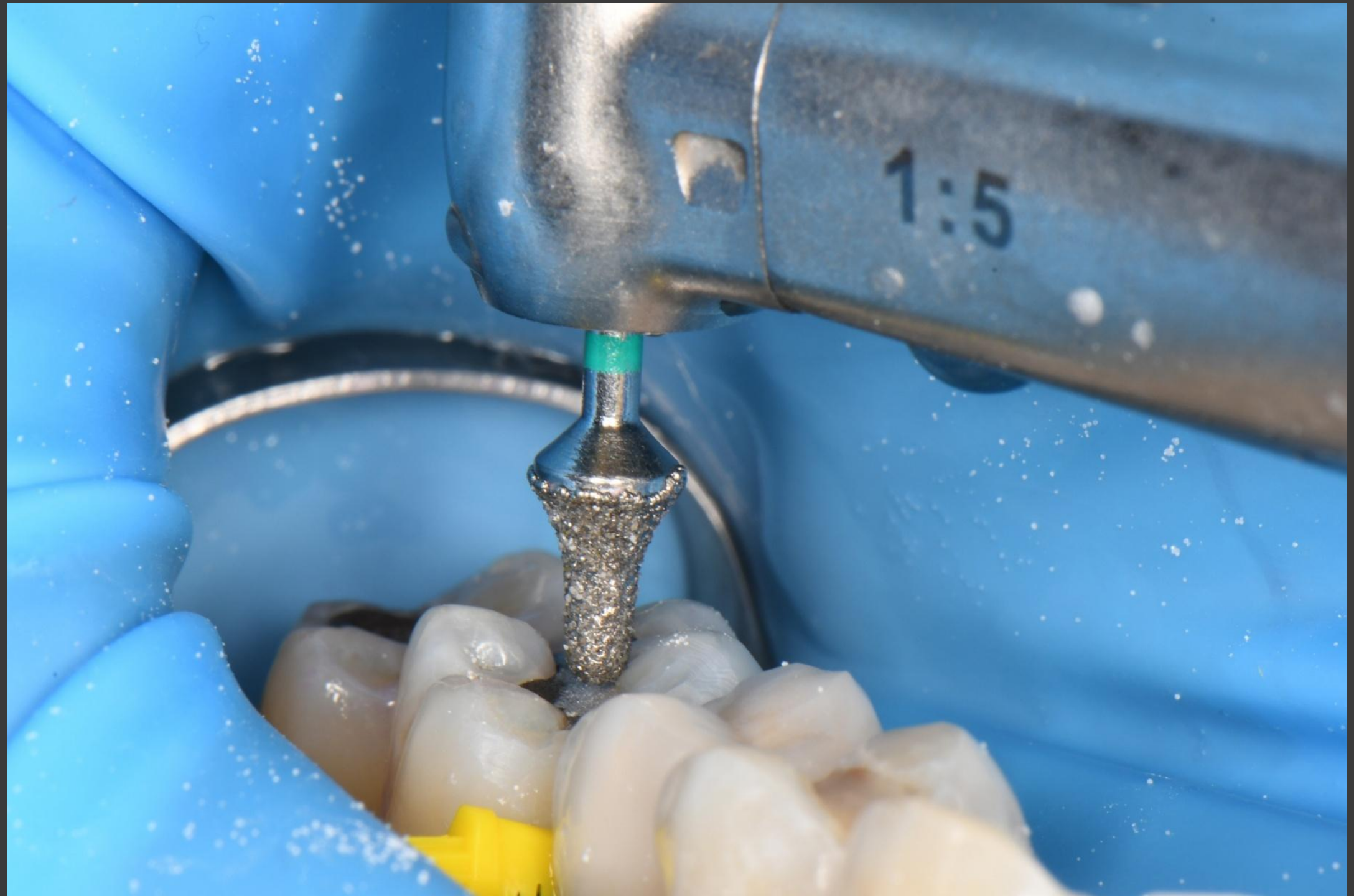
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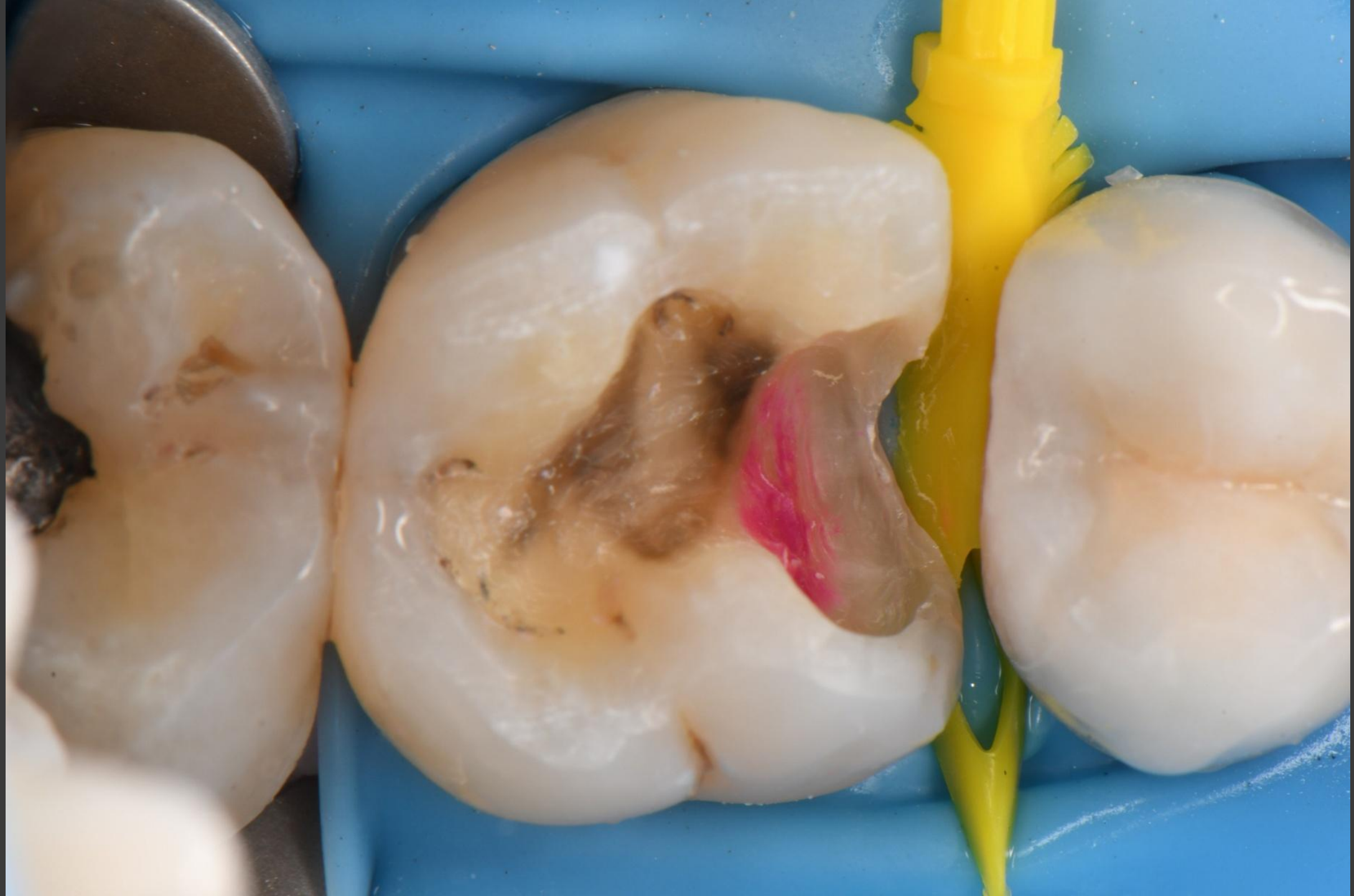

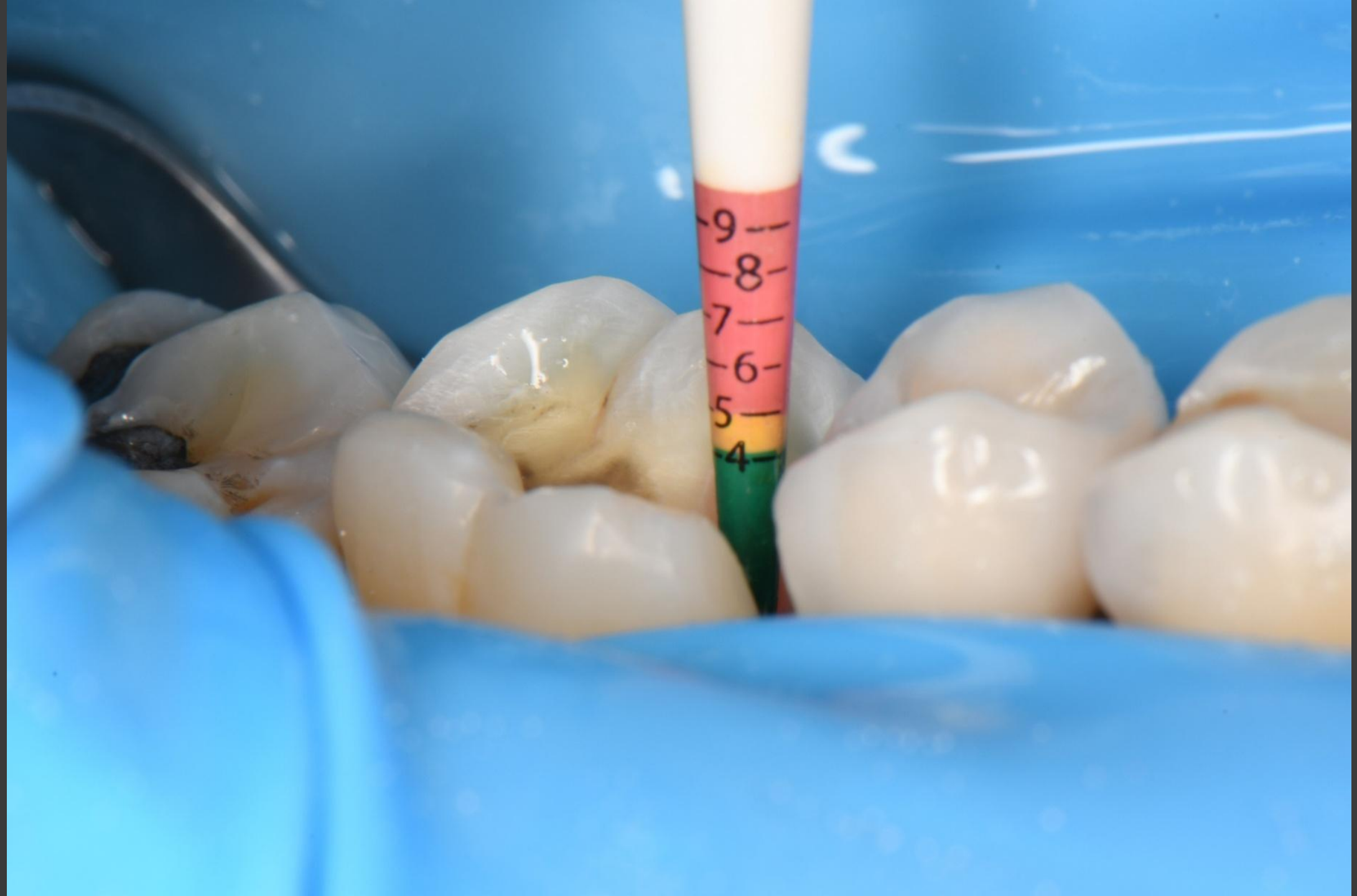
9
8
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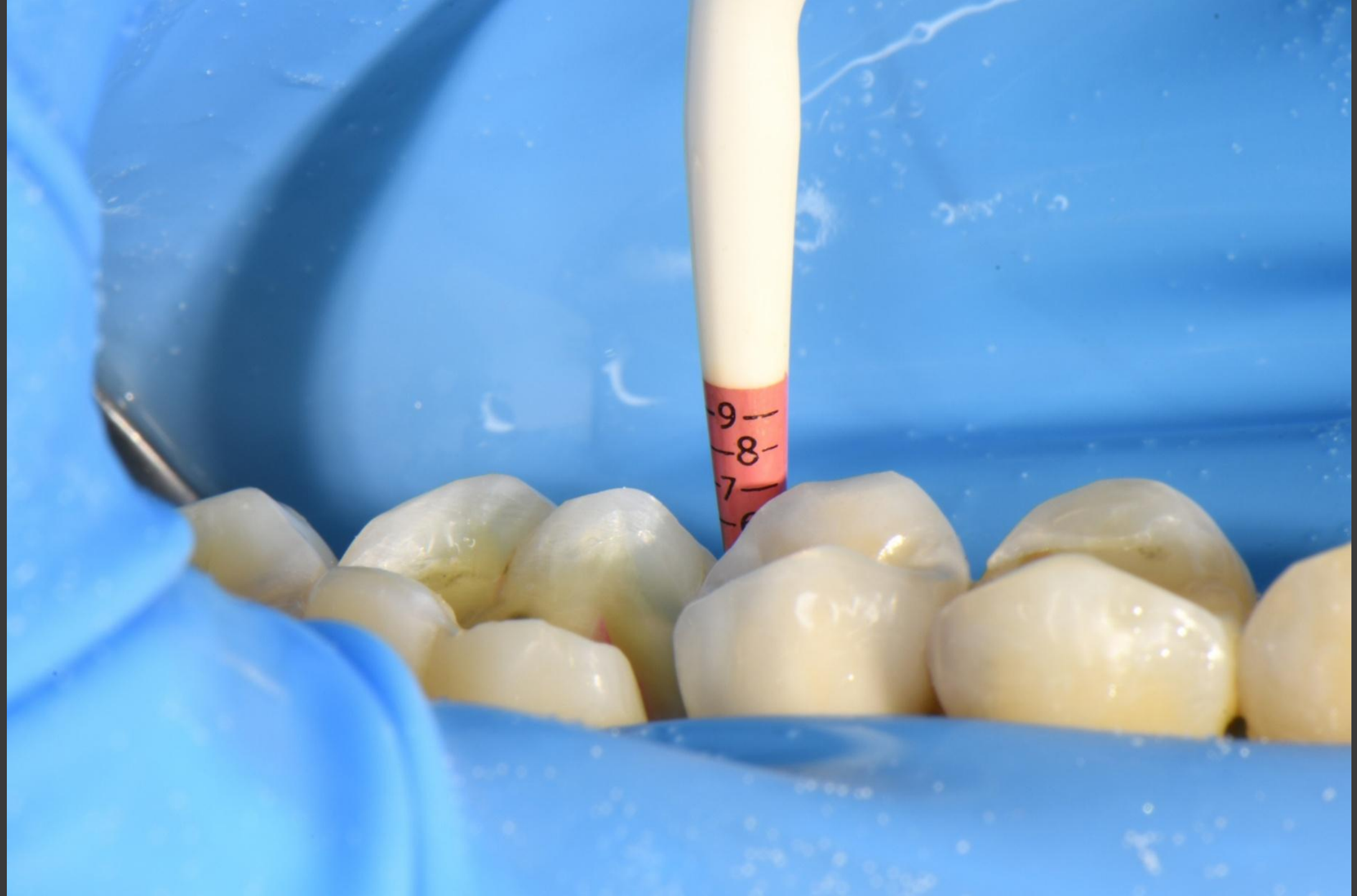
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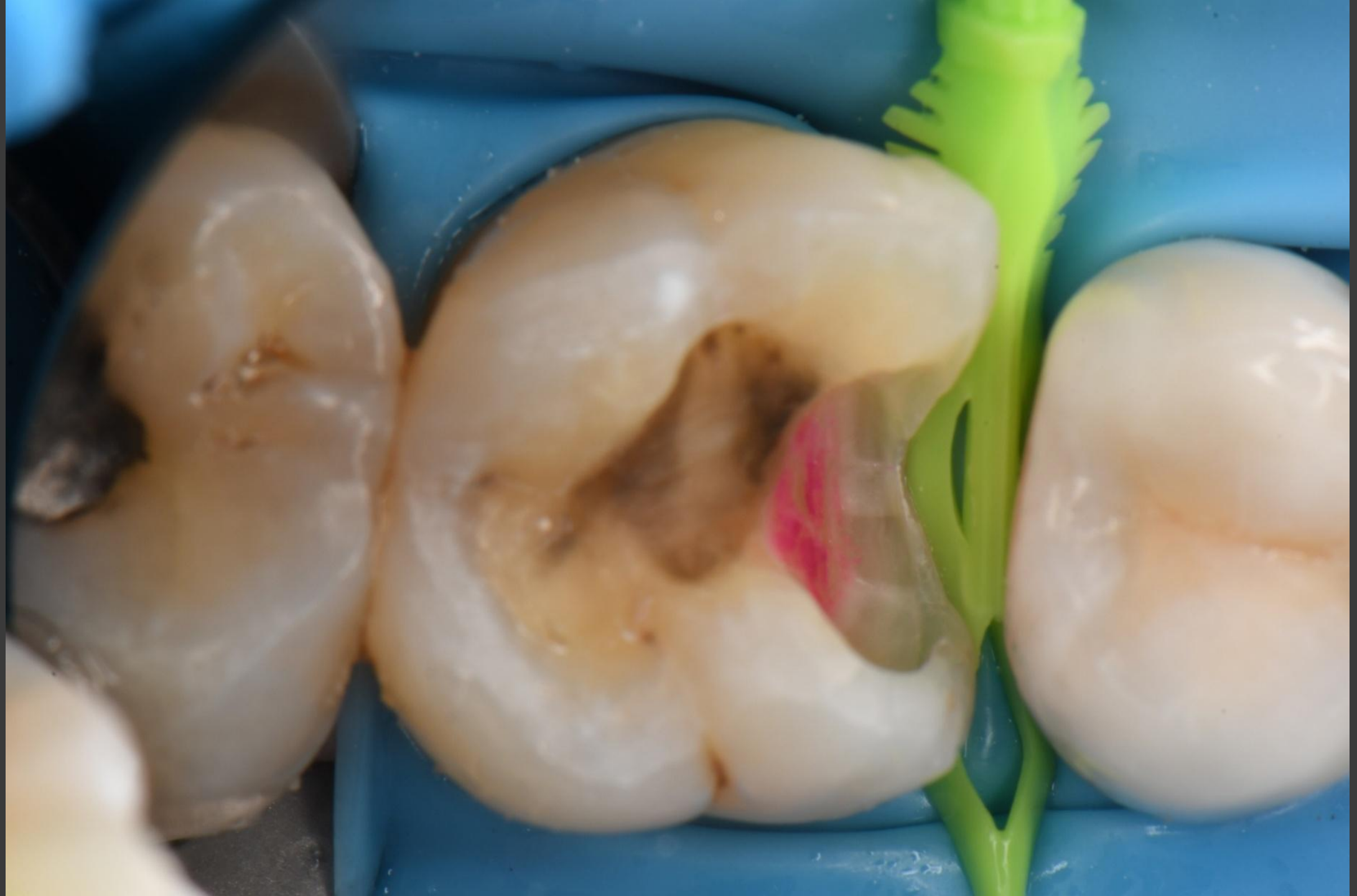
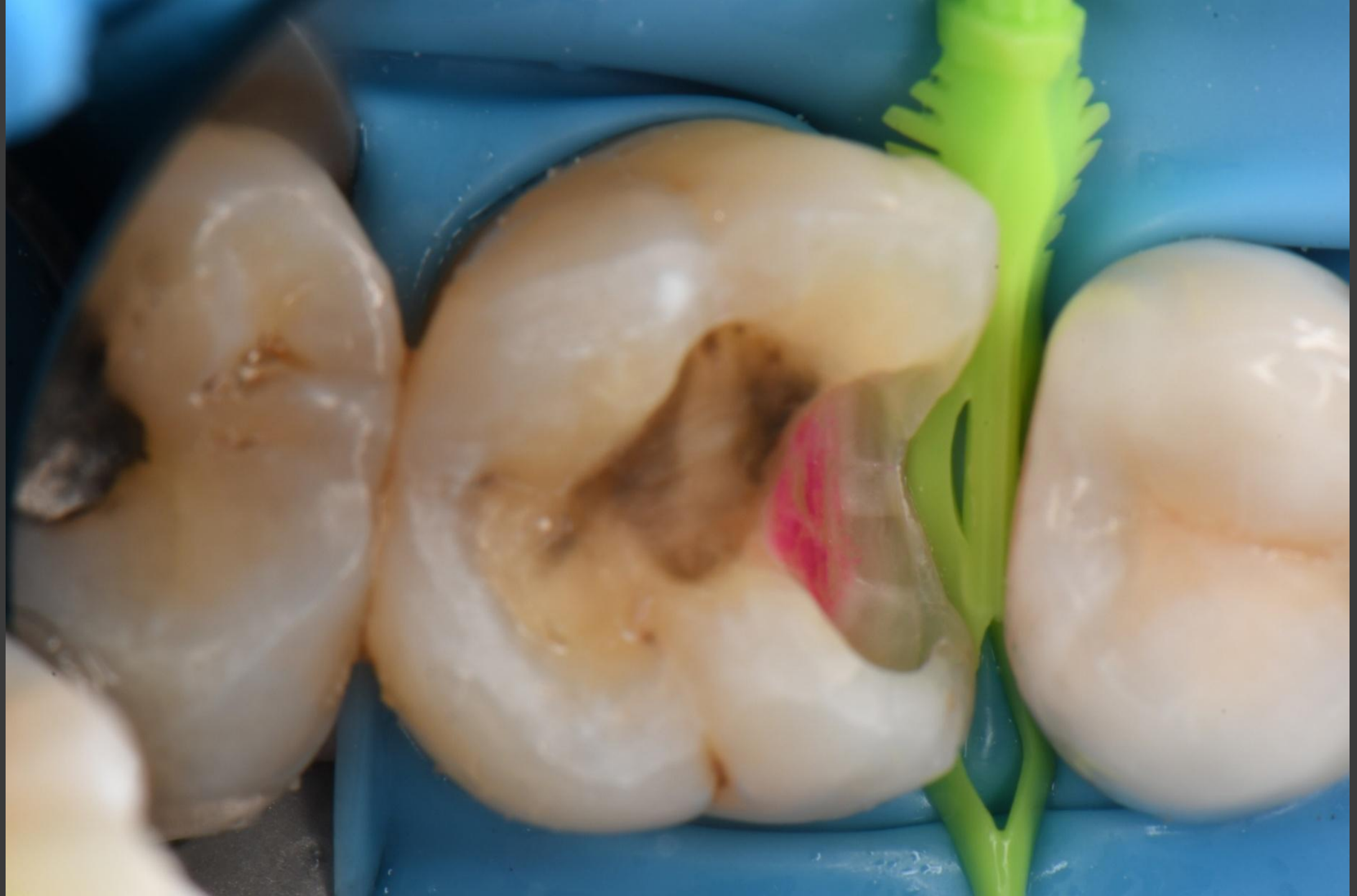
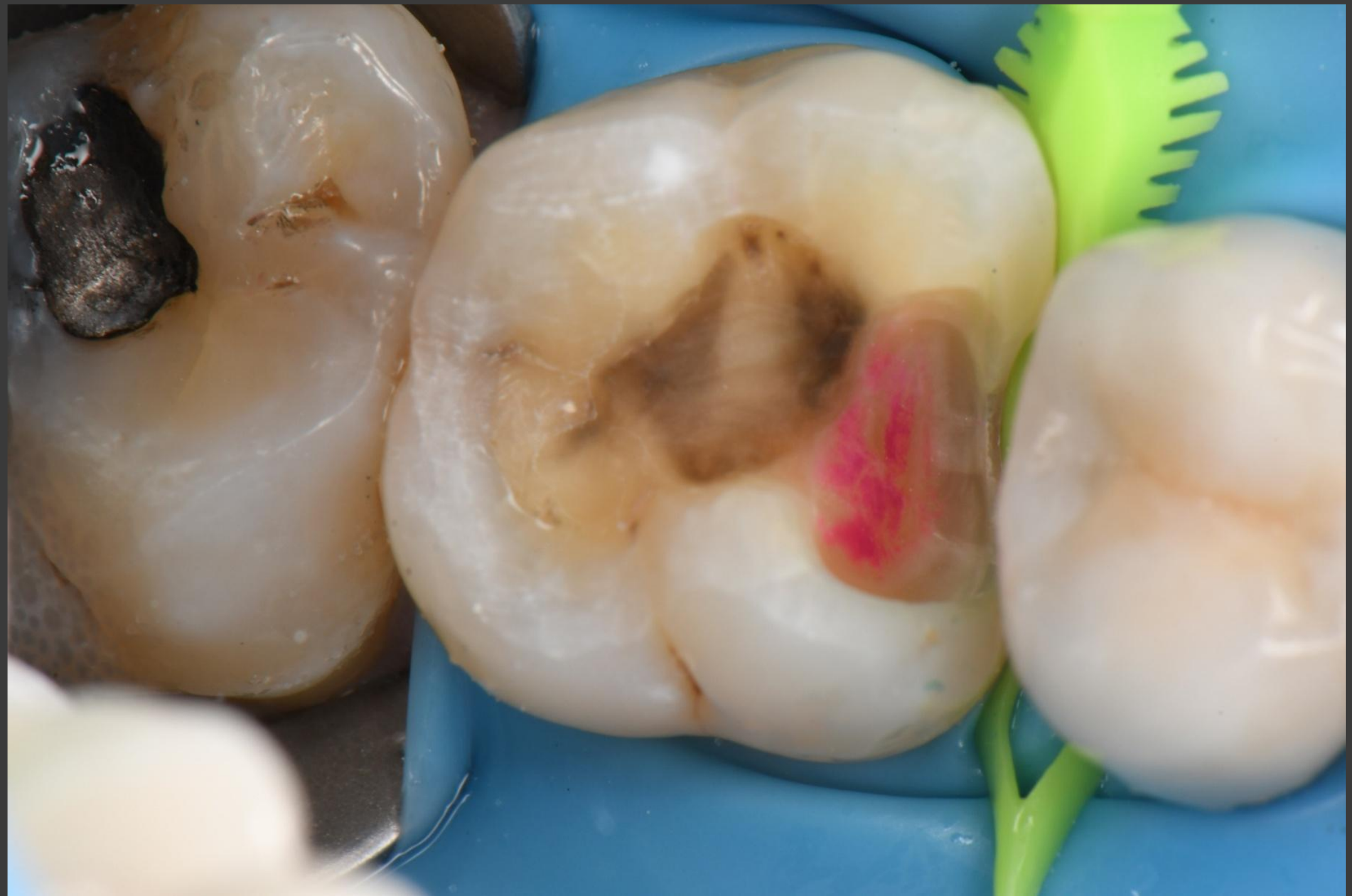
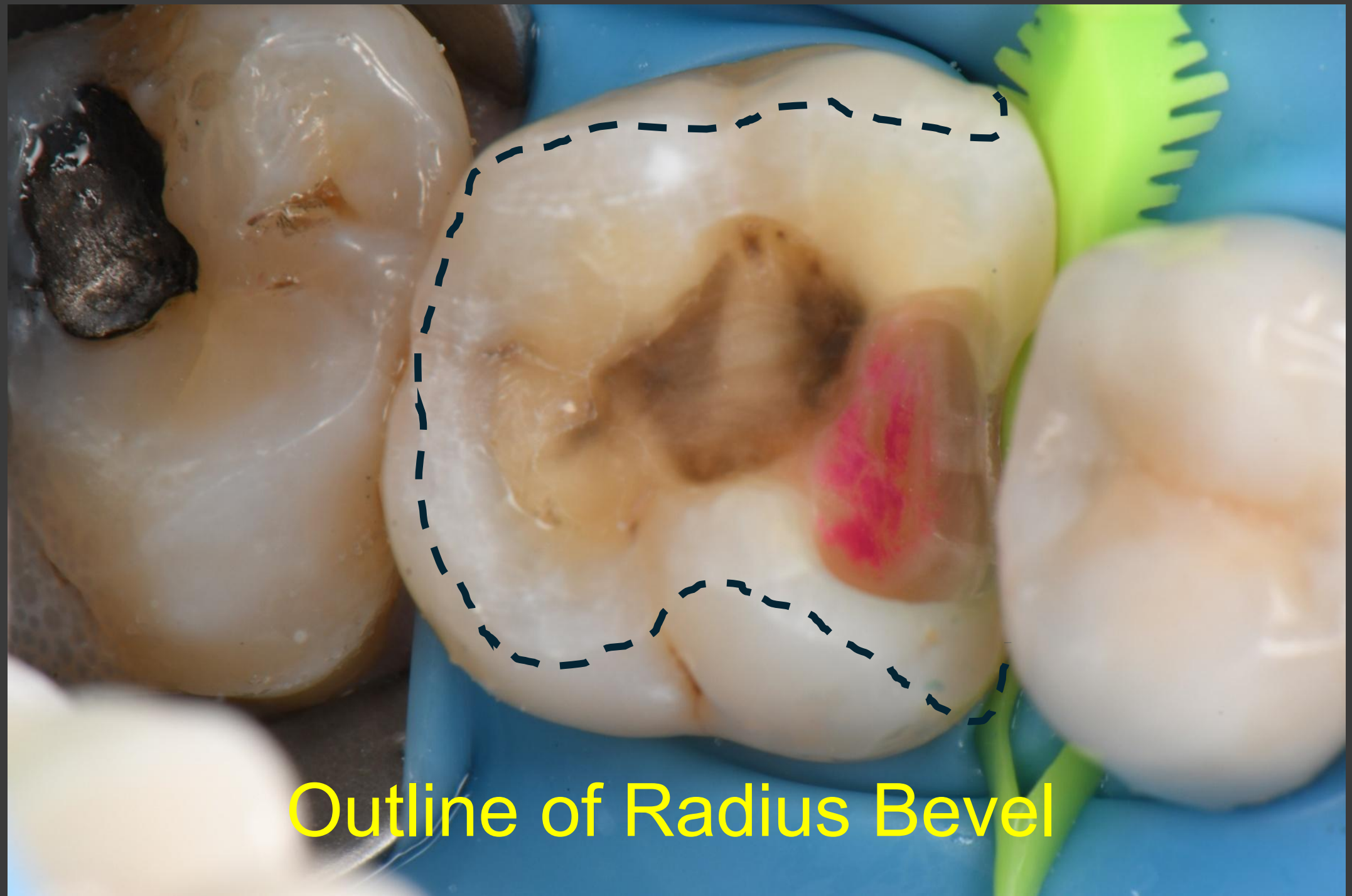


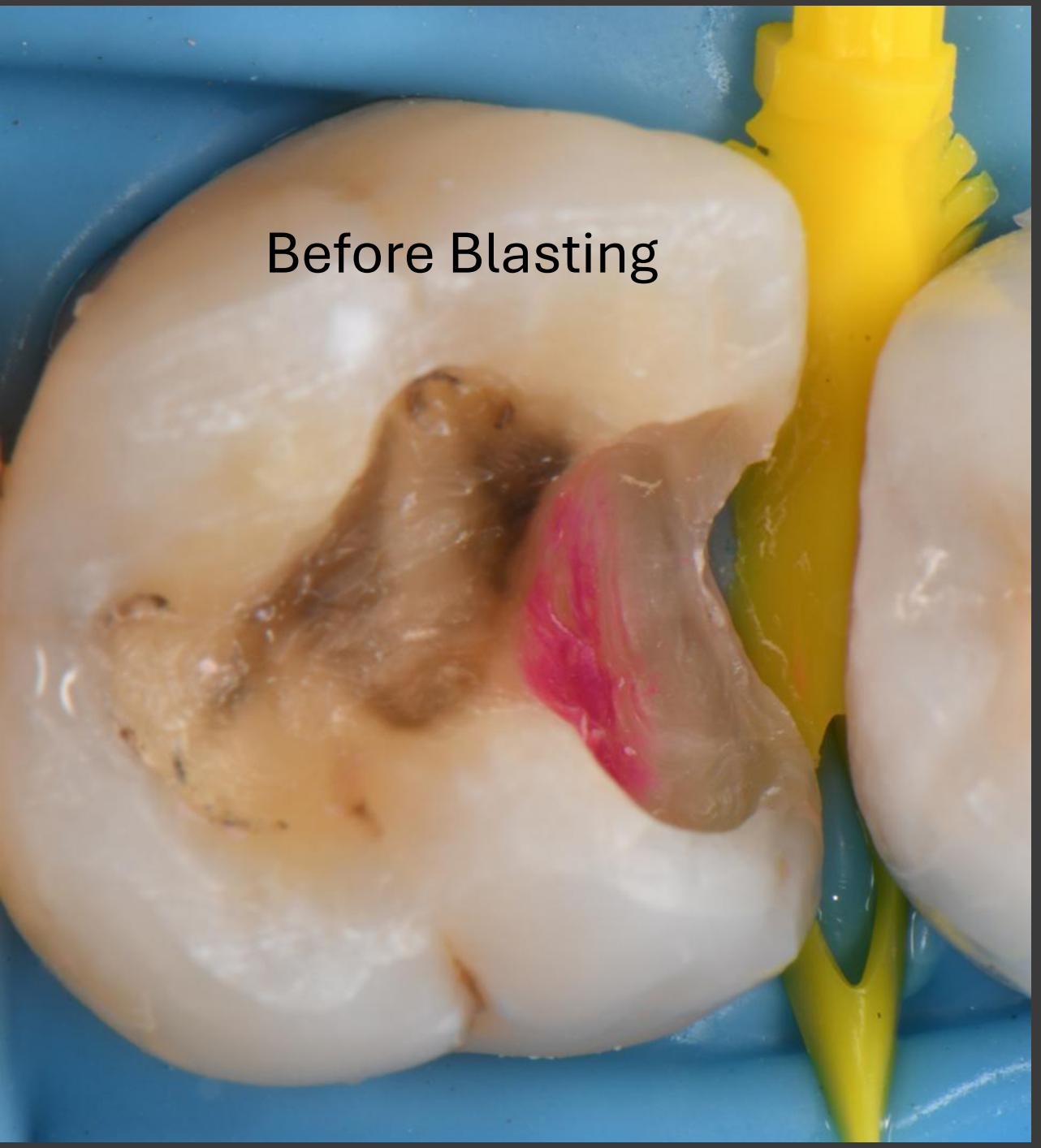
The new “Long Diamond Wedge” Available
in all five Diamond Wedge shapes

Long (Double-Hump) Furcal Wedge

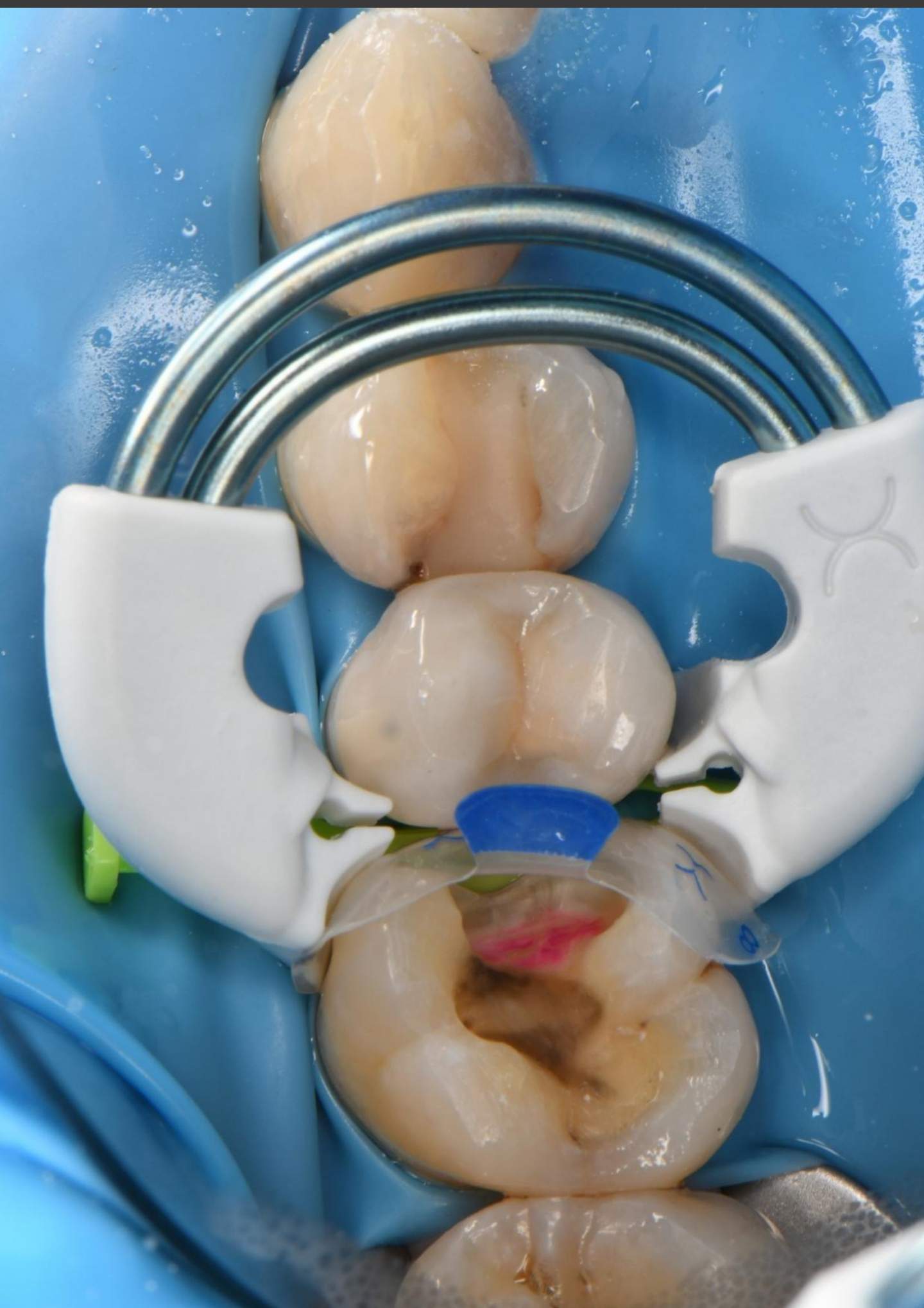


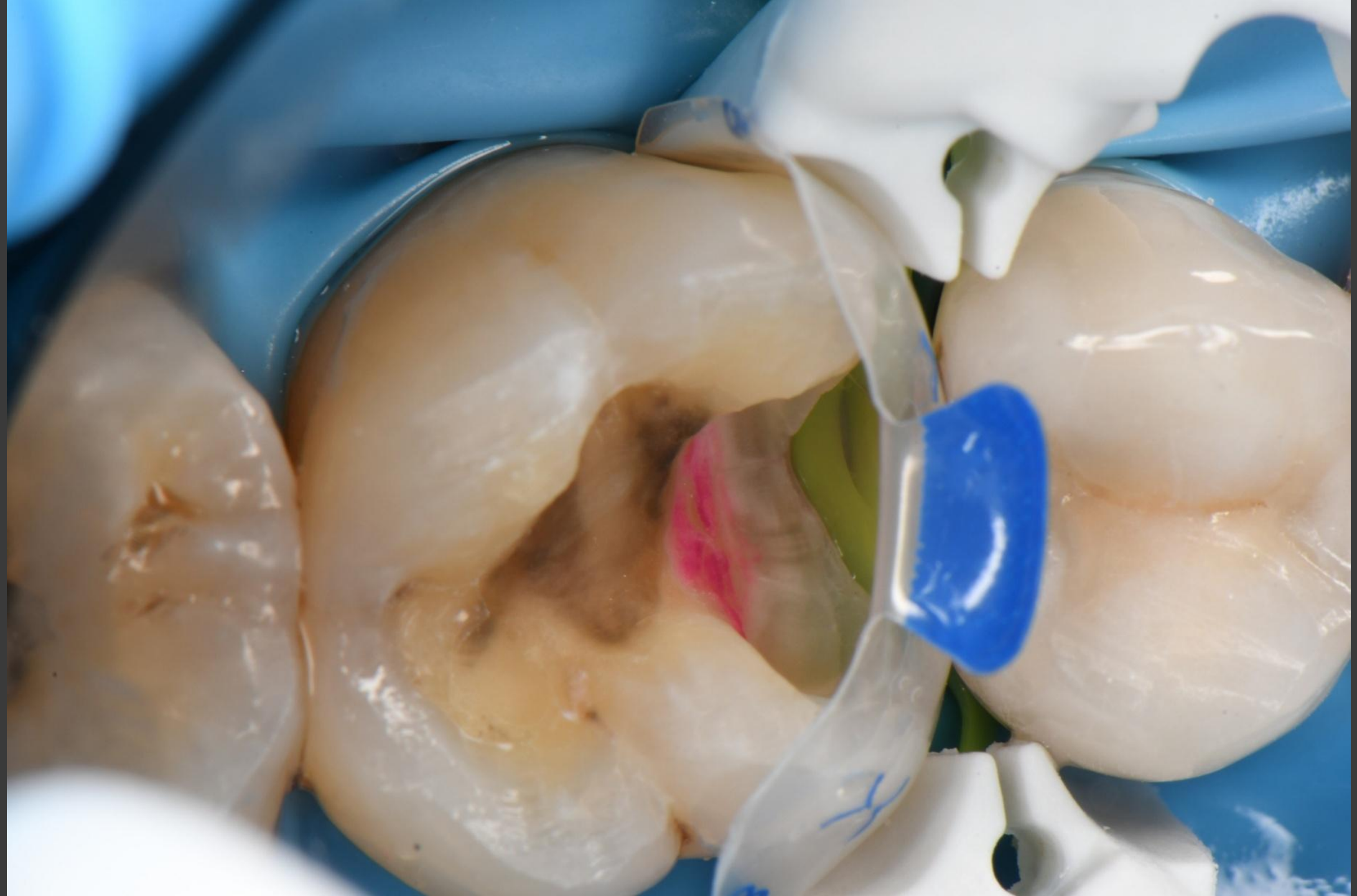


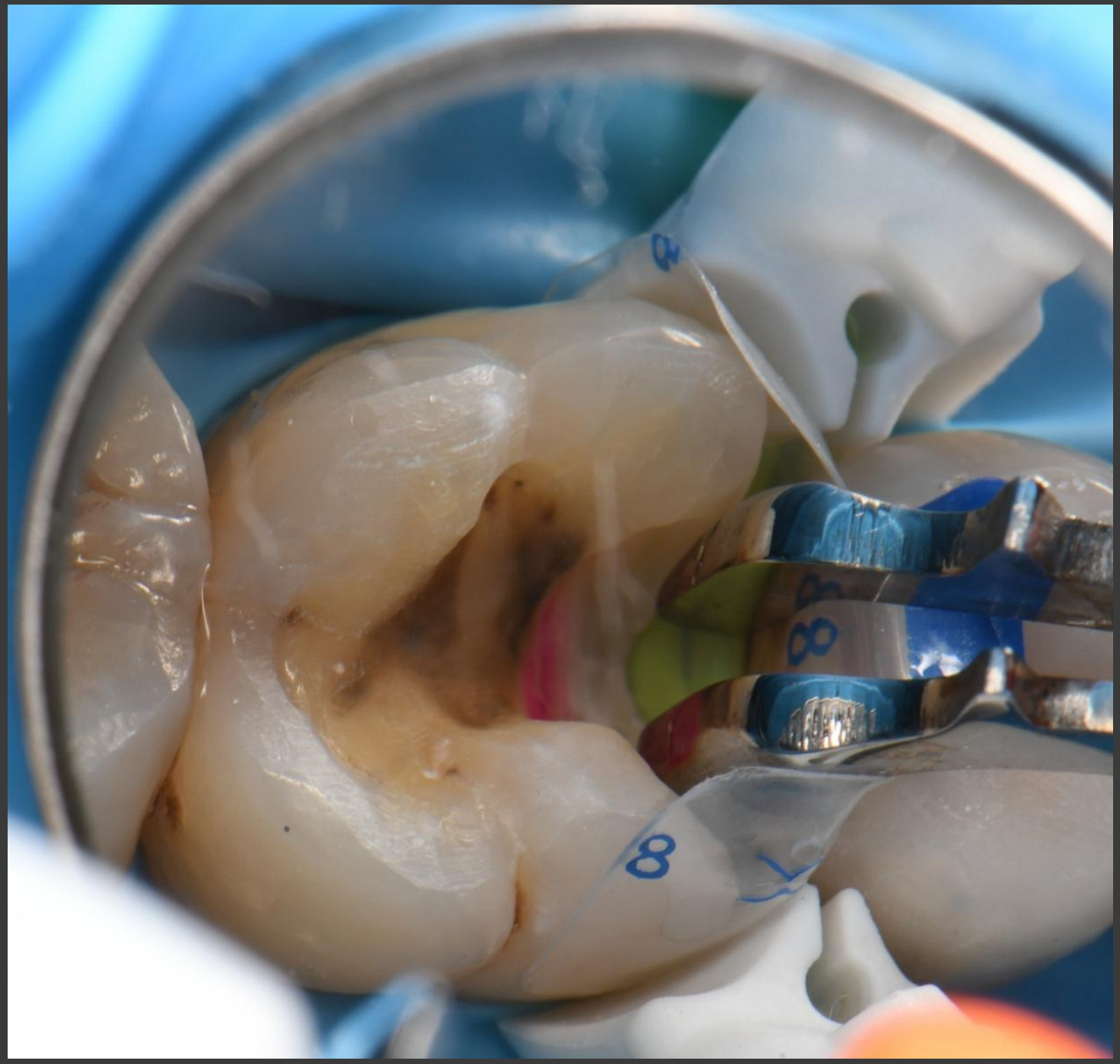

Outline of Radius Bevel

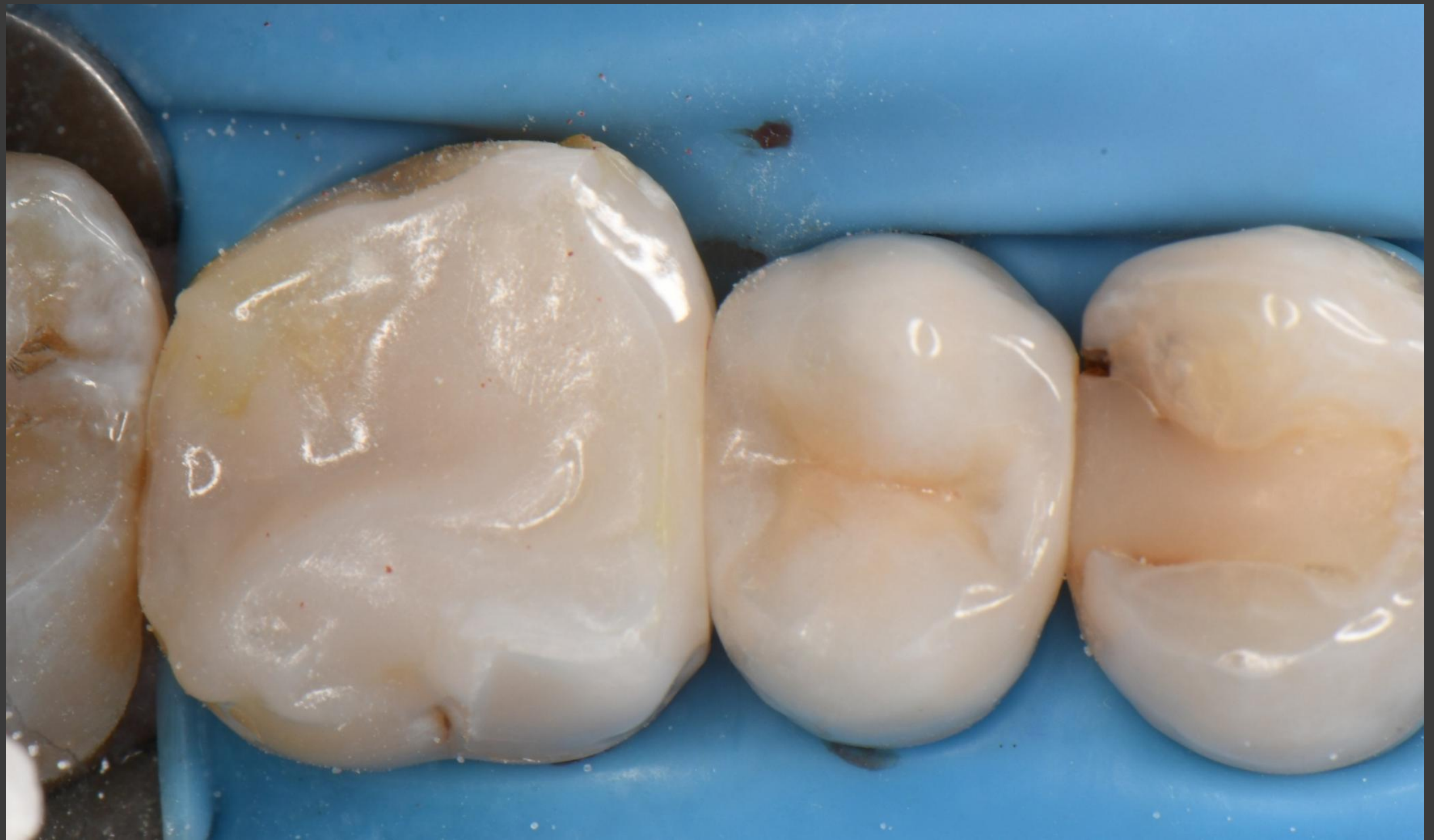

Before Blasting

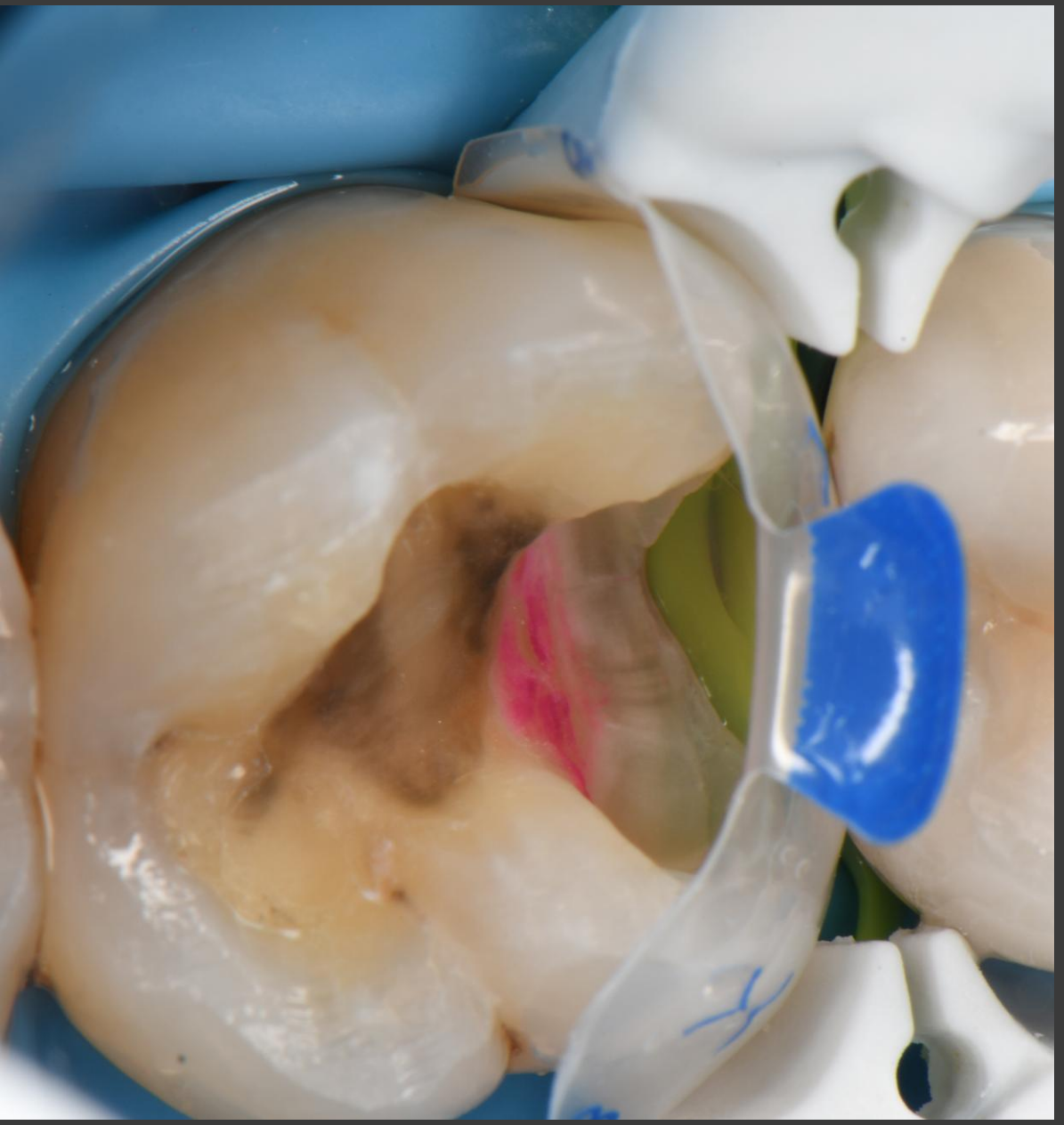

After Blasting and Final
Radius Beveling

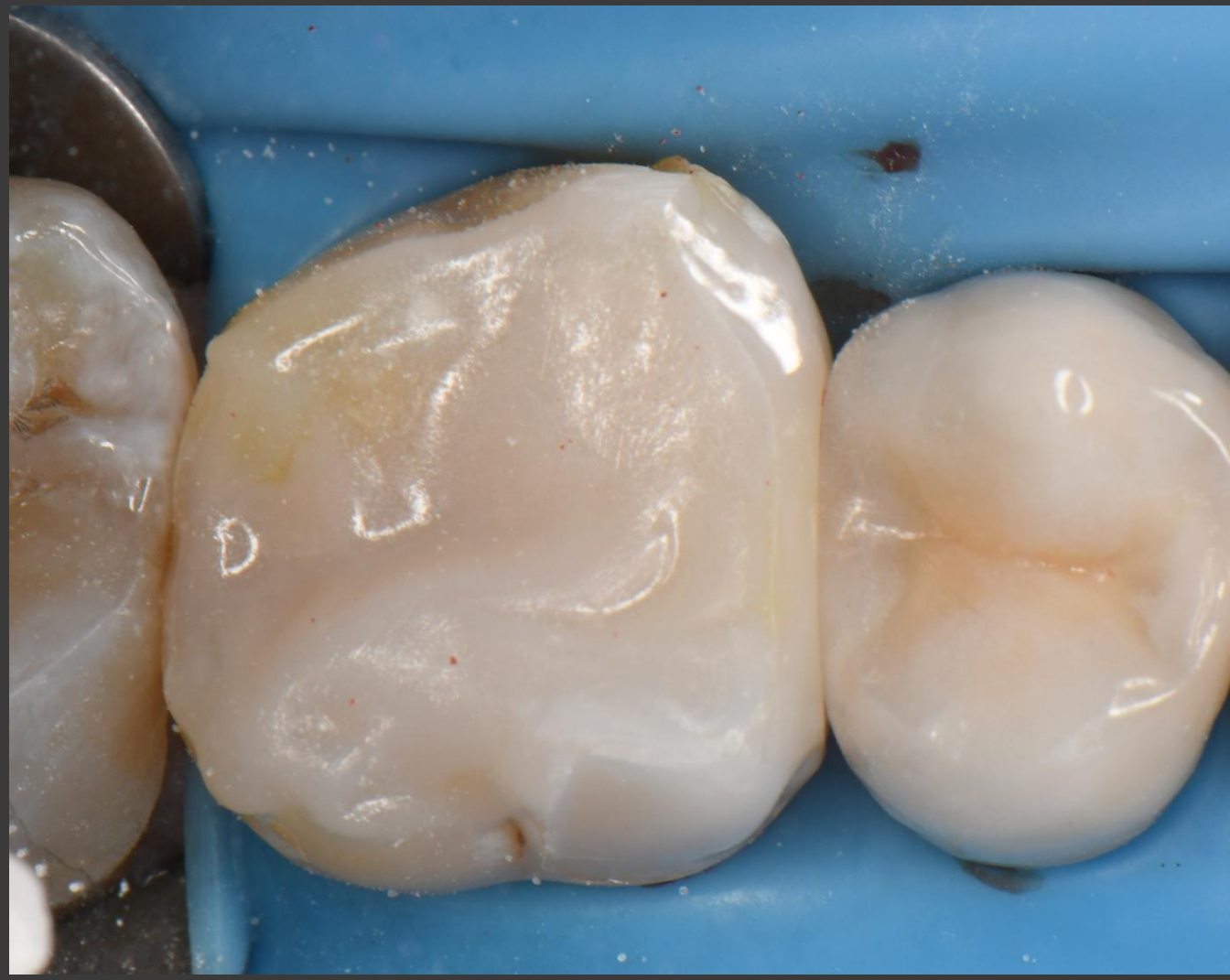


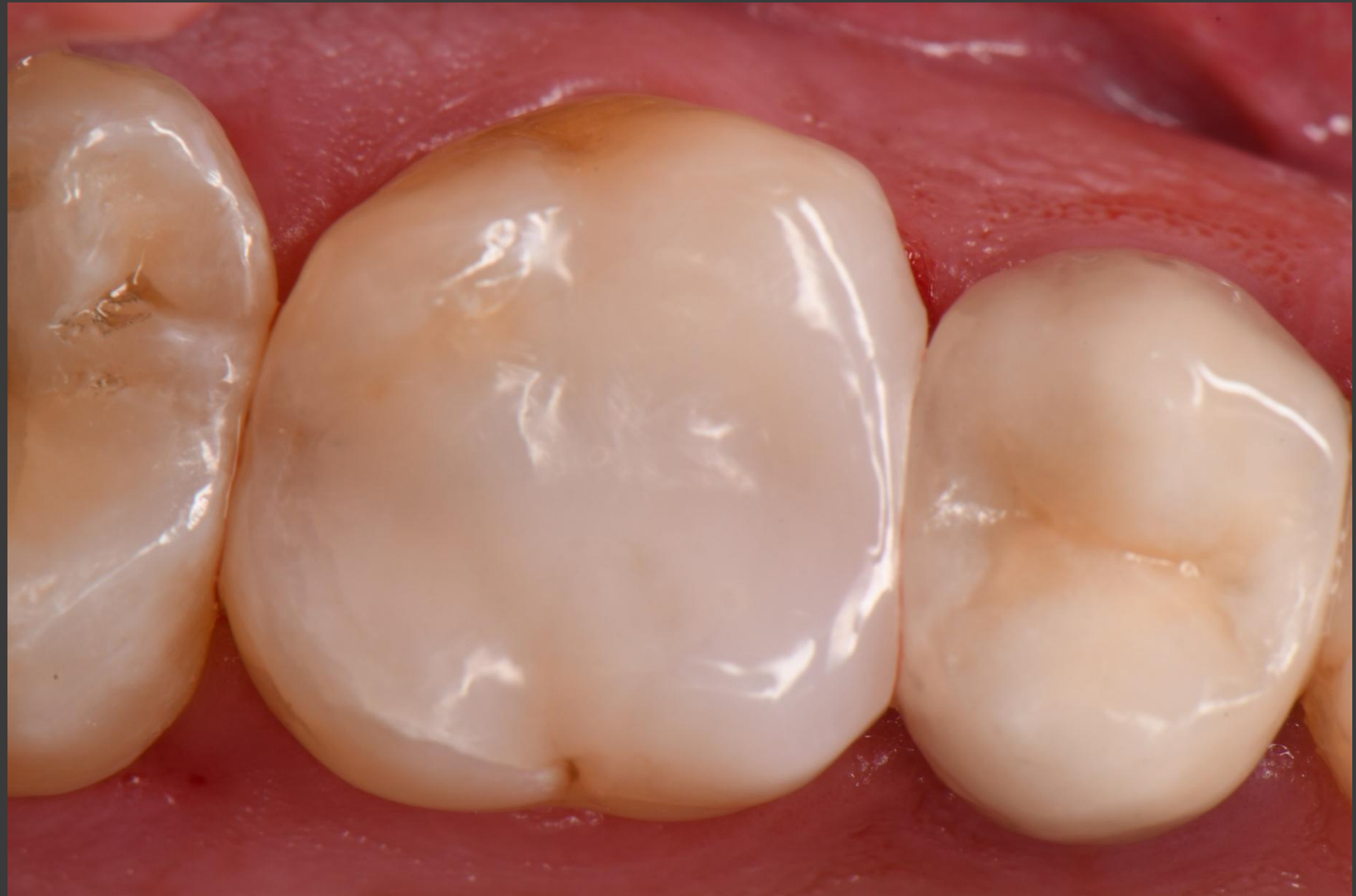


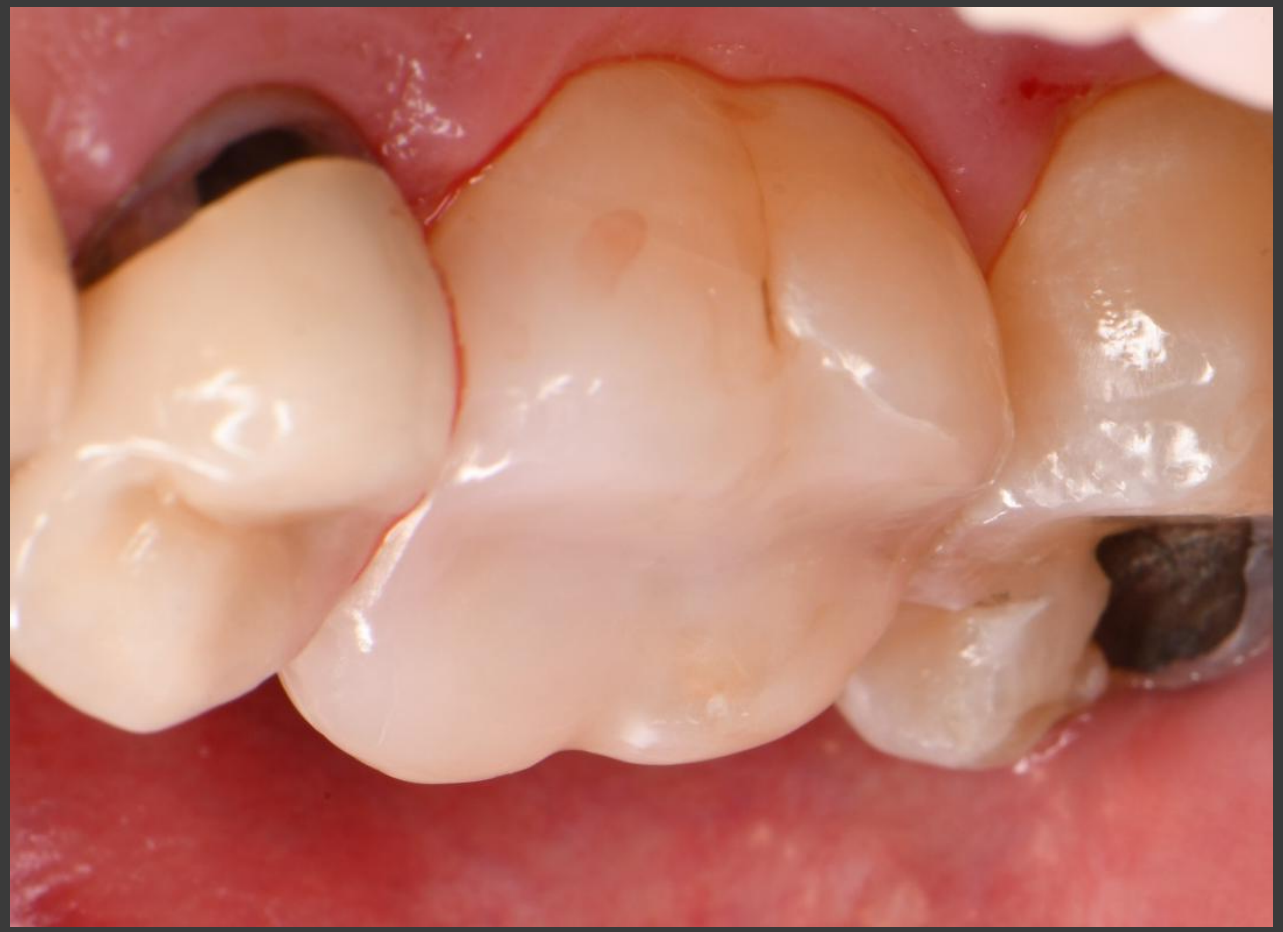


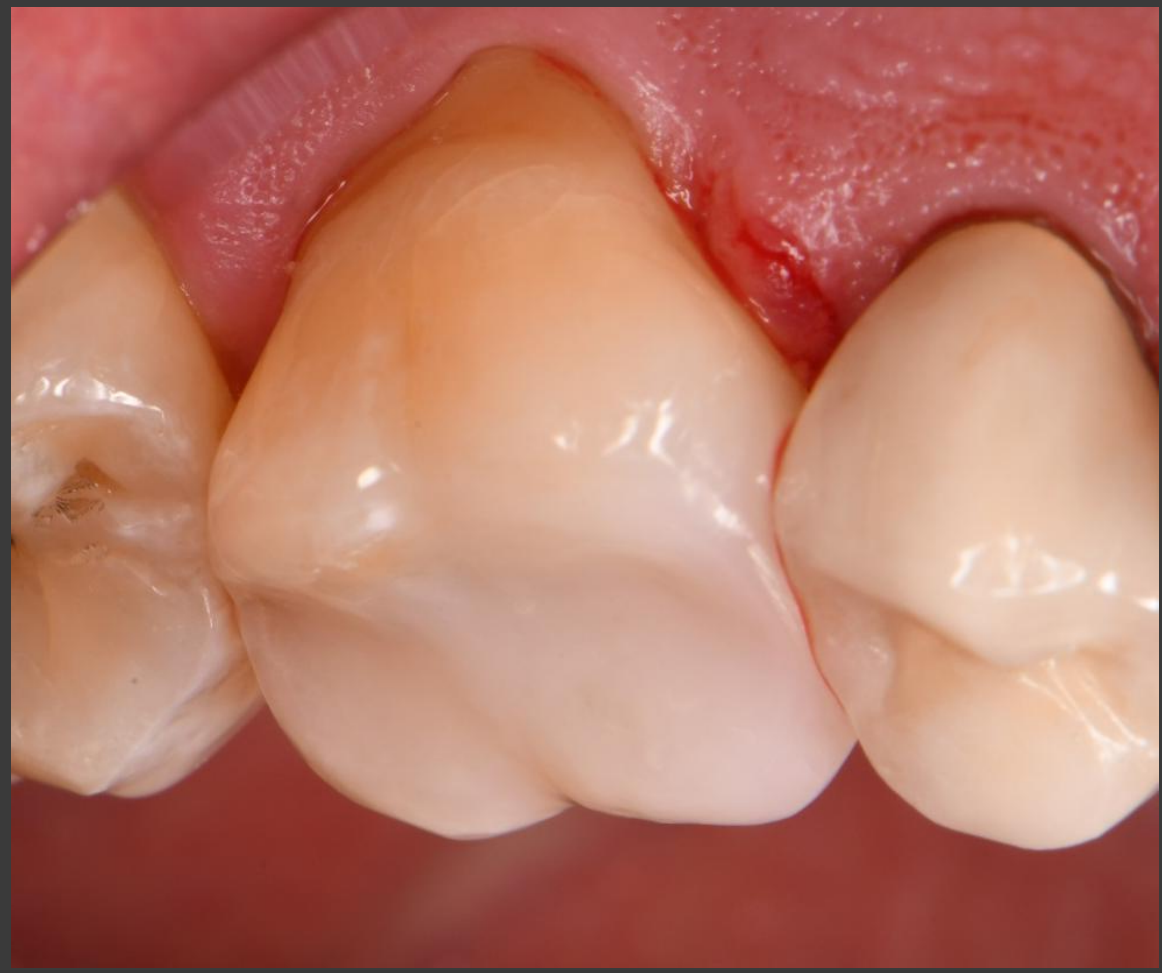


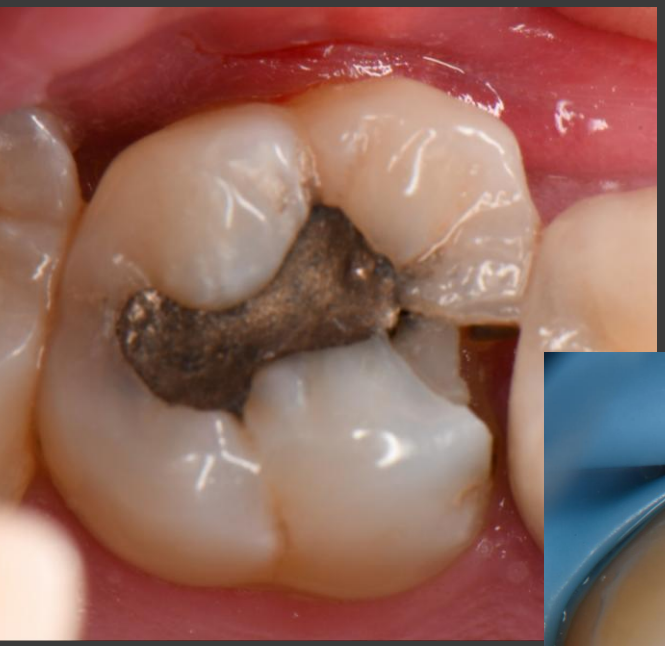
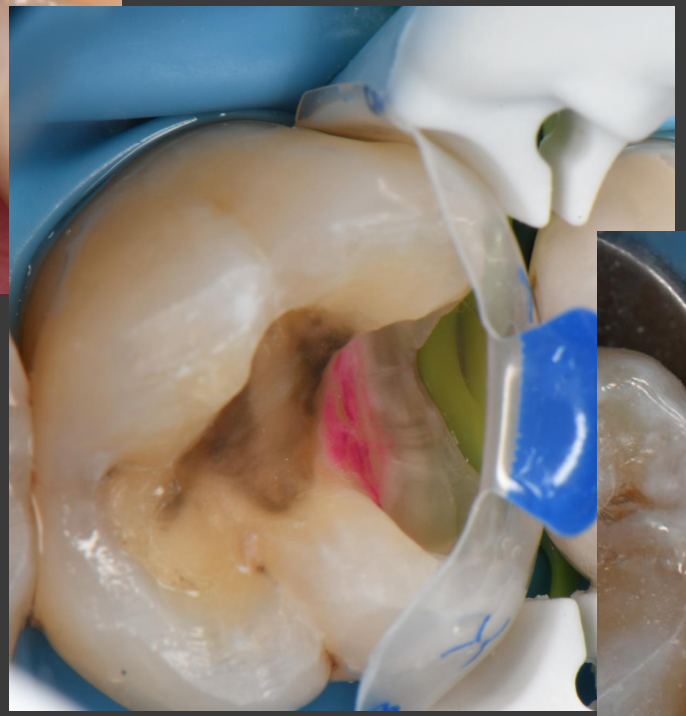
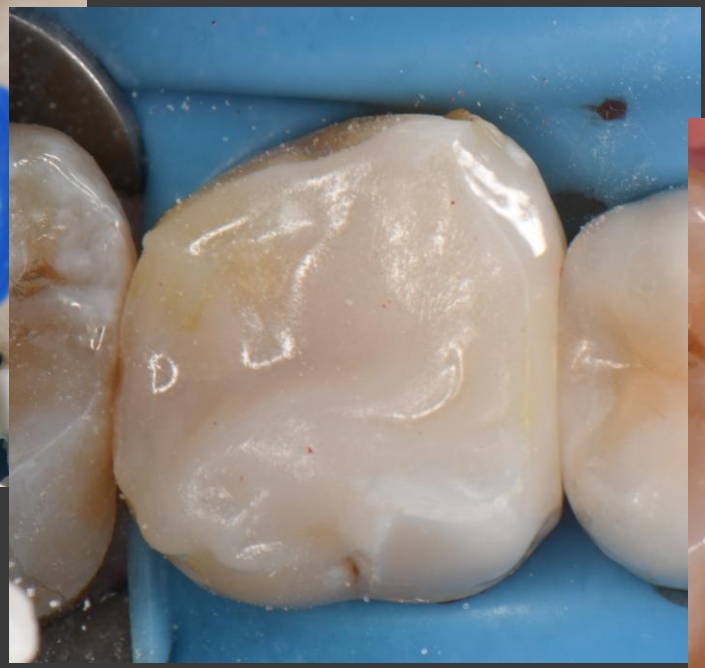
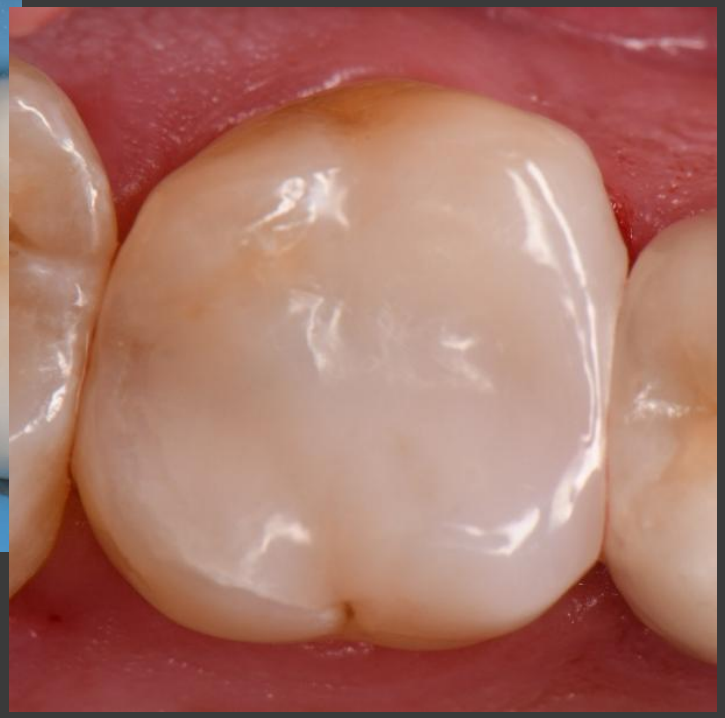










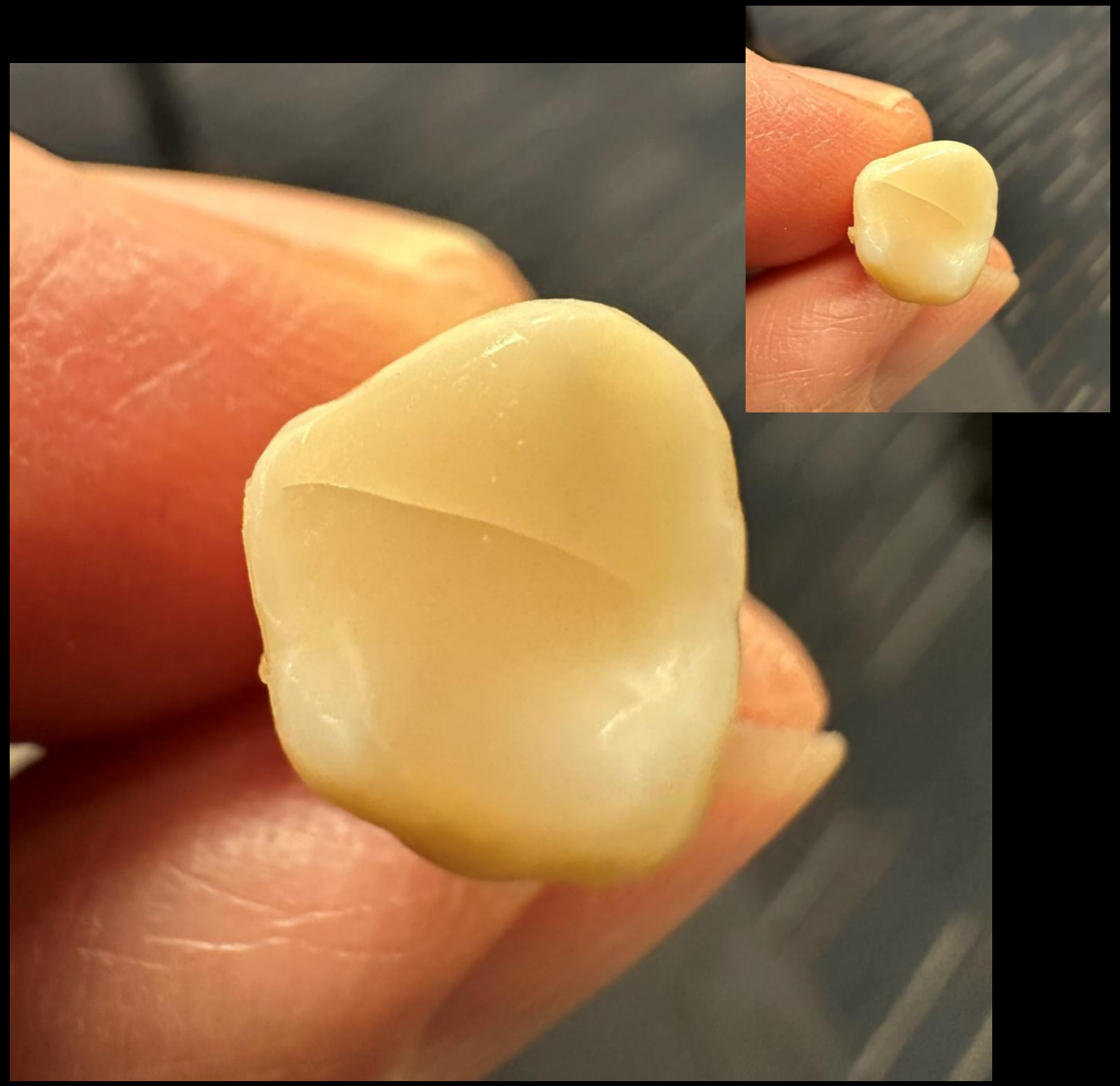





Miles ahead of everybody else for Bulk Fills


YIKES!!
GC “Bulk Injectable”

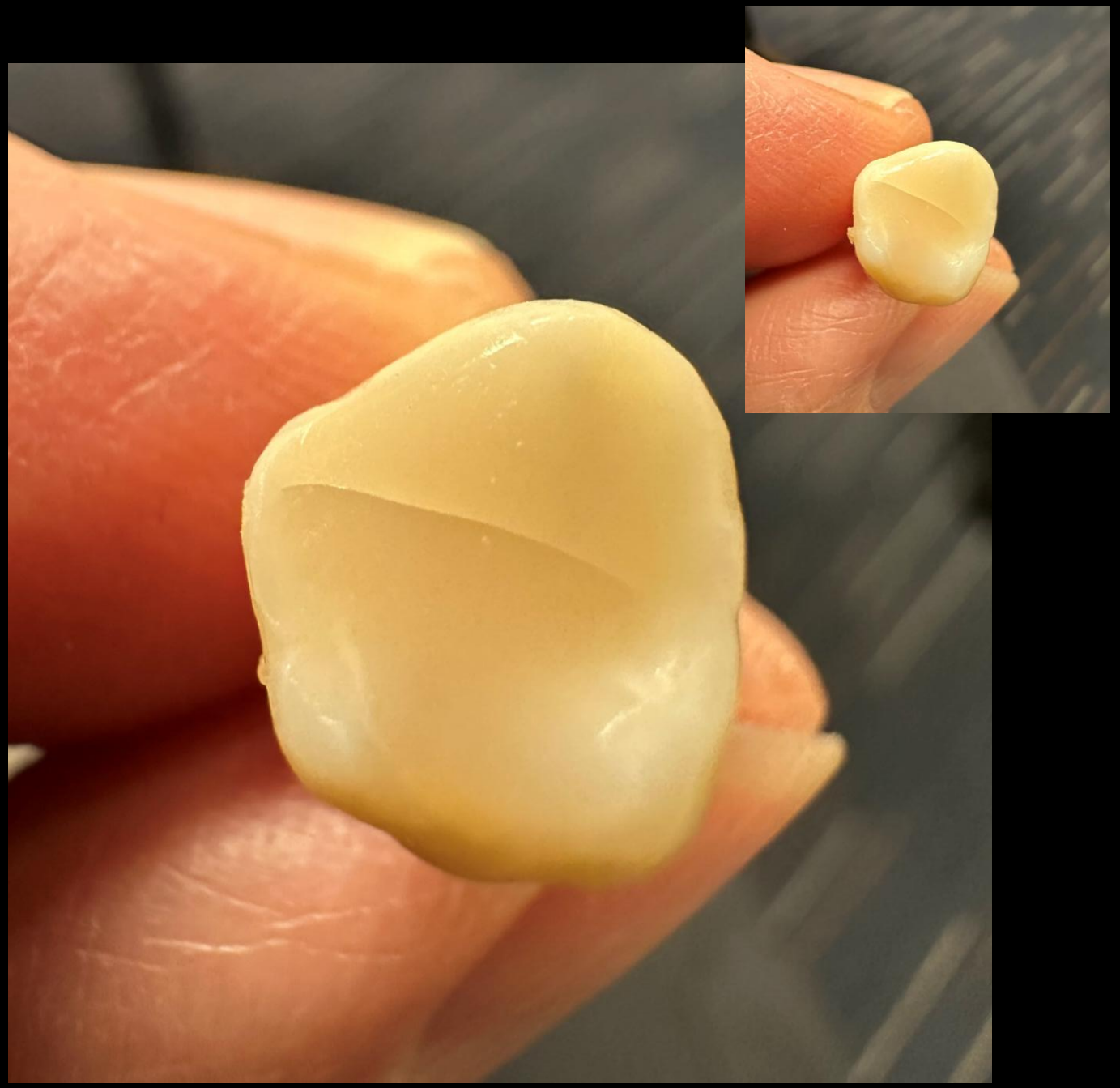
Discussion:

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



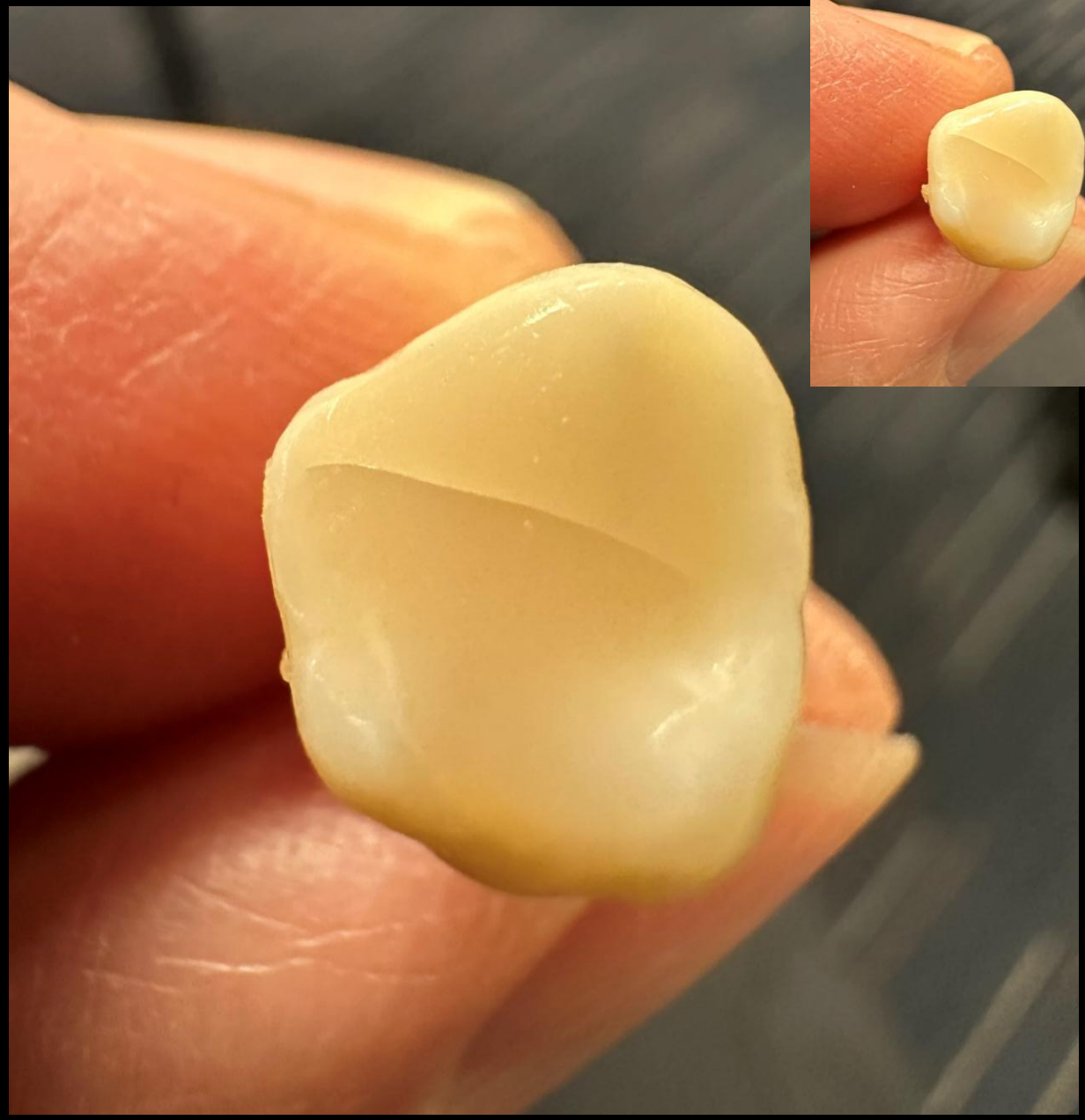
Discussion:

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



Discussion:

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



Miles ahead of everybody else for Bulk Fills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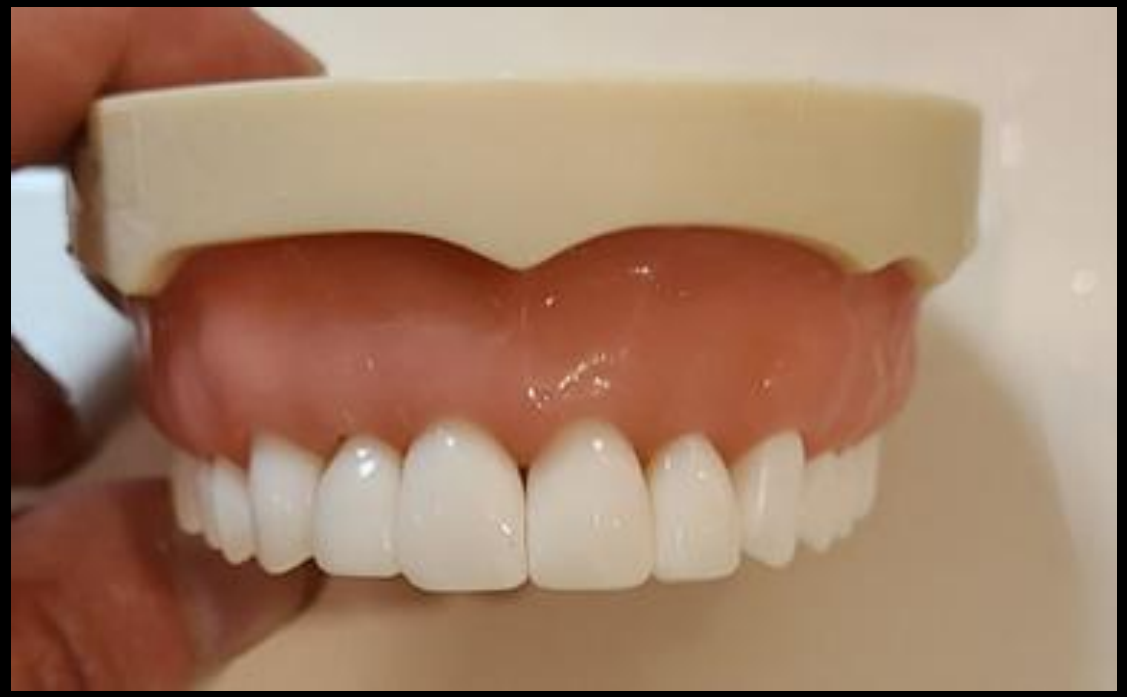
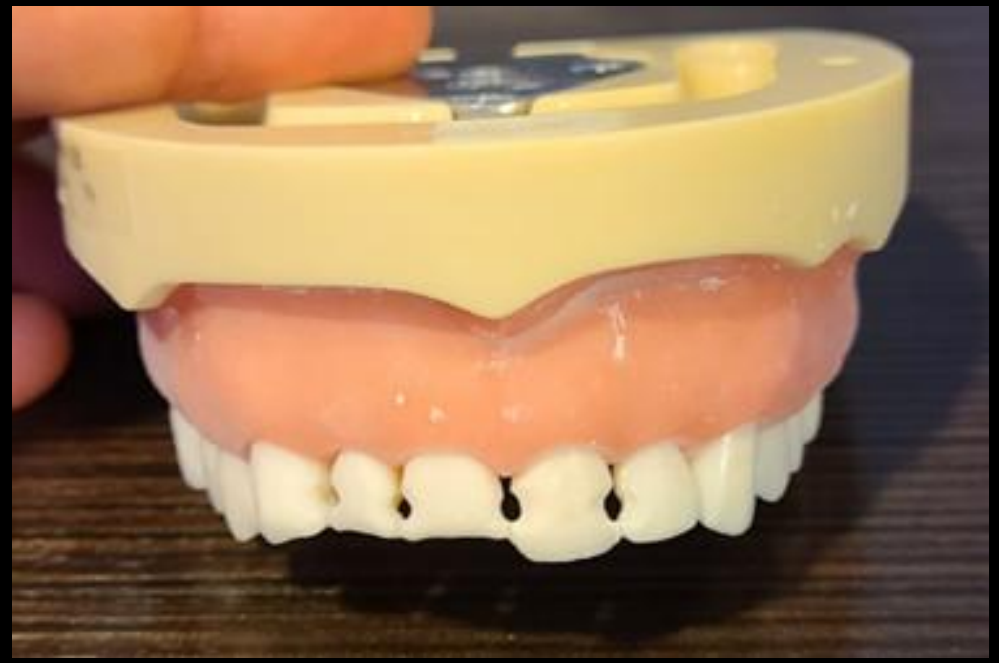
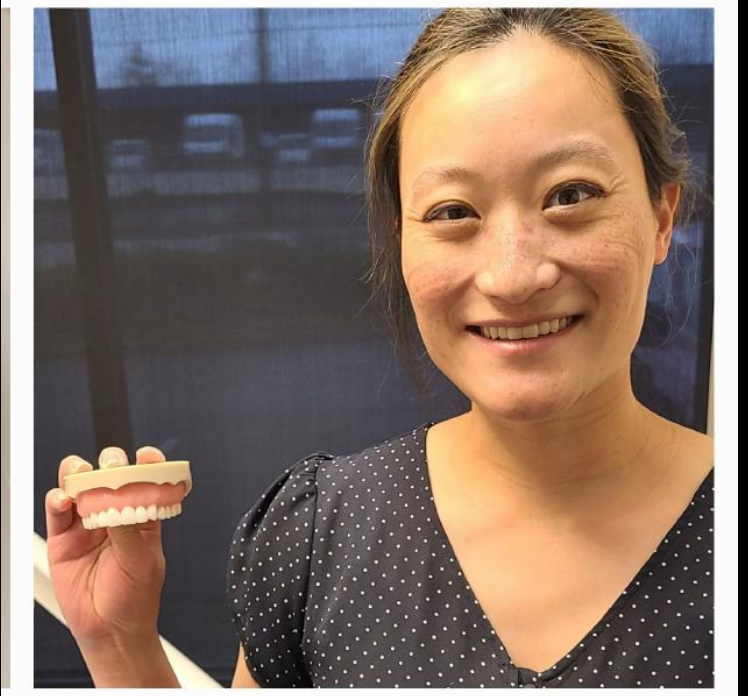
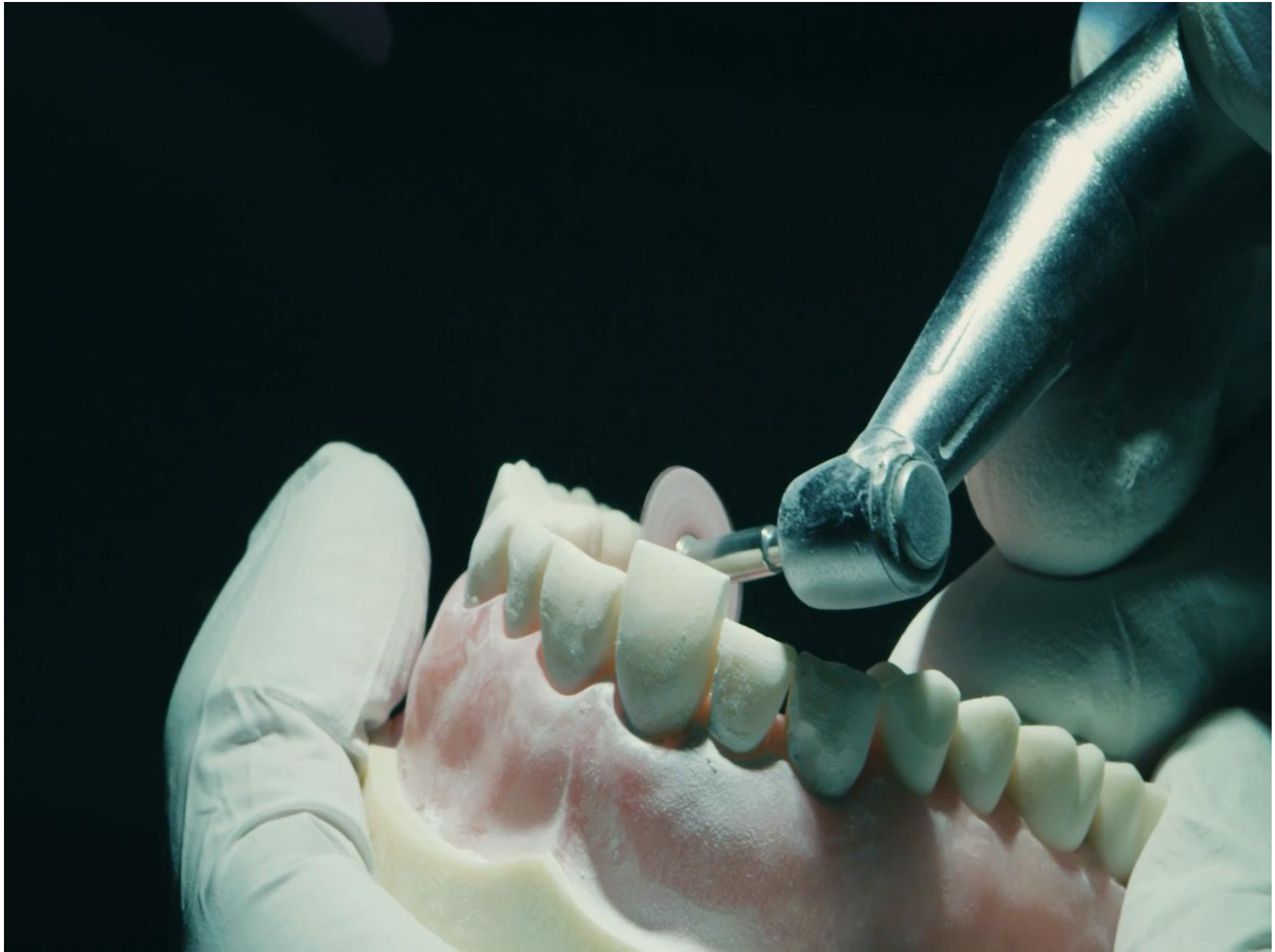
Bioclear Method for Composite Restorations







Last week’s attendees at the certification course



Hands-On Workshop: Better, Faster, Prettier Composite Dentistry - 3 CE 1:45PM-4:15PM

- Audience: Hands-On Workshop Pre-registered $100
- Location: Room 410 C, Boise Centre East
- **by Dr. David Clark, Bioclear**

Experience a fresh approach to modern composite dentistry with Dr. Clark. Say goodbye to traditional techniques like
layering, condensing, and burnishing. Join us to master injection molding, achieving precise margins, smooth
contours, and flawless, mirror-like restorations in both black triangle and Class II scenarios.

- Learn: The 6 steps to achieve rock solid posterior contacts in even the most difficult cases
- Learn: How can you combine flowable & regular composites with the injection molding technique & when to use bulk fills
- Learn: Treating the dreaded black triangle, especially common after tray aligner therapy
- Learn: How to handle heated composites

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(3M)

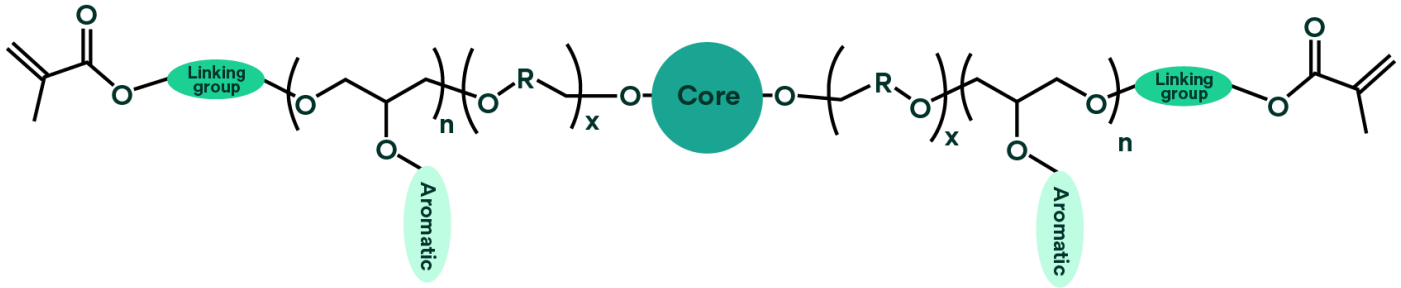
3M™ Filtek™ One Bulk Fill Restorative

Scientific presentation

Innovative methacrylate monomers for lower shrinkage and proven stress relief

AUDMA: Aromatic urethane dimethacrylate

- Higher molecular weight with less number of reactive groups
- Moderates volumetric shrinkage
- Contributes to stress reduction



AFM: Addition-fragmentation (AF) monomer

- Reacts into developing polymer network through terminal methacrylate bonds like other dimethacrylate monomers
- Central AF group can fragment and release stress
- Fragment may then polymerize into network in a lower stress orientation compared to its pre-fragmented state

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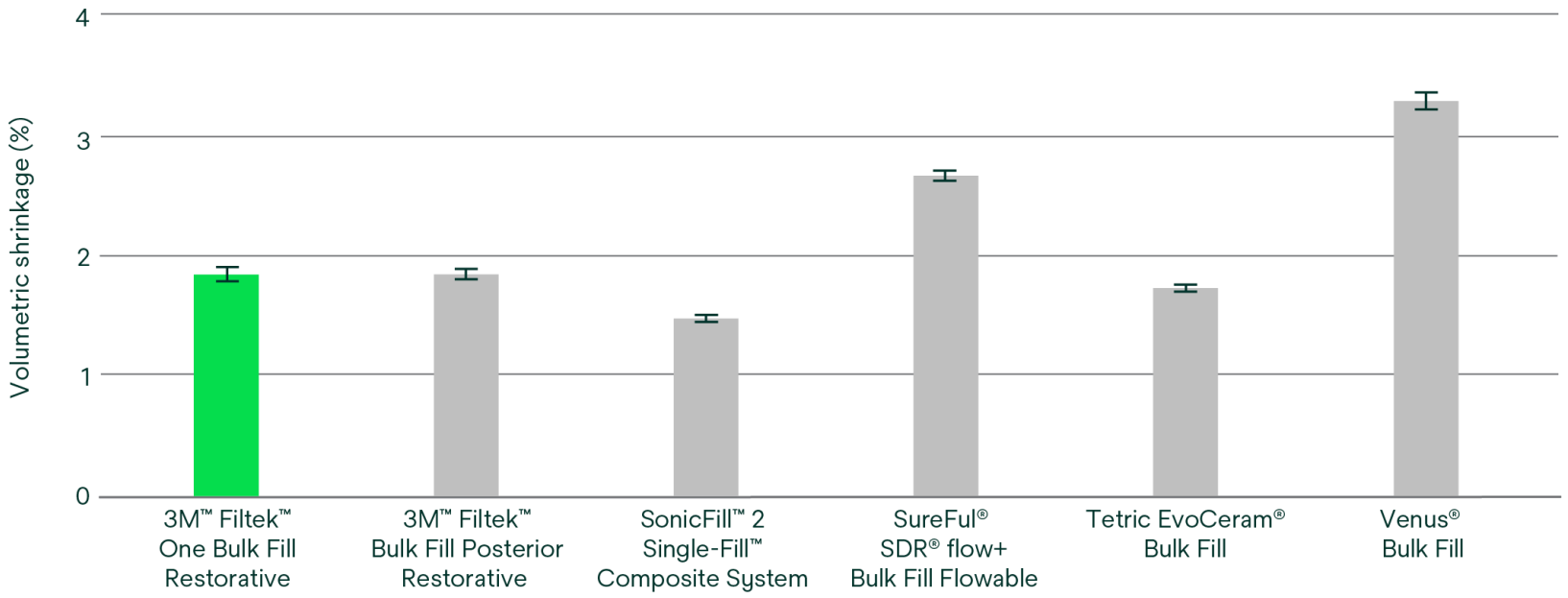
Polymerization shrinkage

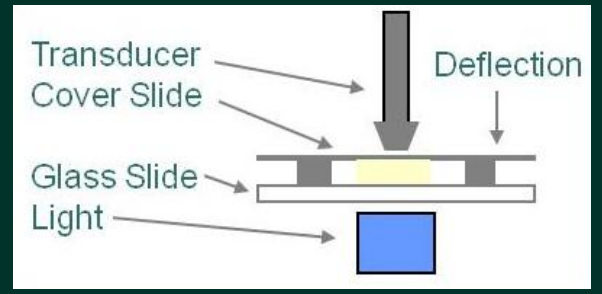
Comparison of common bulk fill composites



Source: Solventum Internal Data

3M™ Filtek™ One Bulk Fill Restorative

is equivalent to 3M™ Filtek™ Bulk Fill Posterior and has lower polymerization shrinkage than Venus® Bulk Fill, Surefil® SDR® Flow +.



Bonded disc method

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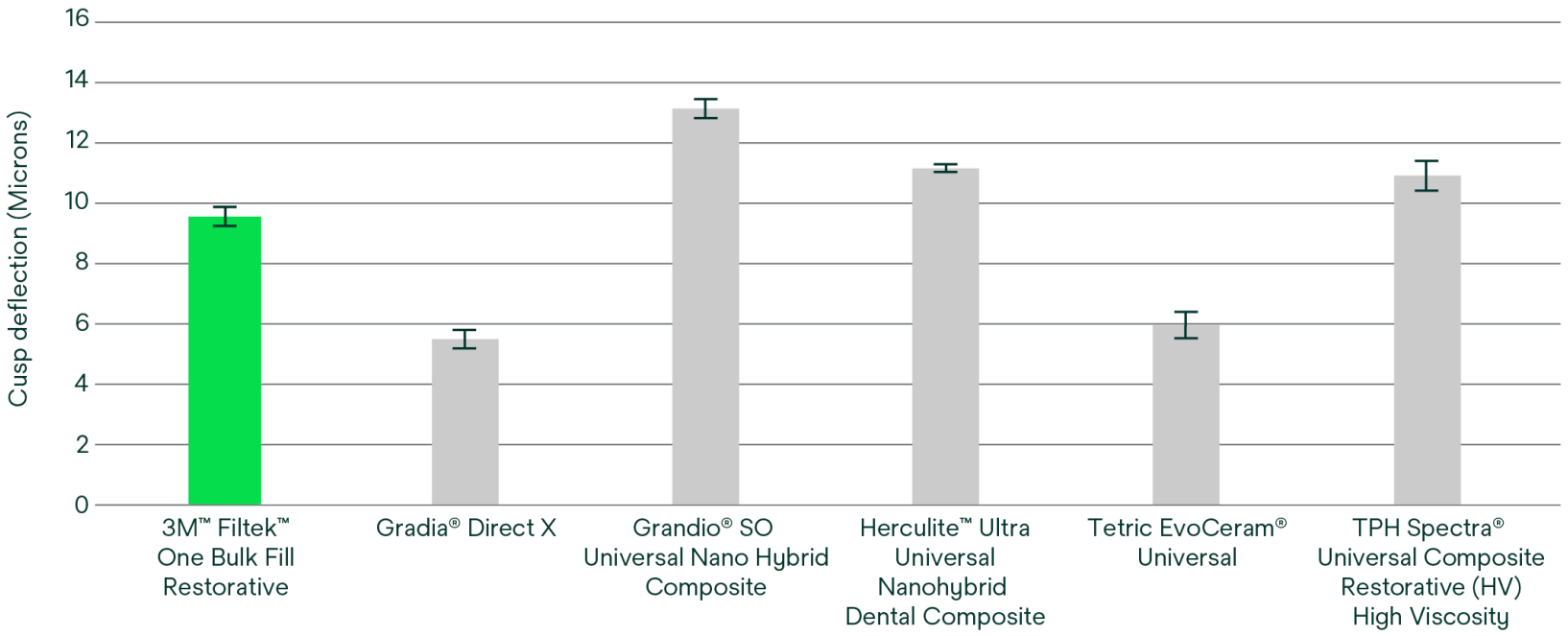
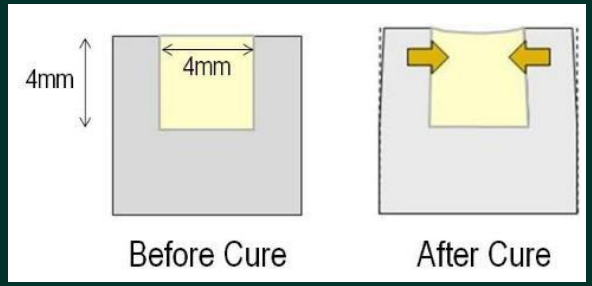
Polymerization stress

Comparison of common universal composites



Source: Solventum Internal Data

3M™ Filtek™ One Bulk Fill Restorative has similar polymerization stress when placed in bulk compared to many of the universal materials that are placed in increments.



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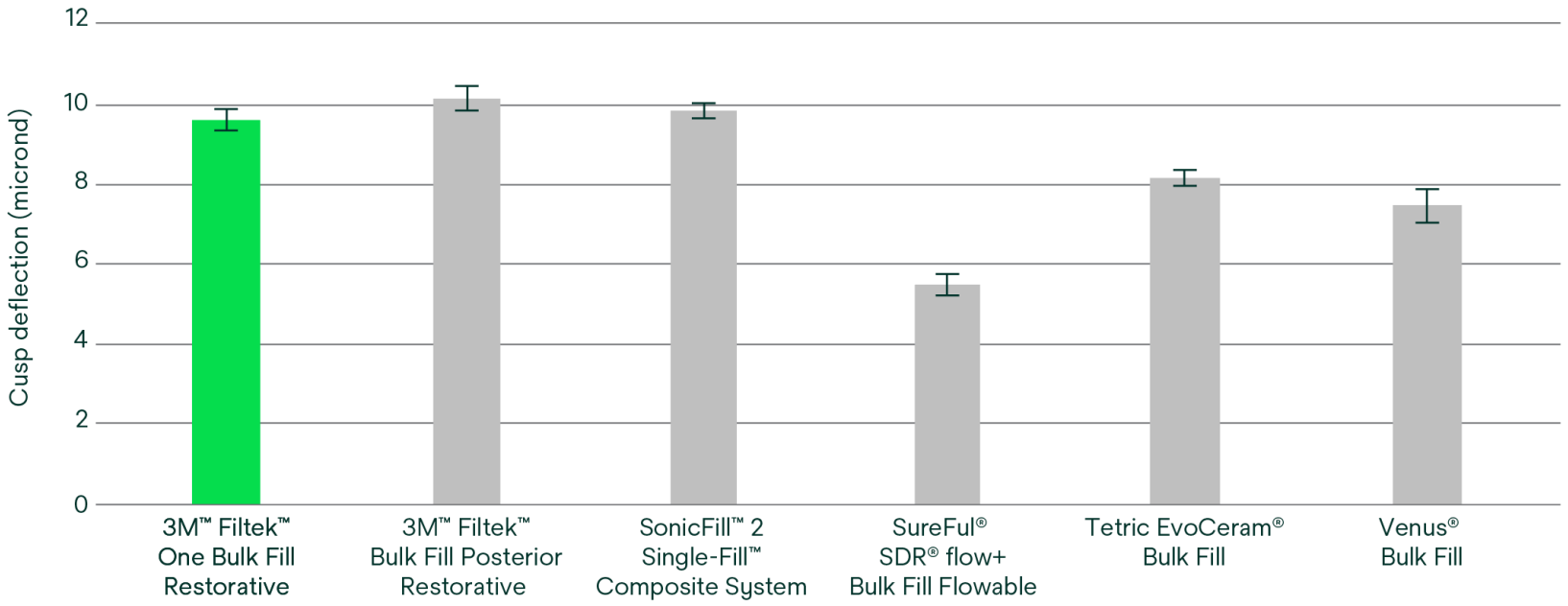
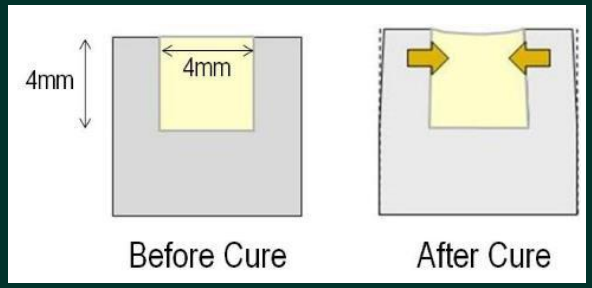
Polymerization stress

Comparison of common bulk fill composites



Source: Solventum Internal Data

3M™ Filtek™ One Bulk Fill Restorative has similar polymerization stress compared to 3M™ Filtek™ Bulk Fill Posterior Restorative and SonicFill™ 2.



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