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Lecture 1-Principles of Tooth Preparations

By Dr Cheryl Fu

Expected Reading:

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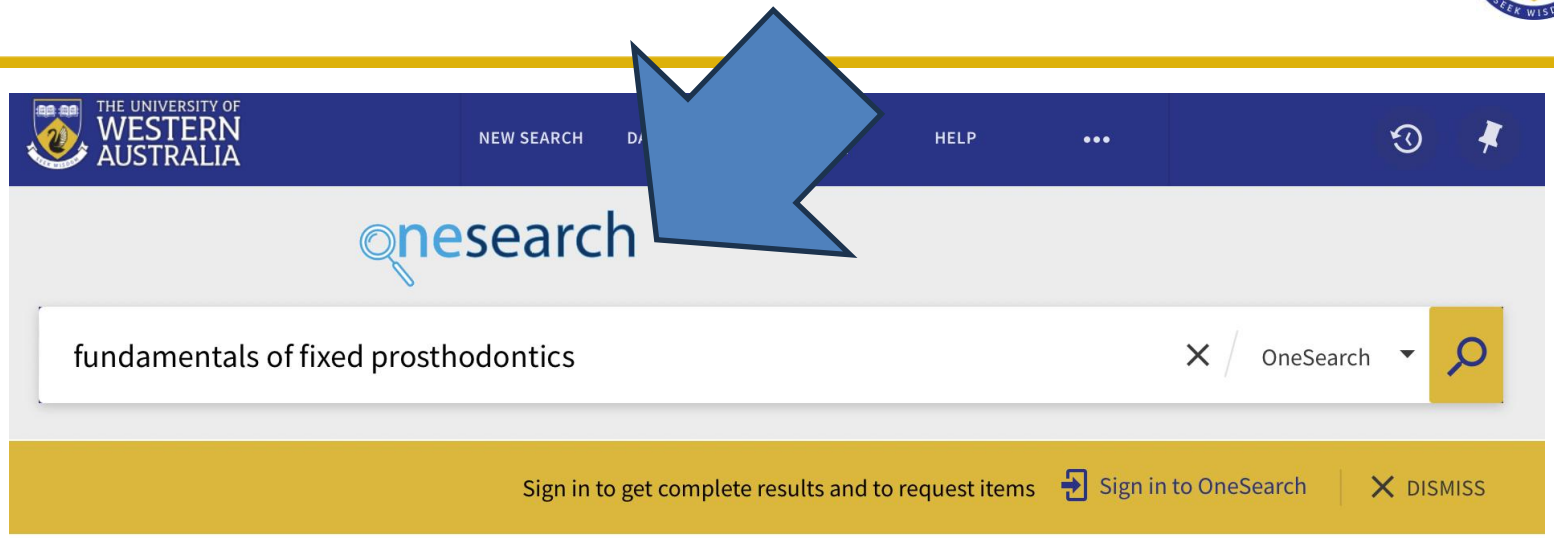
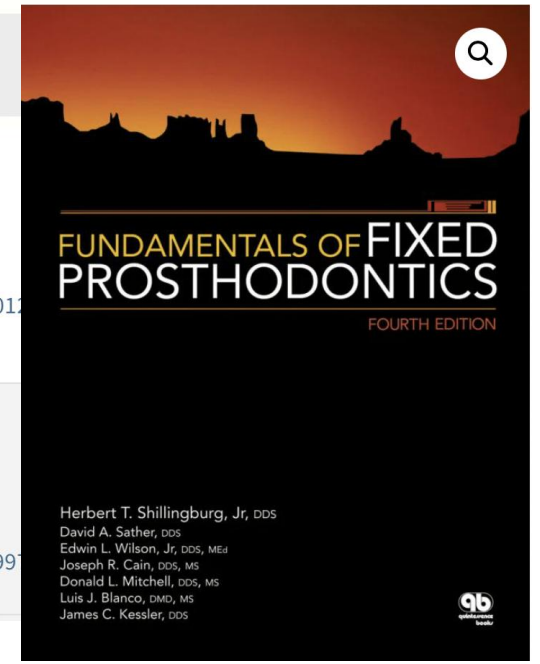


THE READING WILL BE EXAMINABLE CONTENT!



Learning Outcomes:

- Understand basic terminology for crown preparations
- Understand indications of crowns
- Understand the importance of the mechanical, biological, and aesthetic principles of tooth preparation

Reading for this lecture:

Fundamentals of Fixed Prosthodontics: Chapter 9 Principles of Tooth Preparations

Contemporary of Fixed Prosthodontics: Chapter 7 Principles of Tooth Preparations

Why Does a Tooth Need a Crown?

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As part of DMD1 you have learnt about:

- Composite restorations
- GIC restorations
- Amalgam restorations

So why do we need crown?

Considerations for a crown:

- Destruction of tooth structure
- Aesthetics
- Plaque Control/Moisture Control
- Retention
- Finance*
- Other prosthodontic treatment (survey crowns for RPDs)

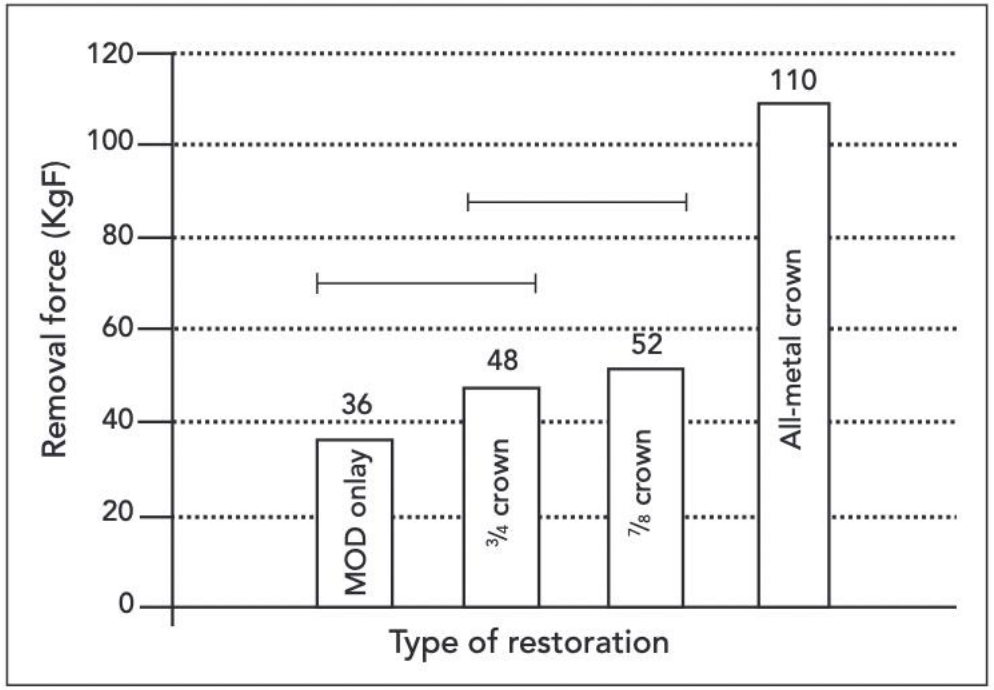

Fig 6-1 A comparison of resistance to removal forces for four types of crowns ($P = .05$).[1,2] MOD, mesio-occlusodistal.

Why Does a Tooth Need a Crown?

Considerations for a crown:

- **Destruction of tooth structure**
- Aesthetics
- Longevity
- **Retention**

Figure 3a.

Figure 3b.

Figure 3. Patients abusing methamphetamine often present with rampant caries. *(Photos courtesy of Dr. Jinus Emrani)*

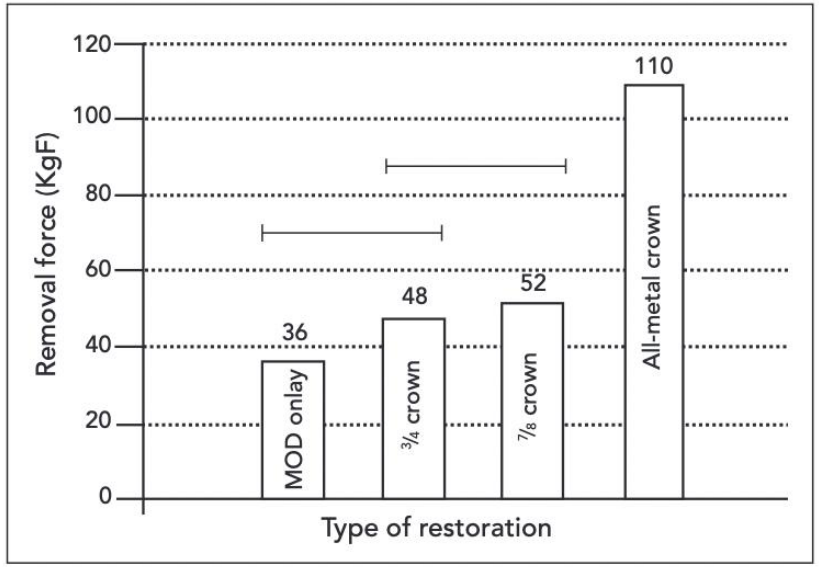

Fig 6-1 A comparison of resistance to removal forces for four types of crowns ($P = .05$).[1,2] MOD, mesio-occlusodistal.

Fundamental of Fixed Prosthodontics

Terry E. Donovan (2006) Longevity of the Tooth/Restoration Complex: A Review

Why Does a Tooth Need a Crown?

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Considerations for a crown:

- Destruction of tooth structure
- **Aesthetics**
- Plaque Control/Moisture Control
- Retention

Incidence and influential factors in pulp necrosis and periapical pathosis following indirect restorations: a systematic review and meta-analysis

Kholod Khalil Al-Manei[1], Shuruq Alzaidi[2], Ghadah Almalki[2], Khaled Al-Manei[1,3*] and Nabeel Almotairy[4]

Results A total of 5,814 studies were identified, of which 37 were included in the meta-analysis. The overall incidences of pulp necrosis and periapical pathosis following indirect restorations were determined to be 5.02% and 3.63%, respectively. All studies were assessed as having a moderate-low risk of bias. The incidence of pulp necrosis following indirect restorations increased when the pulp status was objectively assessed (thermal/electrical testing). The presence of pre-operative caries or restorations, treatment of anterior teeth, temporization for more than two weeks, and cementation with eugenol-free temporary cement, all increased this incidence. Final impression with polyether and permanent cementation with glass ionomer cement both increased the incidence of pulp necrosis. Longer follow-up periods (> 10 years) and treatment provided by undergraduate students or general practitioners were also factors that increased this incidence. On the other hand, the incidence of periapical pathosis increased when teeth were restored with fixed partial dentures, the bone level was < 35%, and the follow-up was > 10 years. The certainty of the evidence overall was assessed as low.

Conclusions Although the incidences of pulp necrosis and periapical pathosis following indirect restorations remain low, many factors affect these incidences that should thus be considered when planning indirect restorations on vital teeth.

Why Does a Tooth Need a Crown?

Considerations for a crown:

- Destruction of tooth structure
- **Aesthetics**
- Longevity
- Retention

Photo by tetracycline staining by Dr. Alessandro Martini

Song MY, Park JM, Park EJ. Full mouth rehabilitation of the patient with severely worn dentition: a case report.

Why Does a Tooth Need a Crown?

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Considerations for a crown:

- Destruction of tooth structure
- Aesthetics
- **Longevity**
- Retention

Some studies report a lower annual failure rate in indirect restorations (ceramic restorations 1.9%) compared to direct (composite 2.2%, amalgam 3%) restorations.
The predominant mode of failure of ceramic restorations is bulk fracture.
The predominant mode of failure for composite restorations were reported to be marginal breakdown (secondary caries or deterioration) or fracture.

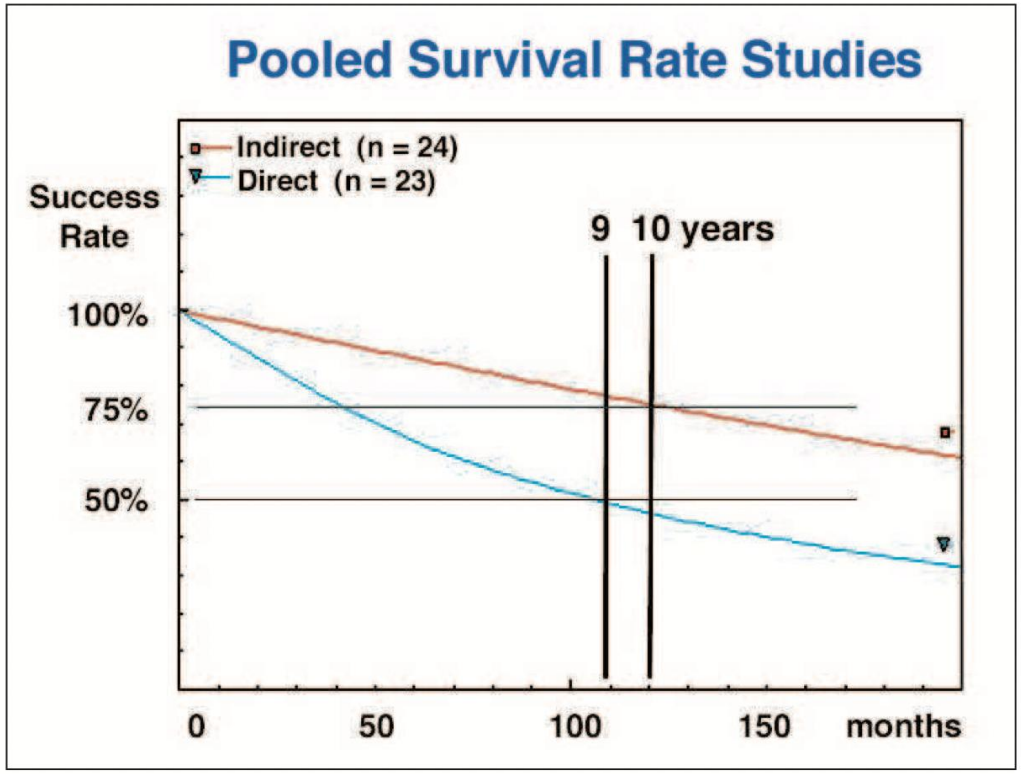

Figure 2. *Comparison of the published survival curves of direct restorations (amalgam and composite) vs indirect adhesive inlays with the 2-parameter fit.*

Manhart J, Chen HY, Hamm G, Hickel R. Review of the clinical survival of direct and indirect restorations in posterior teeth of the permanent dentition.

In summary:

- If correctly used, indirect restorations may be superior to direct restorations in terms of mechanical properties and longevity
- HOWEVER: it is more technically demanding for the clinician, and financially expensive for the patient. ($400 vs $1500+).

- Always keep in mind the balance between the pros vs cons
- Is this the best option for the patient?
- Have you carefully considered all aspects of the clinical scenario/patient's details?
- If the patient was a family member, would you still recommend the same treatment?

In summary:

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CLINICAL PROCEDURES

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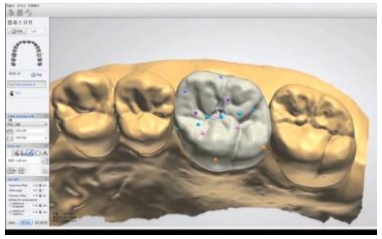
Clinical examination → Primary Impression

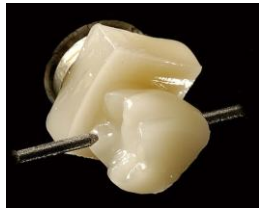
→ Tooth preparation + Temporisation

→ Definitive Impression

→ Intraoral scanning → CAD All-ceramic



→ Milling



→ Try-in

→ Cementation

→ Review

Try-in → Casting and veneering

Wax up (gold crown, PFM)

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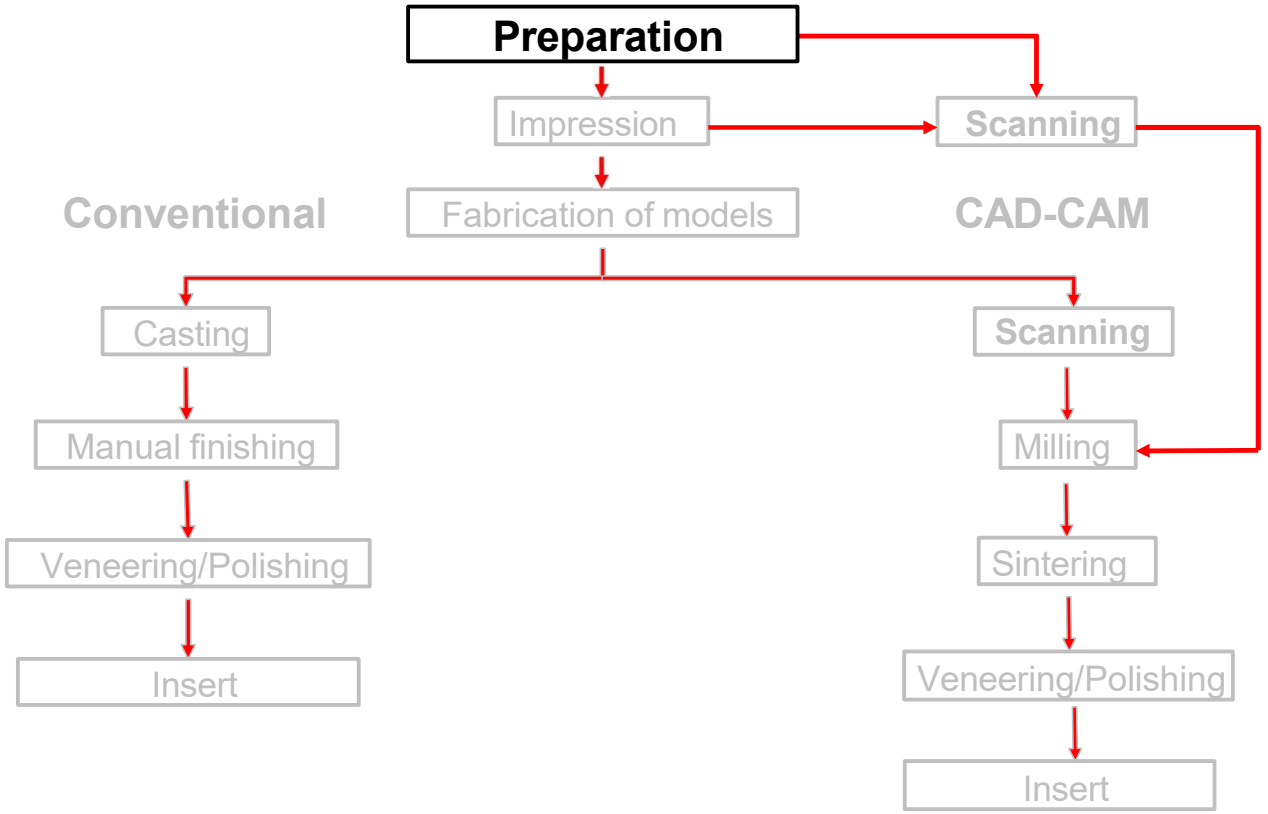

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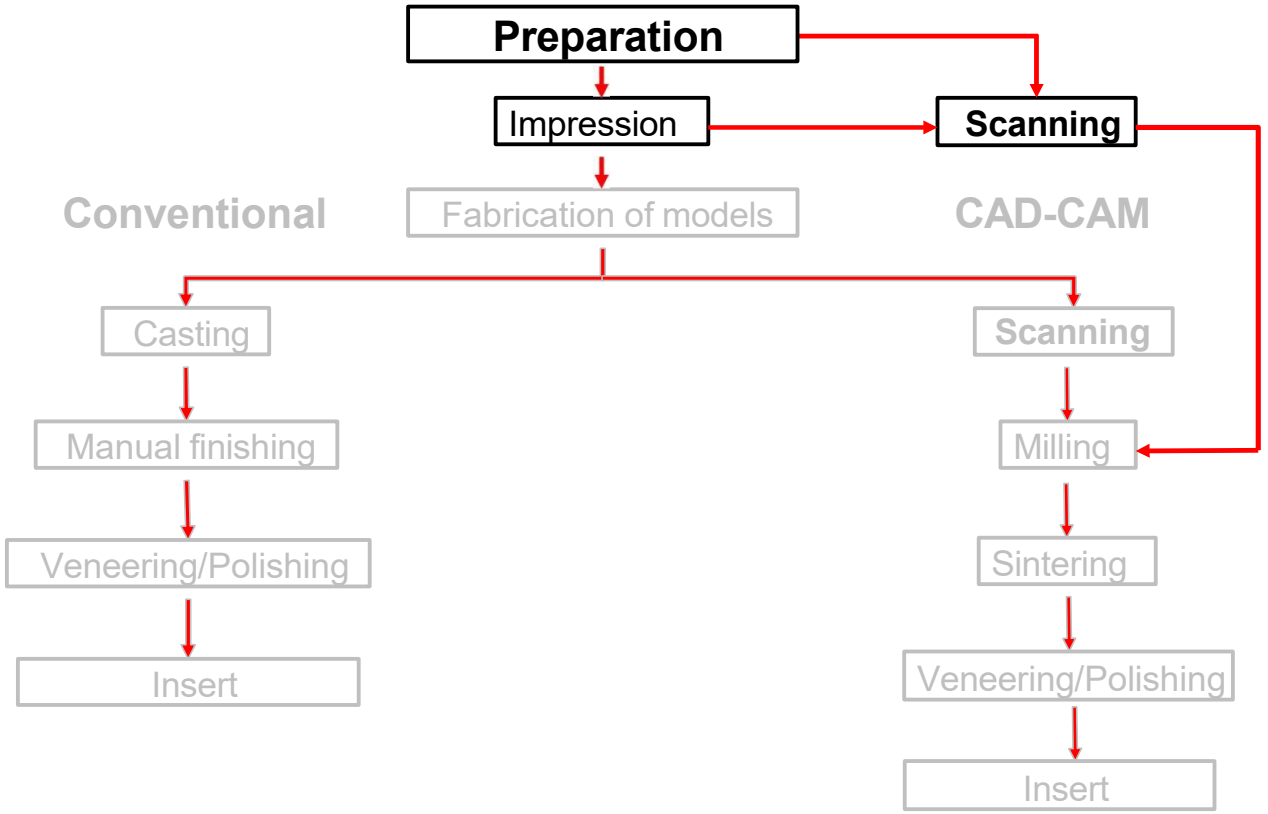

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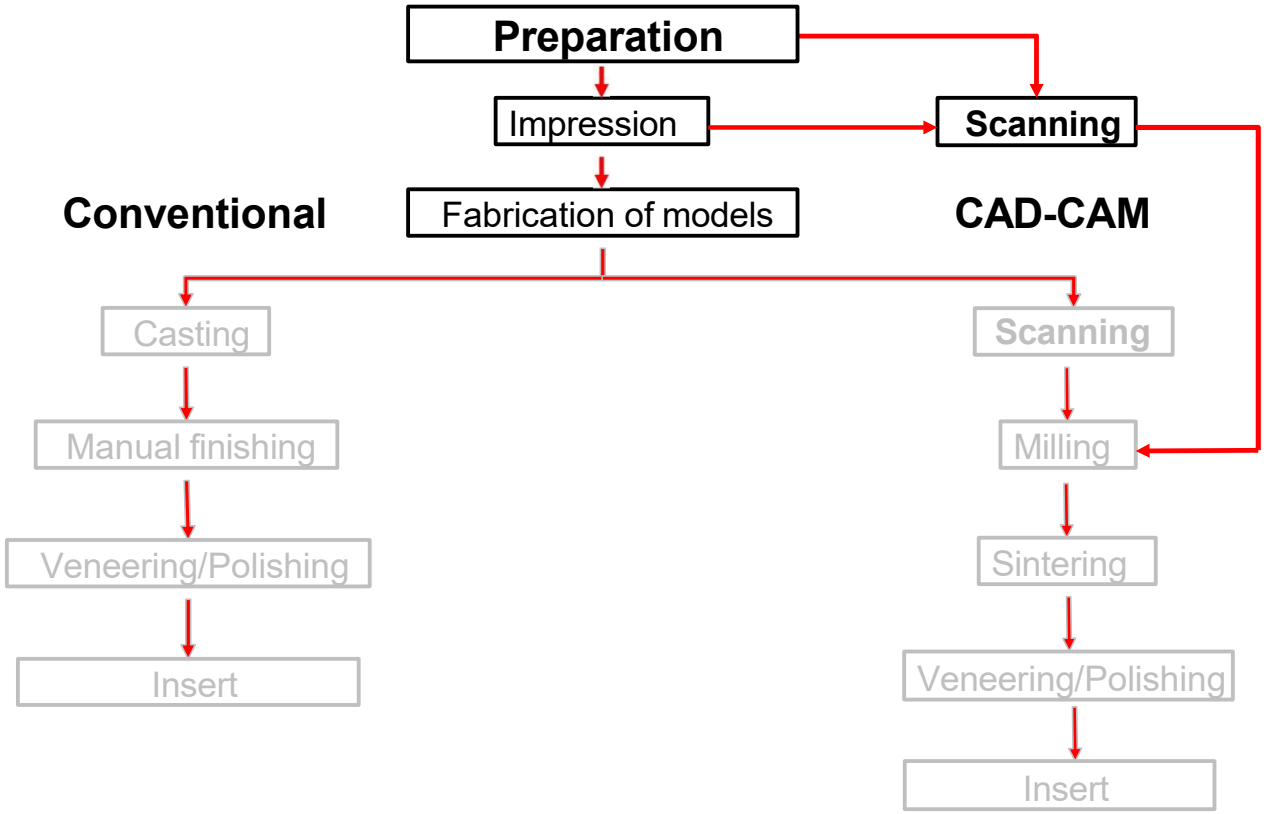

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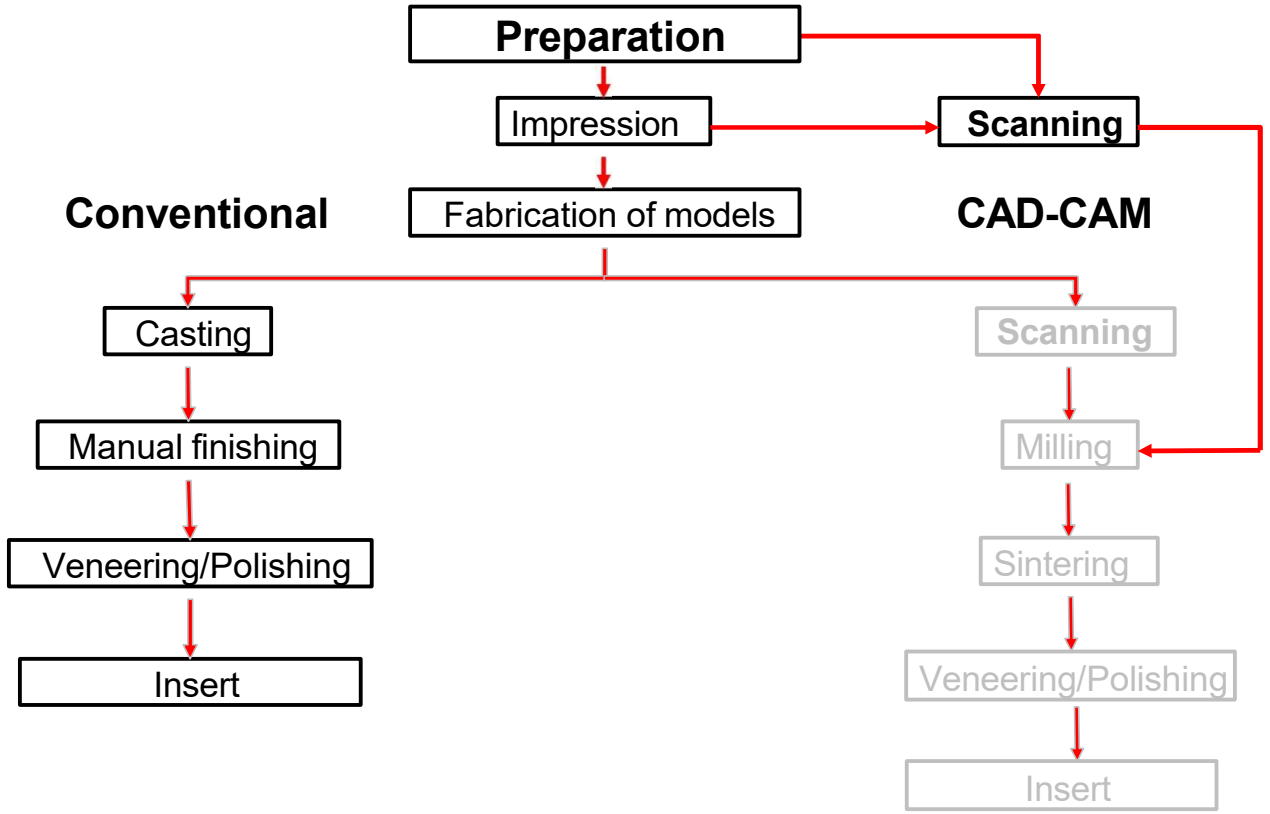

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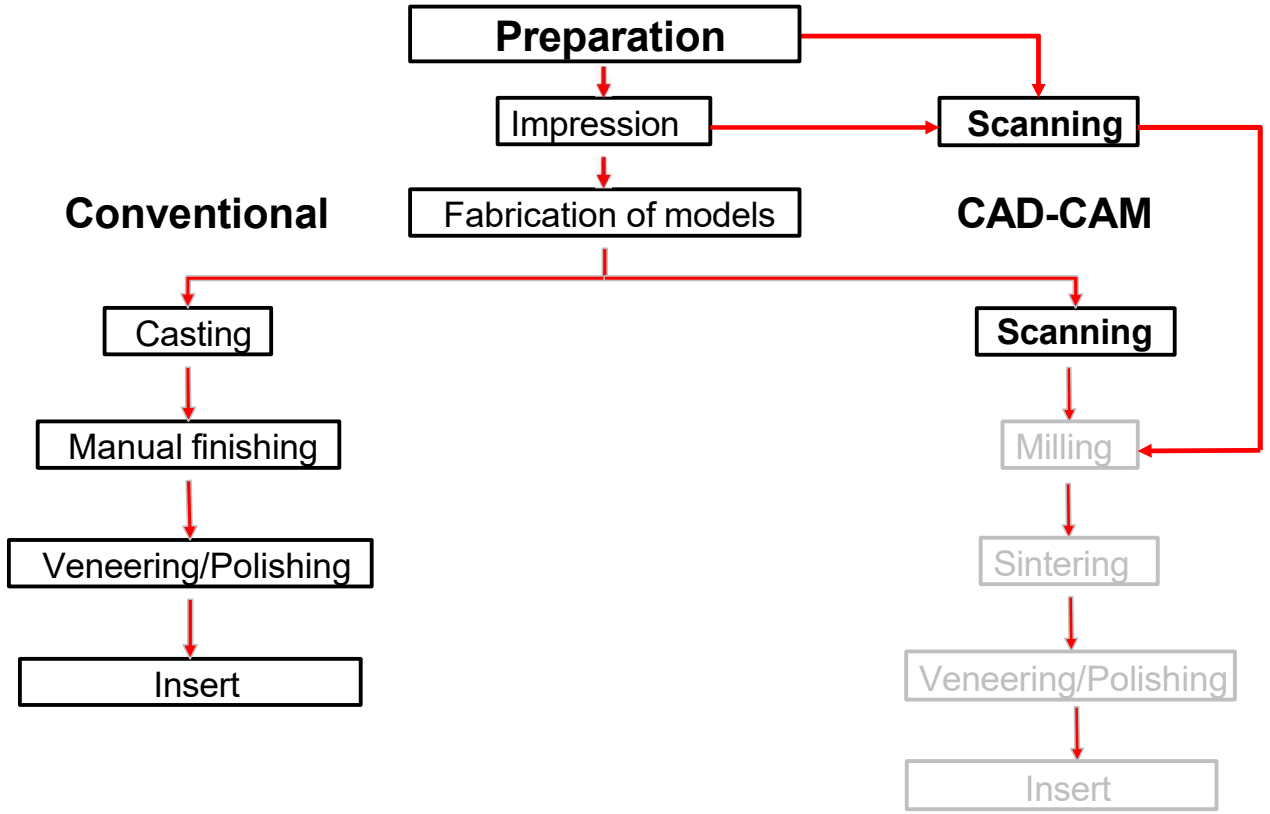

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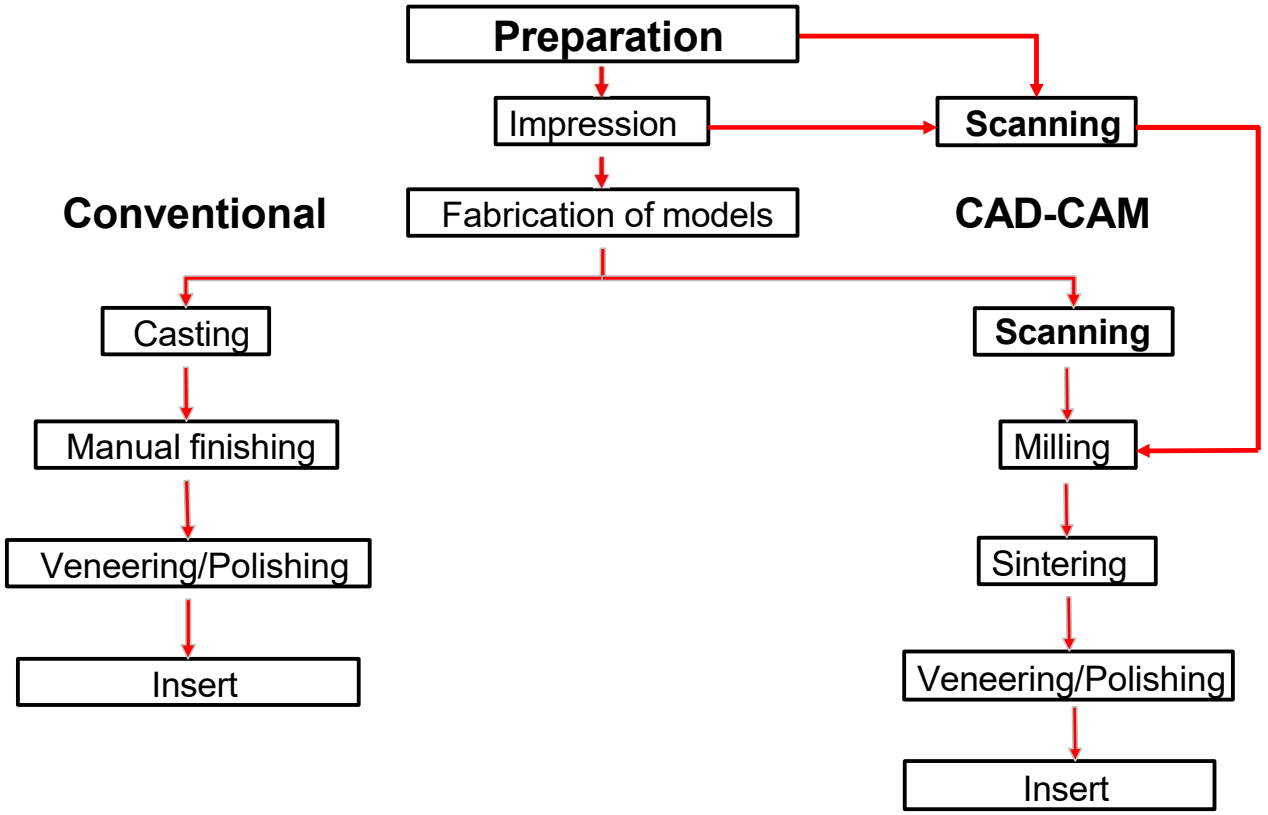
Workflow



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Crown Preparation Terminology

FIGURE 8-25 ■ The completed preparation is characterized by a smooth, even chamfer margin; a 6-degree taper; and gradual transitions between all prepared surfaces.

Contemporary Fixed Prosthodontics

Crowns

Materials:

- All ceramic
  - Zirconia or Glassy Ceramics (eg Lithium Sillicate or Lithium Disillicate)
- Metal
  - Varying alloys
- Porcelain Fused to Metal (PFM)

Each material may require different preparations.

Crown Preparation Terminology

Margins:

- Supra-gingival of subgingival
- Types of margins
  - Feather edge
  - Bevel
  - Chamfer
  - Shoulder
  - Shoulder with bevel

Supragingival Margins

- Easily prepared
- Easier to take impressions
- Easily maintained by patient
- Easily evaluated at recalls
- Preserve periodontium

Subgingival Margins

Indications

- Subgingival dental caries, erosion, fracture line or restoration
- Additional retention is needed
- Aesthetic margins
- Coverage of root surface
- Modification of axial contour

Margins

Margins:

- Supra-gingival of subgingival
- Types of margins
  - Feather edge
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  - Chamfer
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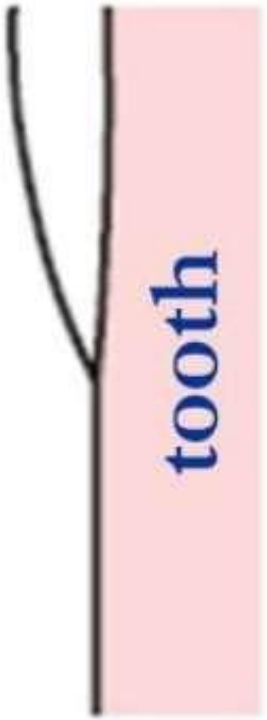

Advantages:

- Conservation of tooth structure

Disadvantages:

- Fail to provide adequate bulk at margins

CONTRA-INDICATED IN MOST CASES!

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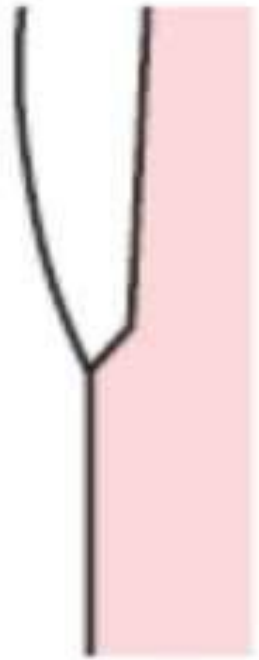
Margins

Margins:

- Supra-gingival of subgingival
- Types of margins
  - Feather edge
  - Bevel
  - Chamfer
  - Shoulder
  - Shoulder with bevel



Commonly for cast restorations

Advantages:

- Allow the margin of the crown to be burnished against tooth structure
- Protect the unprepared tooth structure from chipping by removing unsupported enamel
- May reduce marginal discrepancy when complete crown fails to seat completely. (But doesn't work for oversized crown)

Disadvantages:

- Can lead to subgingival extension

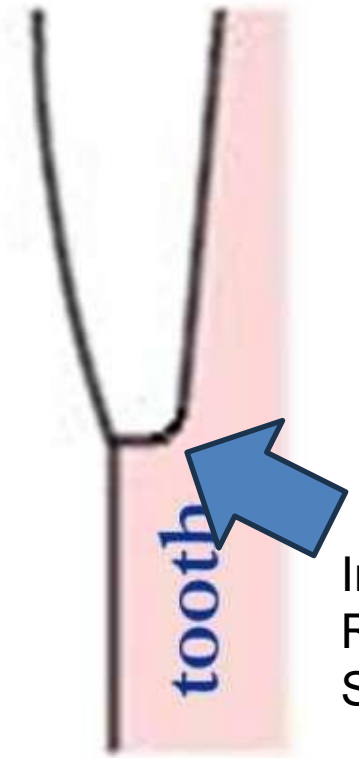
Slide by Dr Nedelcu

Margins

Margins:

- Supra-gingival of subgingival
- Types of margins
  - Feather edge
  - Bevel
  - Chamfer
  - Shoulder
  - Shoulder with bevel

Can be used for all materials.



Advantages:

- Easy to prepare and finish well
- Easy to judge on impressions

Disadvantages:

- More aggressive preparation

Internal angle is ROUNDED NOT SHARP 90 degrees.

Slide by Dr Nedelcu

Margins

Margins:

- Supra-gingival of subgingival
- Types of margins
  - Feather edge
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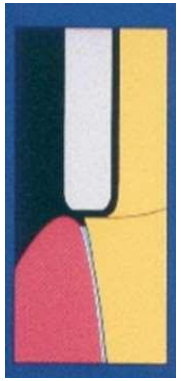
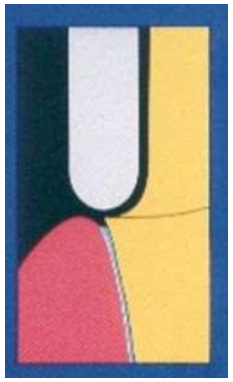


Shoulder



Chamfer

Advantages:

- Conserves tooth structure whilst providing distinct finish lines
- Easy to read in impressions

Commonly used for metal, or ceramic crowns

Use a tapered diamond bur with round tip!

Slide by Dr Nedelcu

Margins

Margins:

- Supra-gingival of subgingival
- Types of margins
  - Feather edge
  - Bevel
  - Chamfer
  - Shoulder
  - Shoulder with bevel

Sometimes used for PFM crowns with a metal labial margin (hidden in the sulcus). But a shoulder/chamber is preferred for biologic and aesthetic considerations

Uncommonly used.

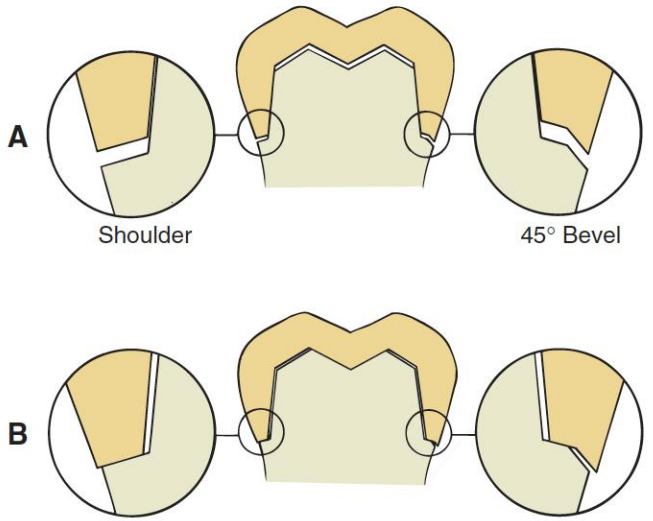
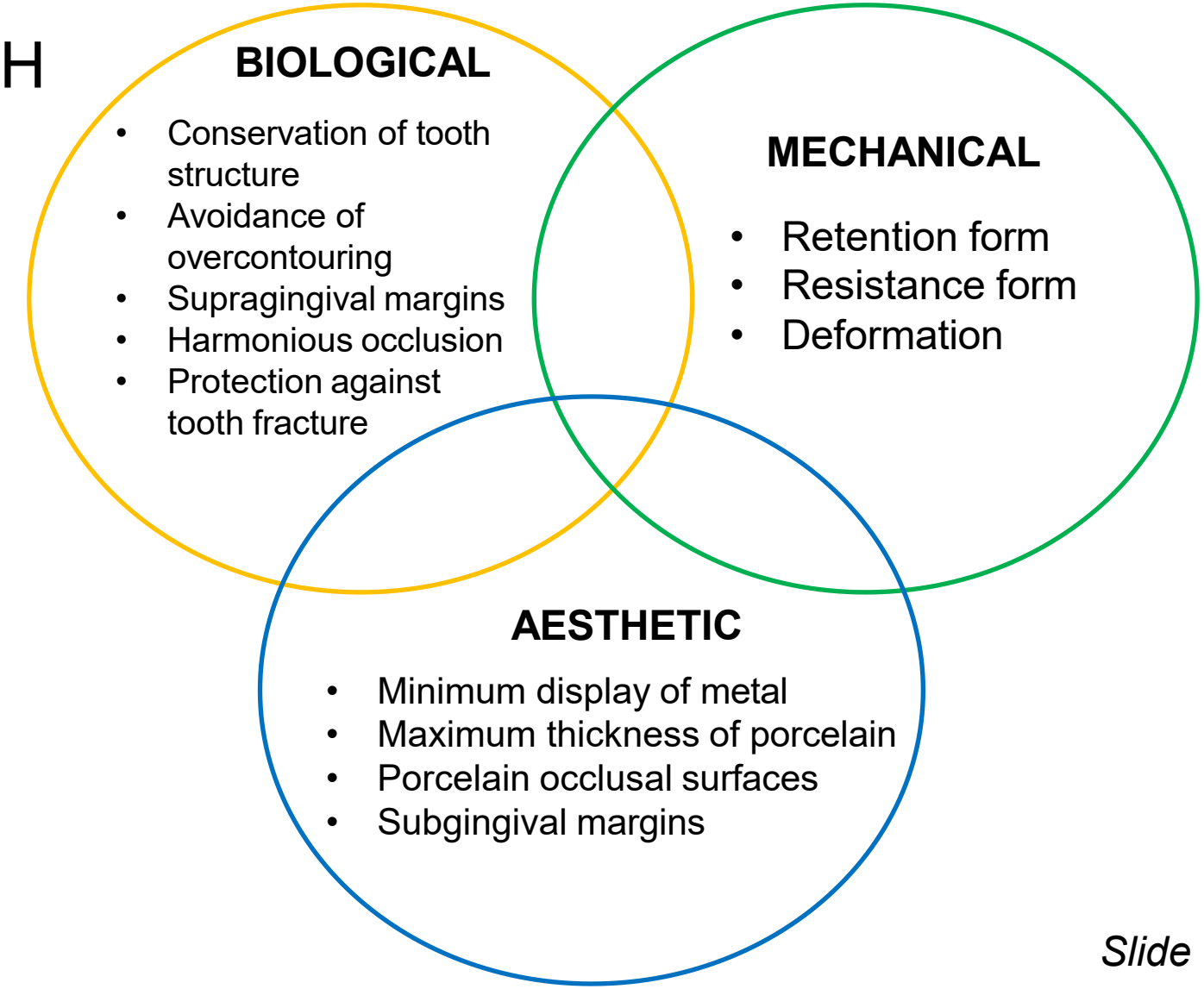


FIGURE 7-25 ■ Effect on marginal fit of beveling the gingival margin. **A,** If the internal cross section of a crown is the same as or less than that of the prepared tooth, a 45-degree bevel decreases the marginal discrepancy by 70%. **B,** If the internal diameter is slightly larger than the prepared tooth, beveling increases the marginal discrepancy. In practice, crowns are made slightly larger than the prepared tooth to allow for the luting agent.

Principles of Tooth Preparations

ABUTMENT TOOTH

- Principles of tooth preparation
- Partial or complete preparation



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Principles of Tooth Preparations

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ABUTMENT TOOTH

- Principles of tooth preparation
- Partial or complete preparation

BIOLOGICAL

- Conservation of tooth structure
- Avoidance of overcontouring
- Supragingival margins
- Harmonious occlusion
- Protection against tooth fracture

MECHANICAL

- Retention form
- Resistance form
- Deformation

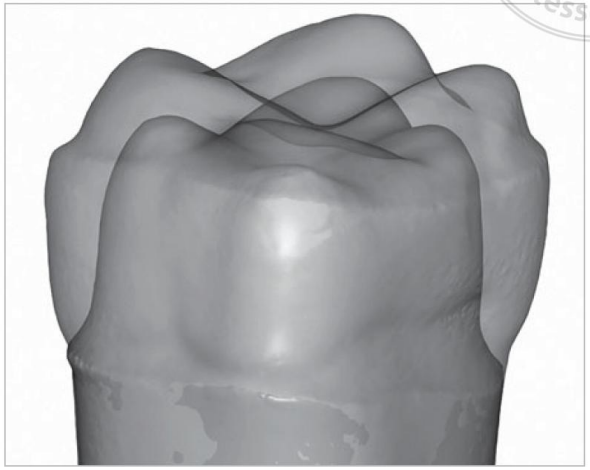

Fig 1 Approximately 70% of the volume of the clinical crown of a posterior tooth is removed for a full-crown preparation (internal contour), whereas only about 30% is lost for an occlusal onlay, unless more tissue has already been lost (see Fig 3b).

Occlusal onlays as a modern treatment concept for the reconstruction of severely worn occlusal surfaces

Article *in* Quintessence international (Berlin, Germany: 1985) · January 2018

DOI: 10.3290/j.qi.a40482

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Principles of Tooth Preparations

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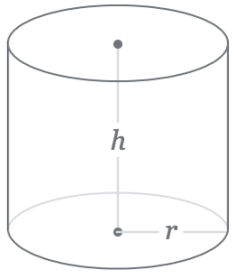
Solve for
volume

$V \approx 785.4$

r Radius 5

h Height 10



Solution

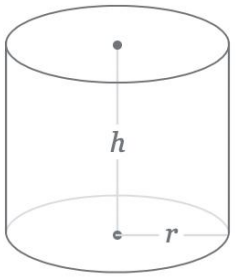
$V = \pi r^2 h = \pi \cdot 5^2 \cdot 10 \approx 785.39816$

Solve for
volume

$V \approx 402.12$

r Radius 4

h Height 8



Solution

$V = \pi r^2 h = \pi \cdot 4^2 \cdot 8 \approx 402.12386$

$$V = \pi r^2 h$$

Obvious limitations for this model such as tooth is not a cylinder shape, and tooth has a pulp chamber resulting in this simplified model giving us an underestimate.

This represents almost 50% decrease in volume!! Even worse if you include a pulp chamber space!

Principles of Tooth Preparations

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- Partial or complete preparation

BIOLOGICAL

- Conservation of tooth structure
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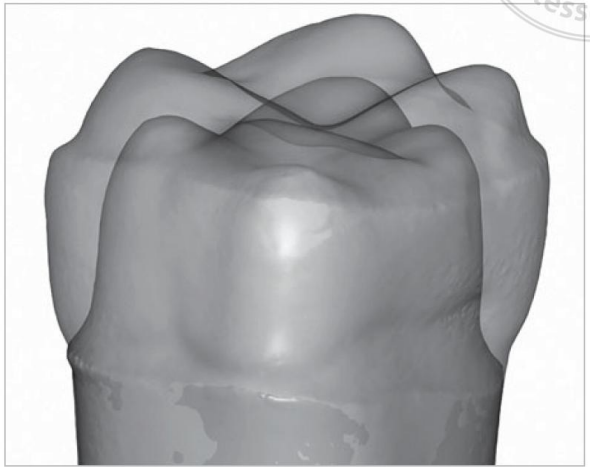
- Supragingival margins
- Harmonious occlusion
- Protection against tooth fracture

MECHANICAL

- Retention form
- Resistance form
- Deformation



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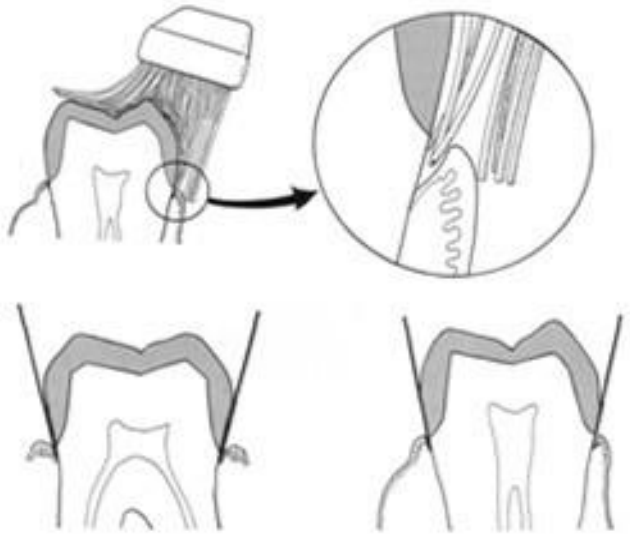


BIOLOGICAL

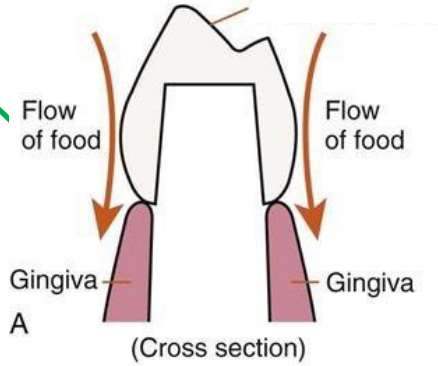
- Conservation of tooth structure
- Avoidance of overcontouring
- Supragingival margins
- Harmonious occlusion
- Protection against tooth fracture

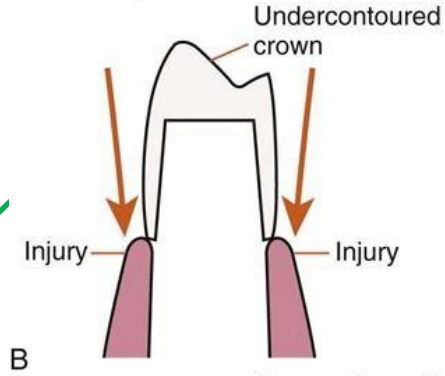
MECHANICAL

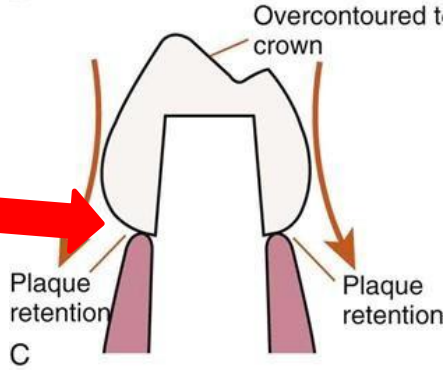
- Retention form
- Resistance form
- Deformation

AESTHETIC

- Minimum display of metal
- Maximum thickness of porcelain
- Porcelain occlusal surfaces
- Subgingival margins







Patient can't clean this!

Principles of Tooth Preparations

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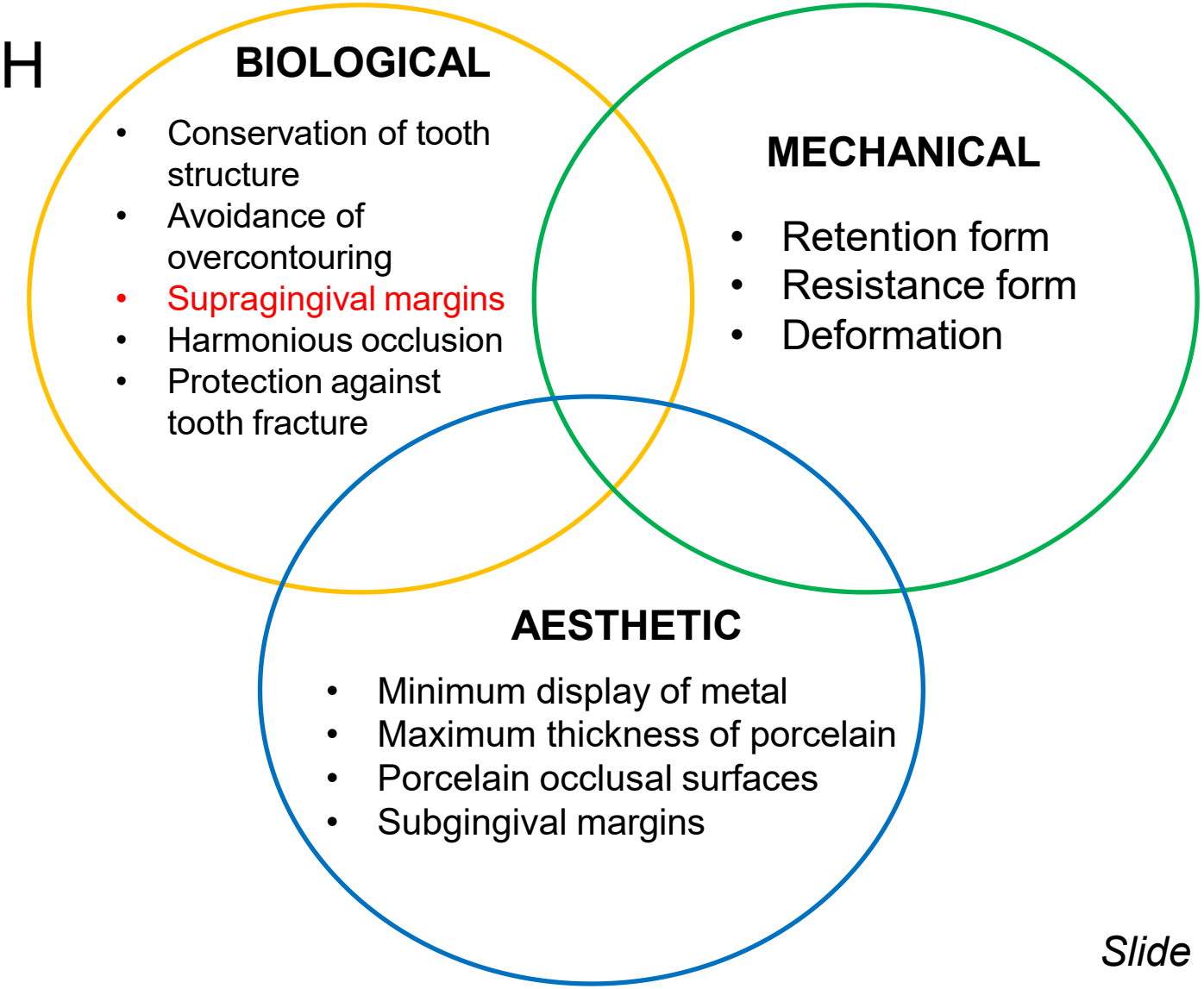

Slide by Dr Matsubara

Principles of Tooth Preparations

Sub-gingival preparation- aesthetic, BUT…..

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Principles of Tooth Preparations

We risk violation of **biologic width!** KNOW THIS WORD!

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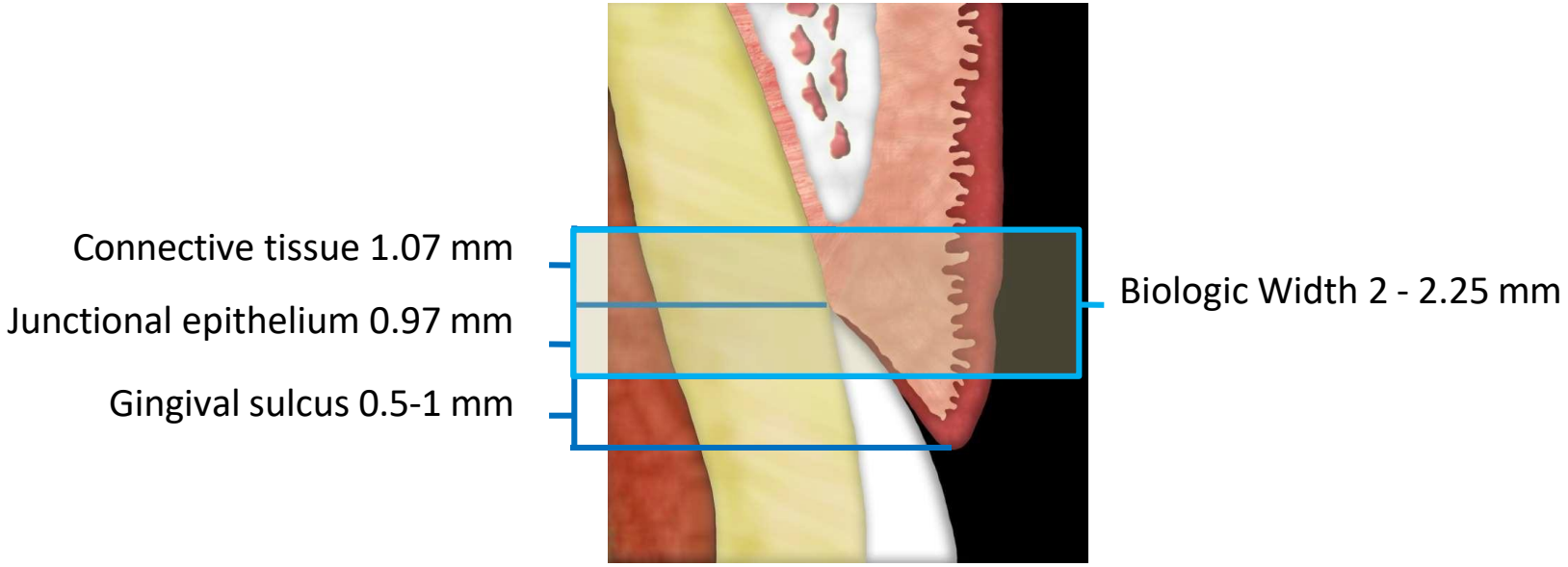
Principles of Tooth Preparations



Margin location

- ► If the margins has to be subgingival it should only be placed intracrevicularly
- ► Maximum depth around 0.7mm

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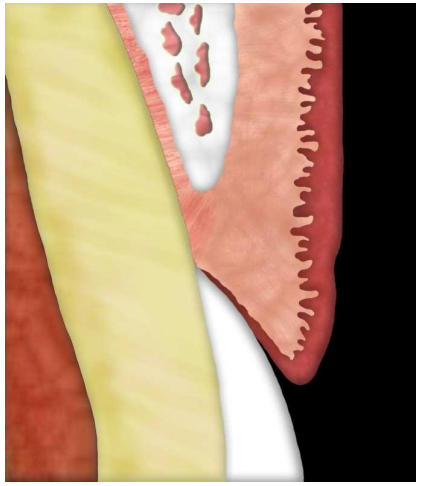
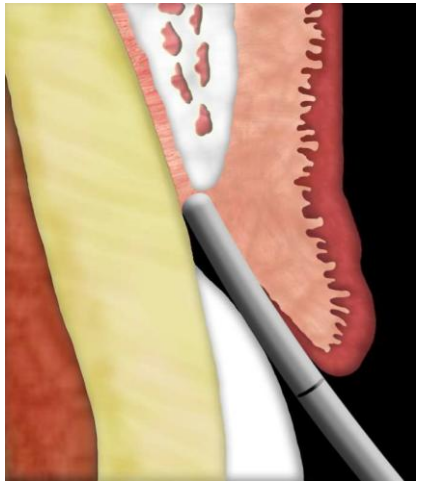
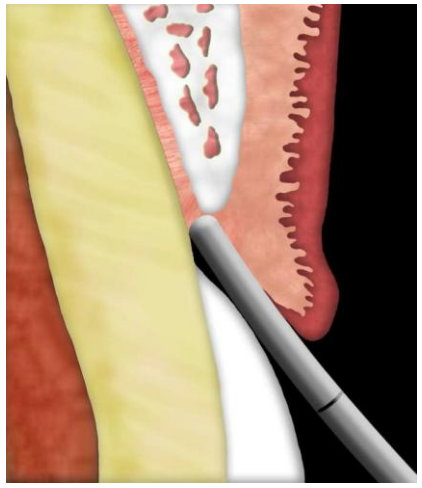
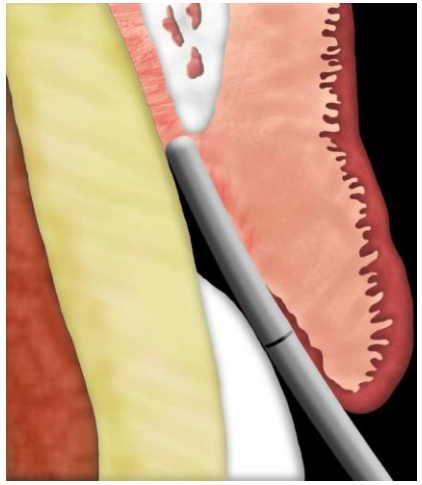
Principles of Tooth Preparations









Normal Crest
3 mm (4 approx)

High Crest
< 3 mm (4 approx)

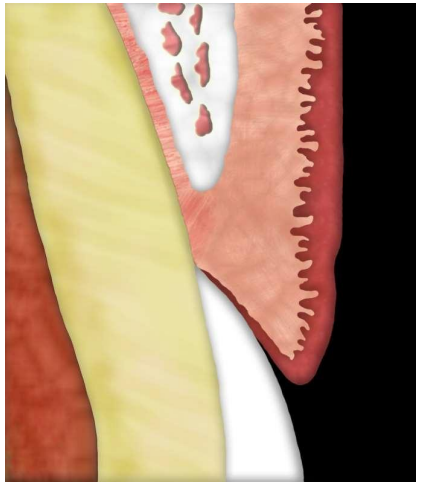
Low Crest
> 3 mm (4 approx)

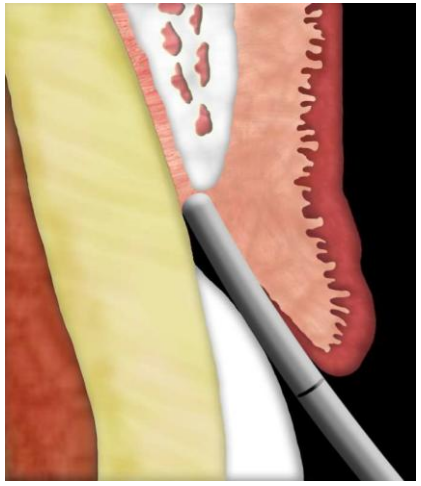
Take Home Message: If you place a margin within 2mm of the crestal bone you will get inflammation, followed by bone loss as the biological width tries to re-establish itself

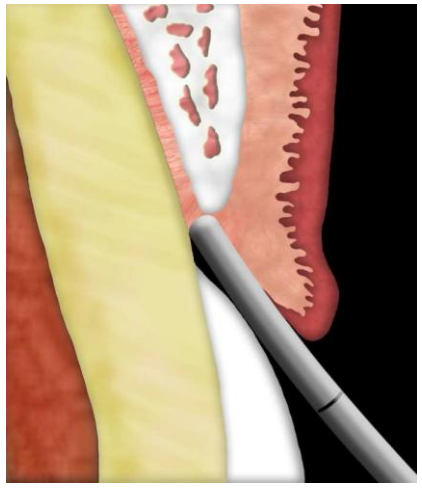
Slide by Dr Matsubara

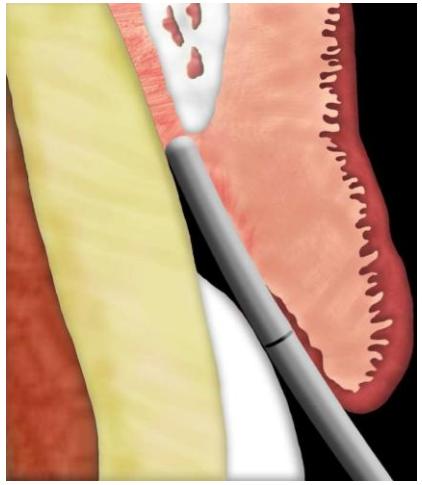
Want to know more about biologic width? Read:
Mulla SA, Patil A, Mali S, Jain A, Sharma D, Jaiswal HC, Saoji HA, Jakhar A, Talekar S, Singh S. Exploring the Biological Width in Dentistry: A Comprehensive Narrative Review. Cureus. 2023 Jul 18;15(7).

Principles of Tooth Preparations









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Principles of Tooth Preparations

The margins of the restoration can be positioned 0.5 mm below the gingival tissue crest if the probing depth of the sulcus is 1.5 mm or less. If the sulcus depth is more than 1.5mm, then the margins of the restoration should be inserted in the sulcus at a depth that is half its probing depth. Lastly, a gingivectomy may be enacted to extend the tooth and design a 1.5 mm sulcus if the probing depth of the sulcus is greater than 2 mm.

Take Home Message: If you place a margin within 2mm of the crestal bone you will get inflammation, followed by bone loss as the biological width tries to re-establish itself

Principles of Tooth Preparations

We risk violation of **biologic width!** KNOW THIS WORD!

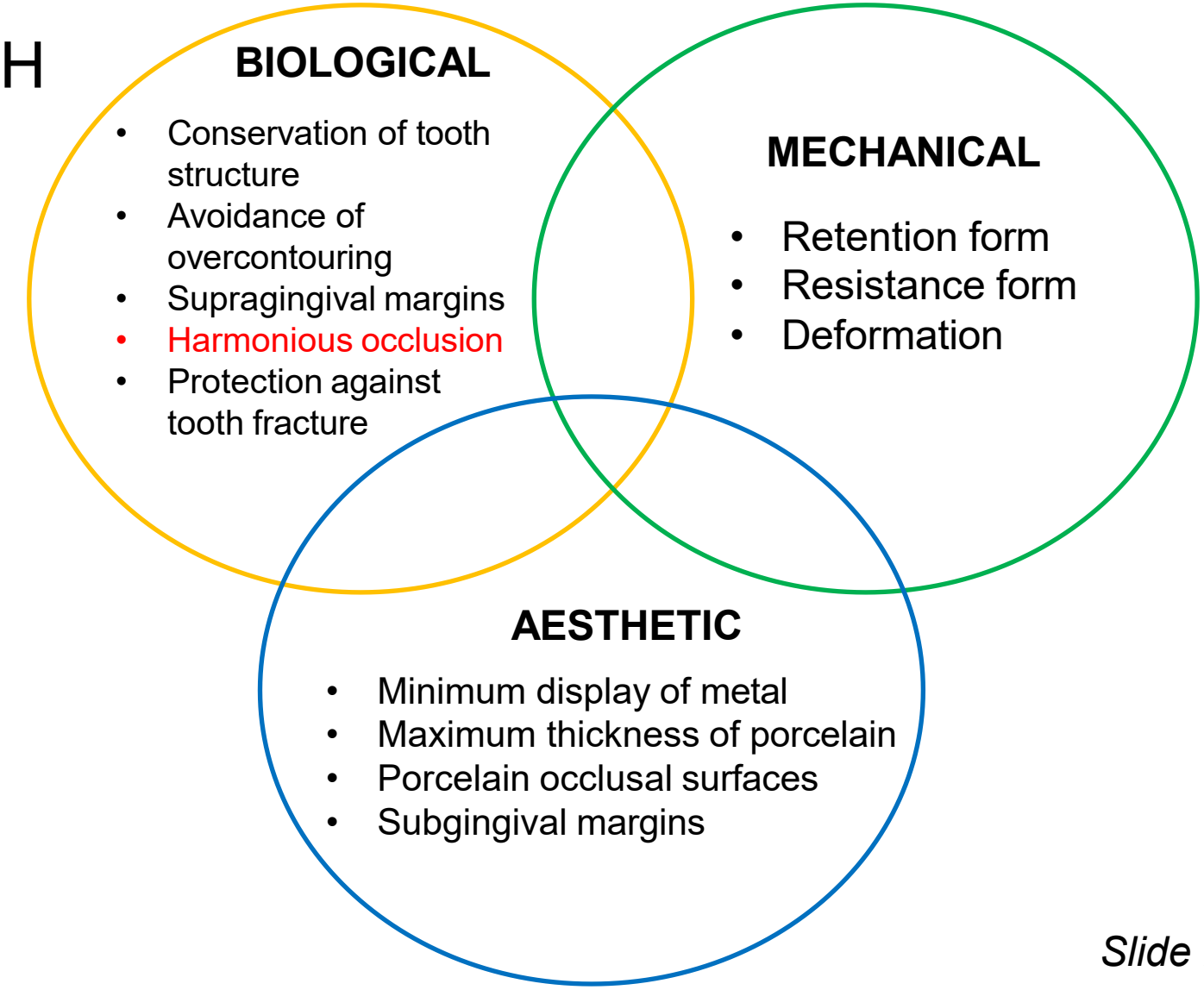
Take Home Message: If you place a margin within 2mm of the crestal bone you will get inflammation
Followed by bone loss as the biological width tries to re-establish itself

Slide by Dr Matsubara

Principles of Tooth Preparations

ABUTMENT TOOTH

- Principles of tooth preparation
- Partial or complete preparation



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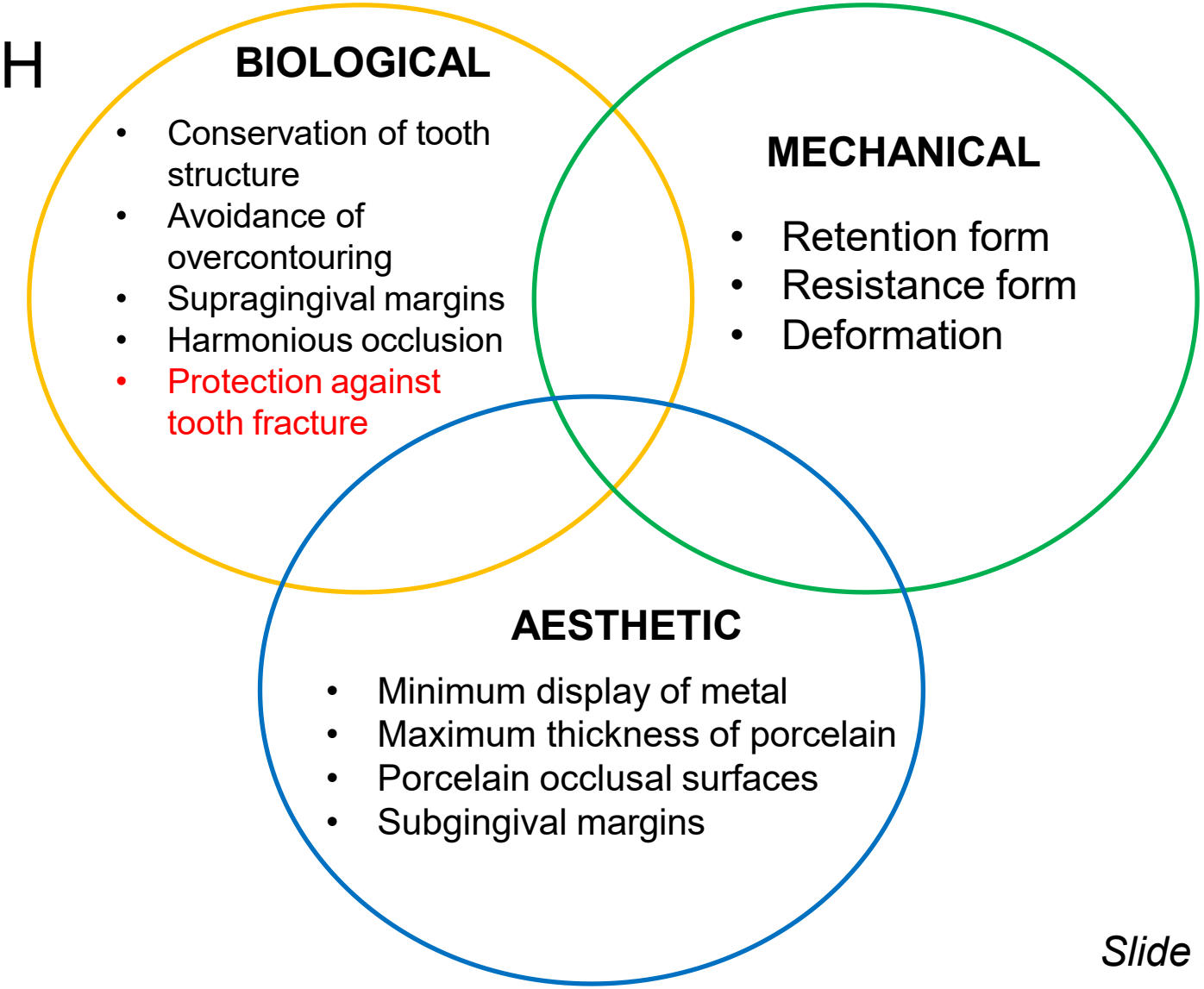

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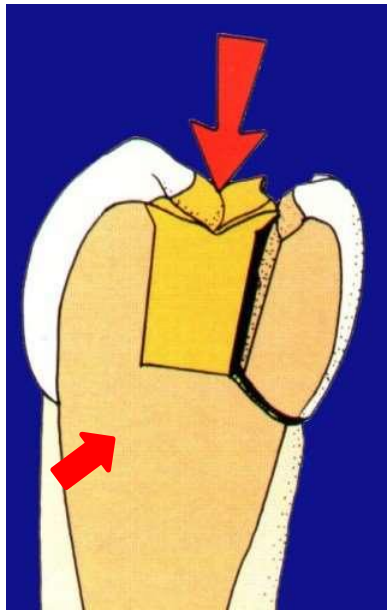
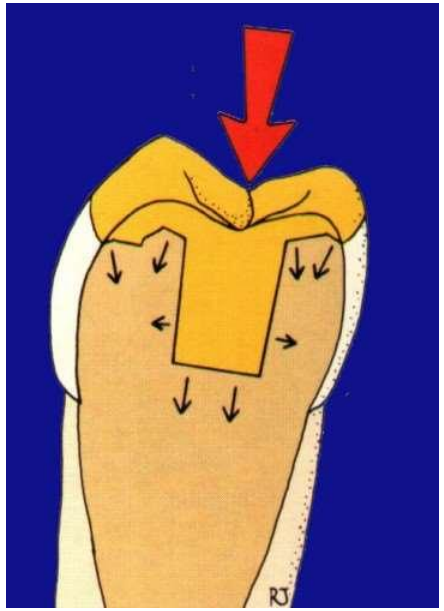
Principles of Tooth Preparations

Cuspal Protection: Coverage of one or more cusps by a indirect or direct restorative material.



Fracture/Uncontrollable tooth structure loss

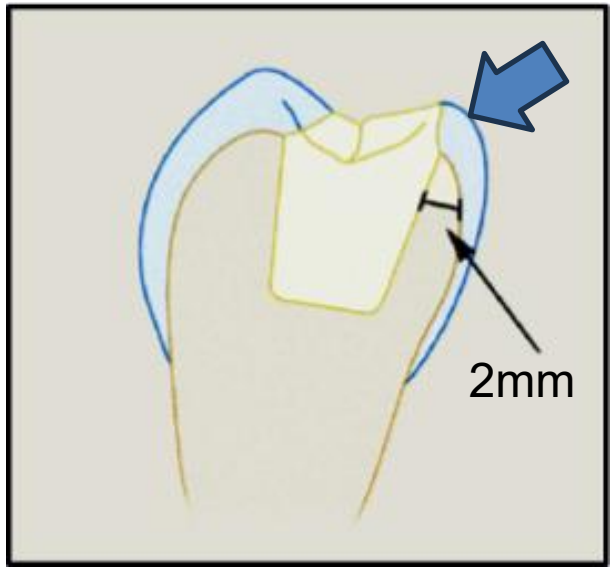


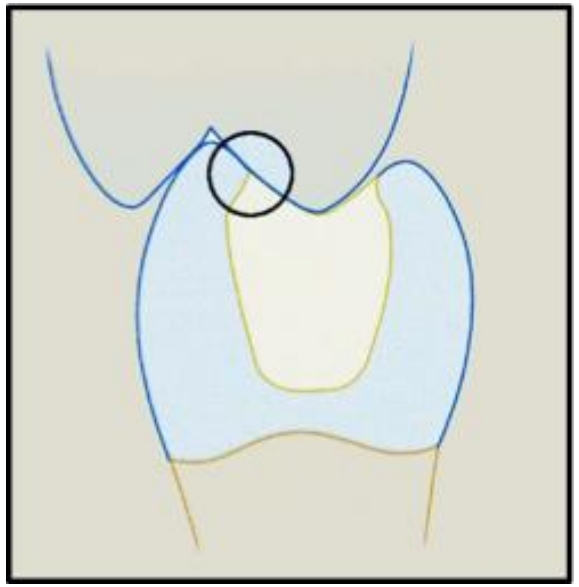
Redistribution of stresses

Slide by Dr Nedelcu

During preparation:

- Removal of tooth structure less than 2mm thick
- Removal of any low quality/undermined enamel on the cusps





Also avoid occlusal contacts on the margin of the preparations

Slide by Dr Nedelcu

Principles of Tooth Preparations

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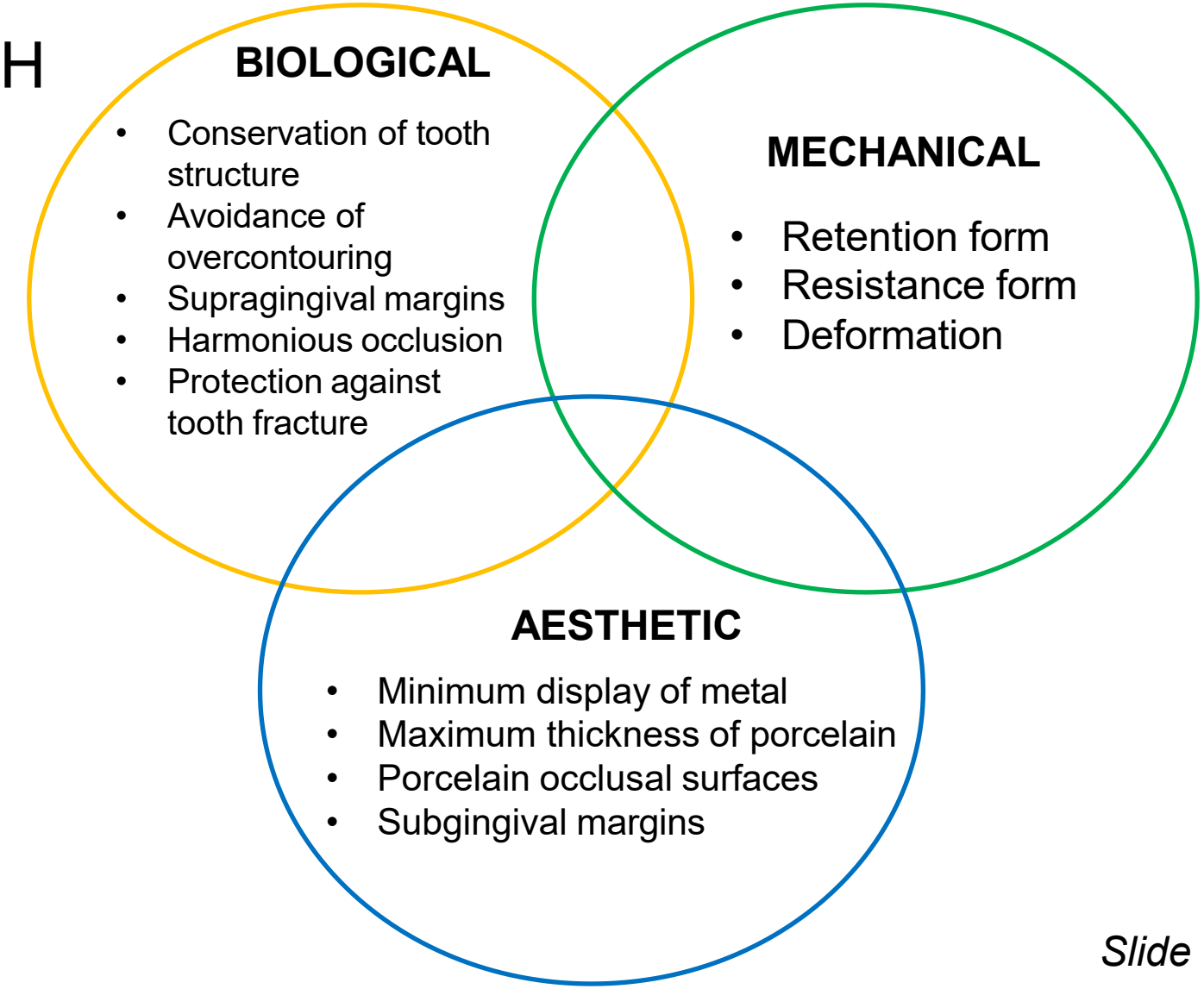
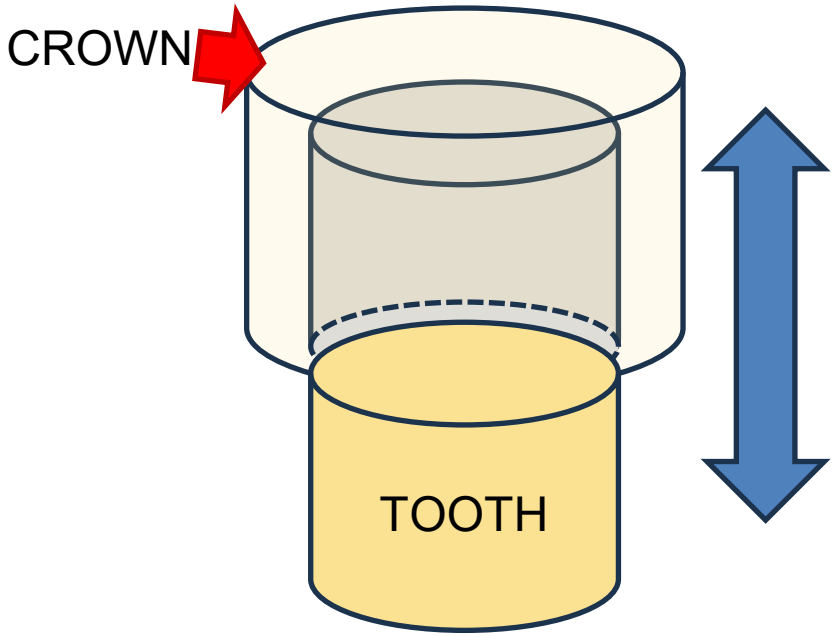


Slide by Dr Matsubara

Principles of Tooth Preparations

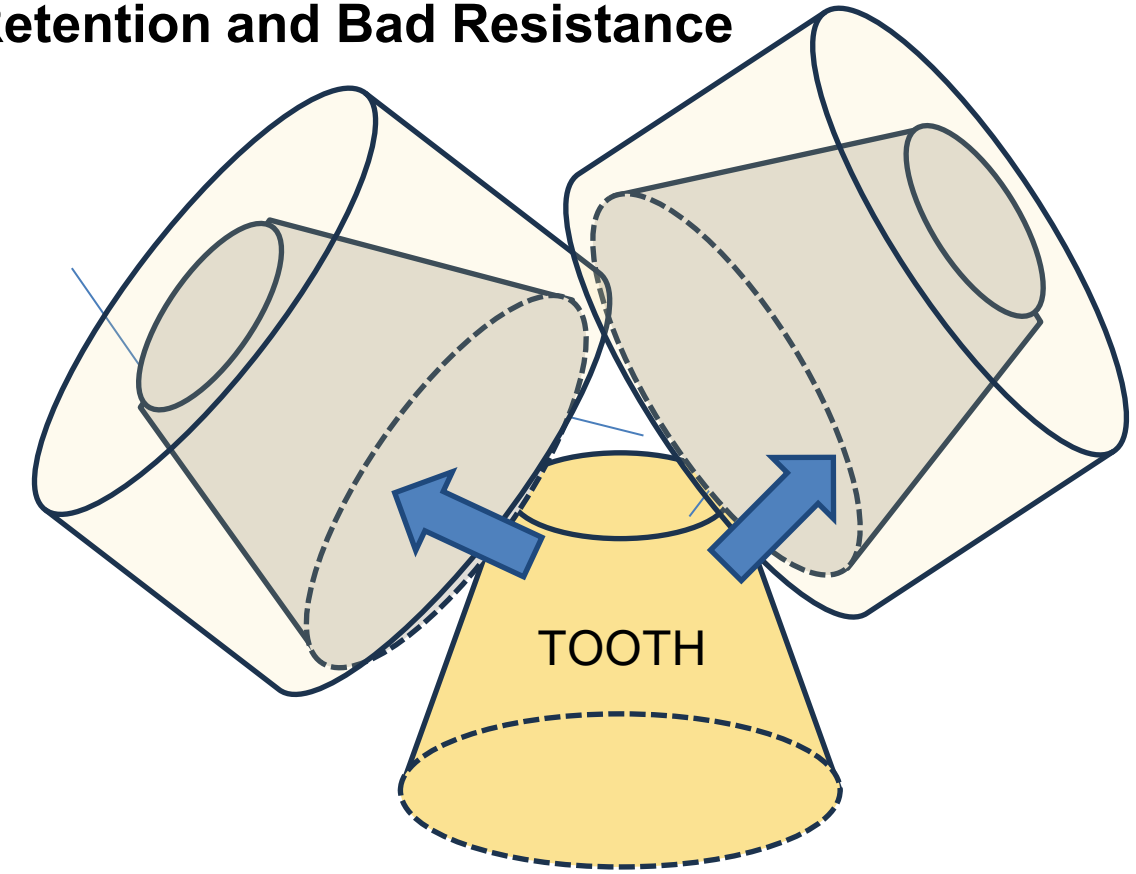
Retention: prevents removal of restoration/crown from coming off the prepared tooth when a force is applied parallel to the path of insertion.

Resistance: prevents dislodging of restoration/crown when apical or oblique forces applied, and stops movement of restoration during chewing.



Good Retention But Bad Resistance

Bad Retention and Bad Resistance



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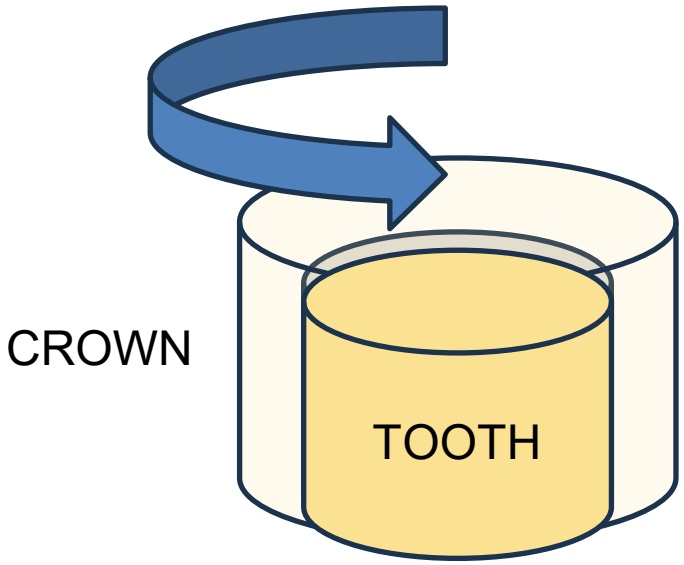
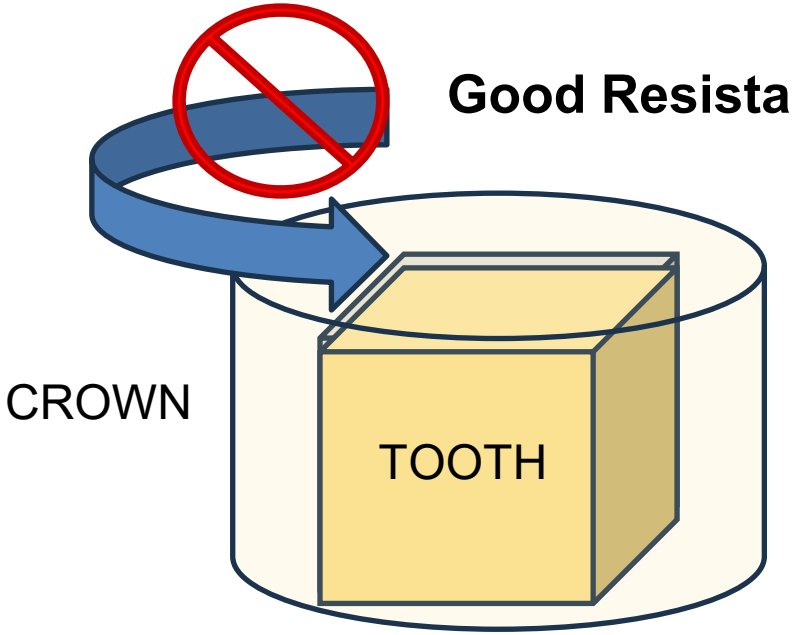


Bad Resistance Form

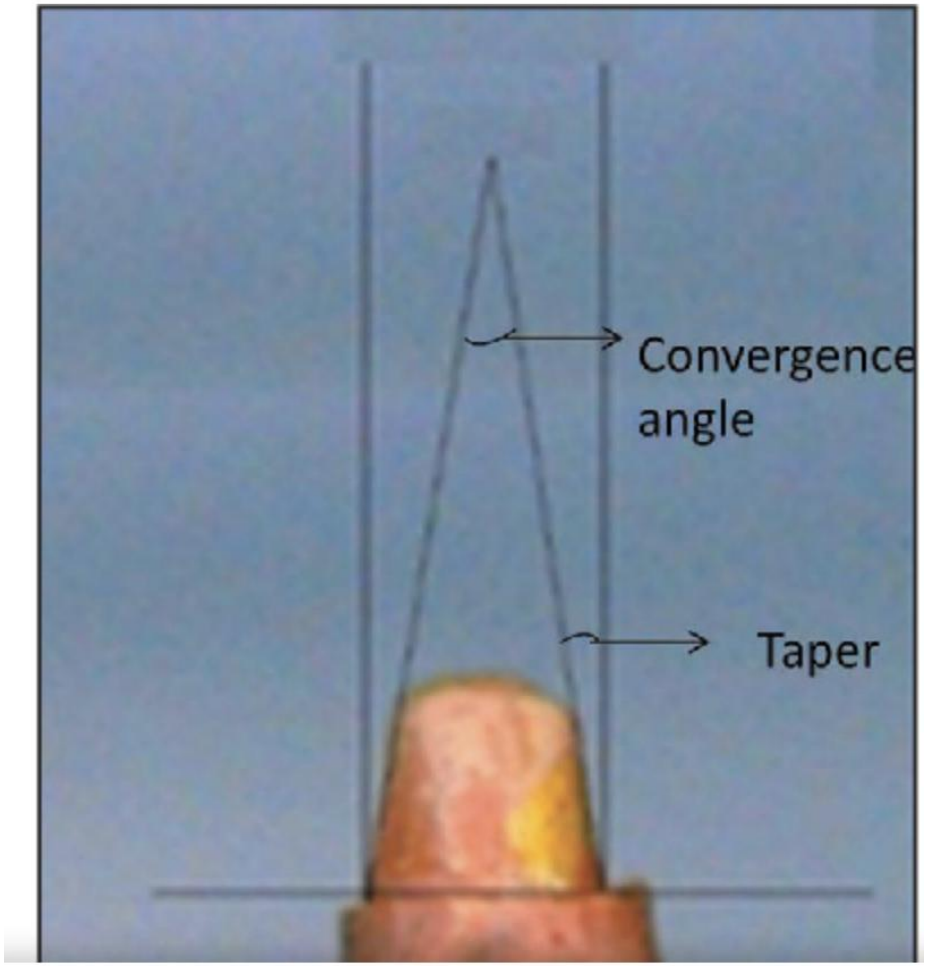
Excessive rounding of preparation can decrease resistance form



Good Resistance Form

Principles of Tooth Preparations

Factors influencing Retention and Resistance:
Taper and Length of axial walls



Fundamental of Fixed Prosthodontics

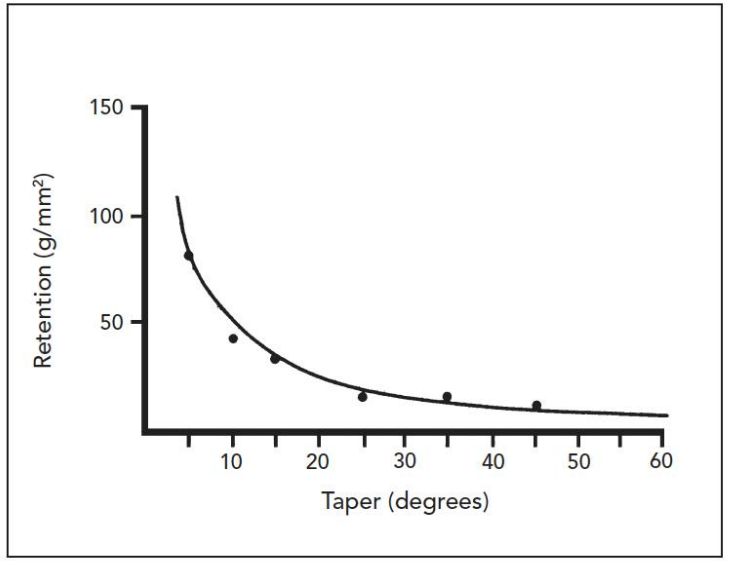


Fig 9-4 As taper increases, retention decreases. (Modified from Jorgensen[4] with permission.)

Evaluation of the degree of taper and convergence angle of full ceramo-metal crown preparations by different specialists centers at Assir Region, Saudi Arabia

Mohammed M. Al-Moaleem, M. Shariff, +2 authors S. Tikare • Published 1 September 2015 • Medicine •
Saudi Journal of Medicine and Medical Sciences

Principles of Tooth Preparations

THE JOURNAL OF PROSTHETIC DENTISTRY

THE GLOSSARY OF PROSTHODONTIC TERMS

Ninth Edition

convergence angle \kon-vûr′jens ăng′gel**:** the angle, measured in degrees as viewed in a given plane, formed by the axial walls when a tooth or machined surface on a metal or ceramic material is prepared for a fixed dental prosthesis; *Editorial note for usage*: the term *total occlusal convergence* applies to the angle formed between two opposing axial walls; the term *taper* applies to the angle formed between an axial wall and the path of placement onto the tooth or machined surfaces of a metal or ceramic material; *syn, angle of convergence,* TOTAL OCCLUSAL CONVERGENCE; *comp*, TAPER

taper: in dentistry, the angle, measured in degrees as viewed in a given plane, formed between an external wall and the path of placement of a tooth preparation or machined surfaces on a metal or ceramic material when prepared for fixed dental prosthesis; *comp,* CONVERGENCE ANGLE, TOTAL OCCLUSAL CONVERGENCE ANGLE

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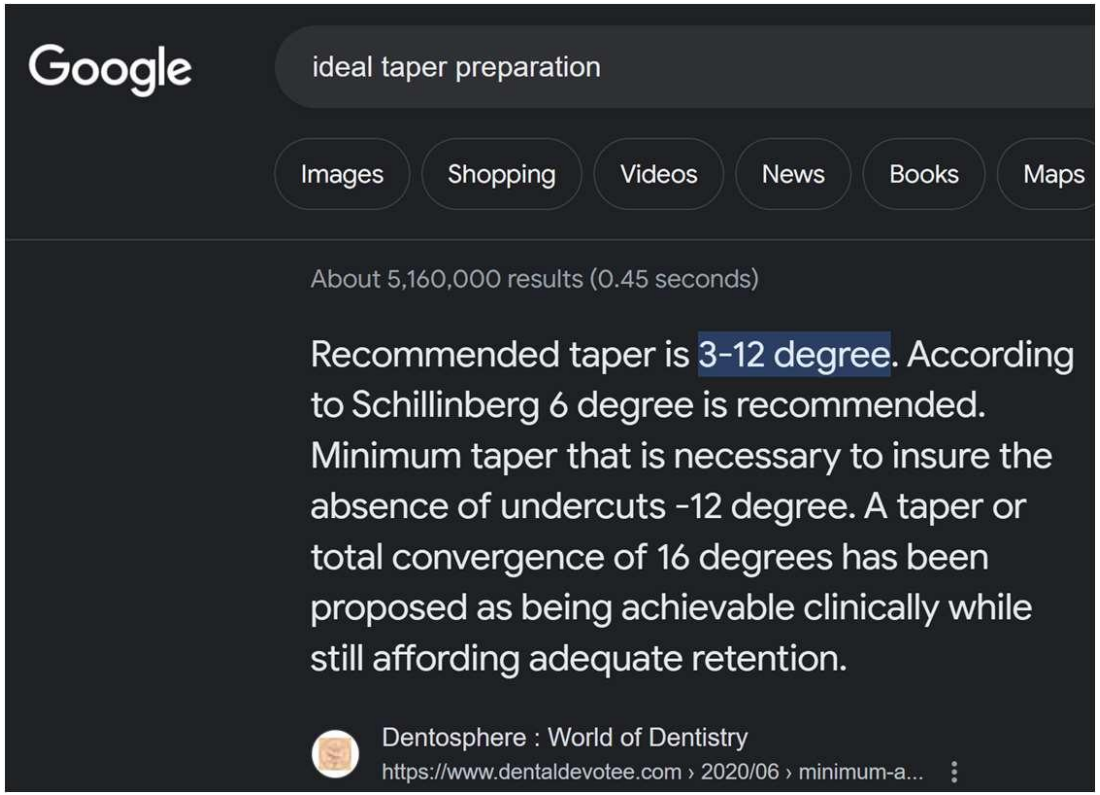
parations

THE UNIVERSITY OF WESTERN AUSTRALIA



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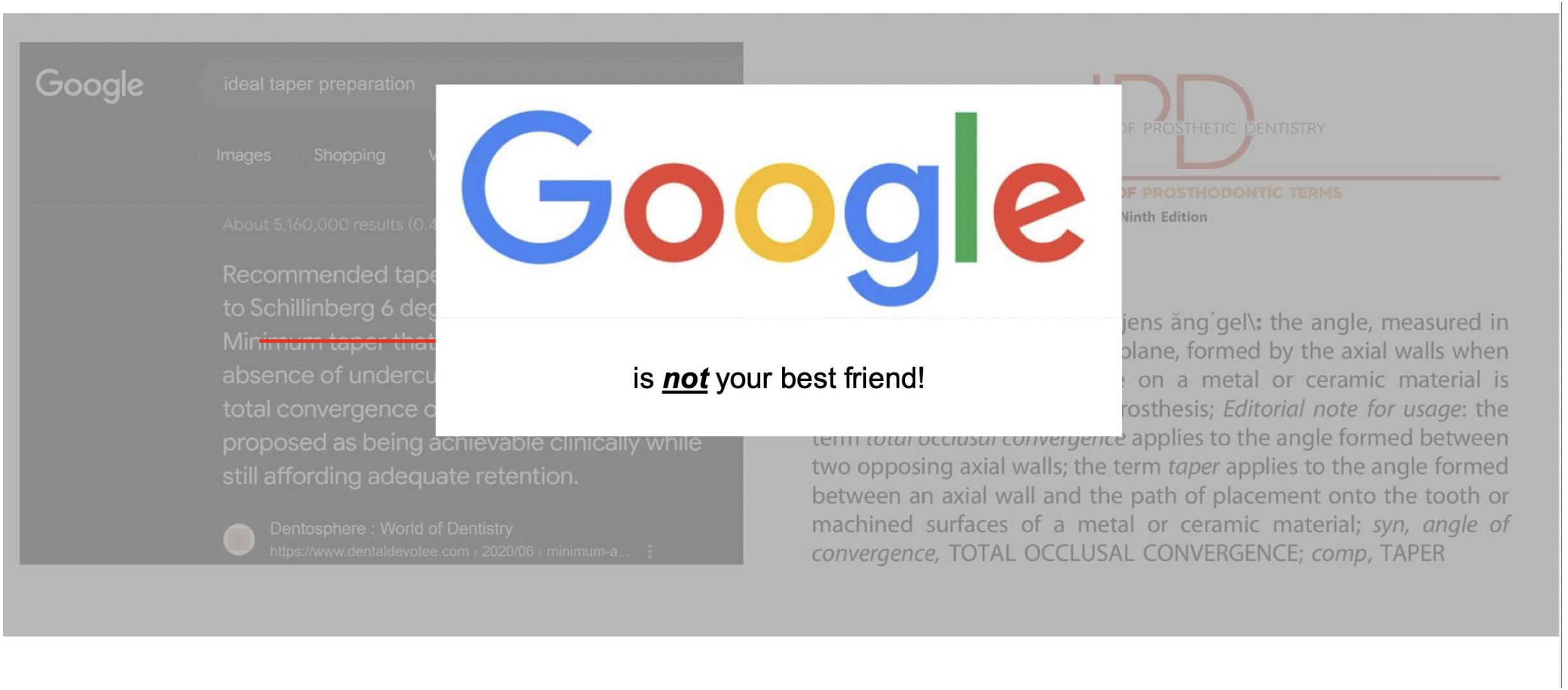
Slide by Dr Nedelcu



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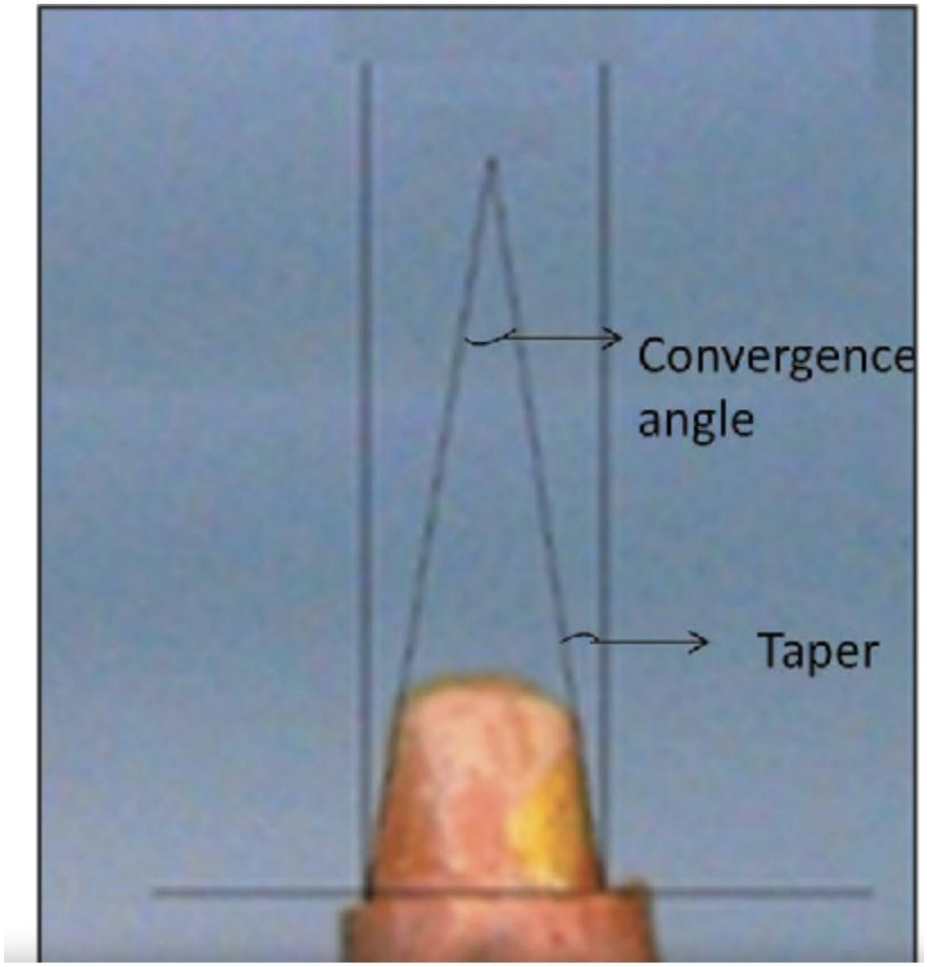
Principles of Tooth Preparations

Factors influencing Retention and Resistance:
Taper and Length of axial walls



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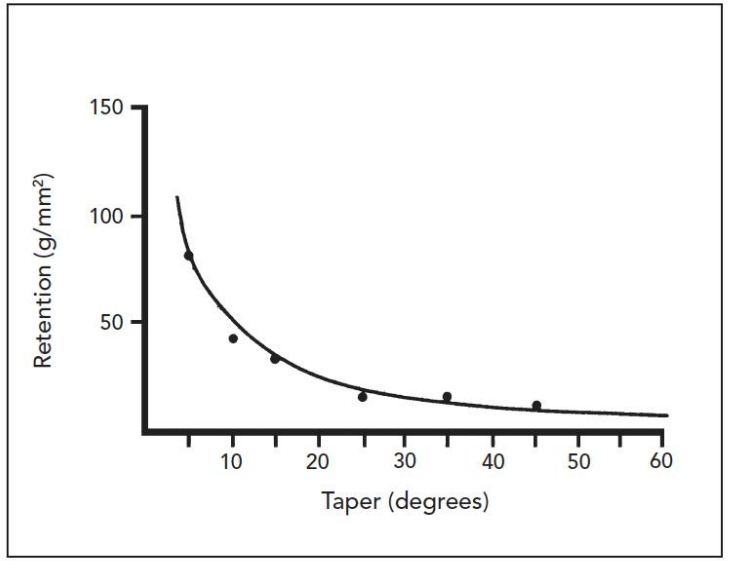

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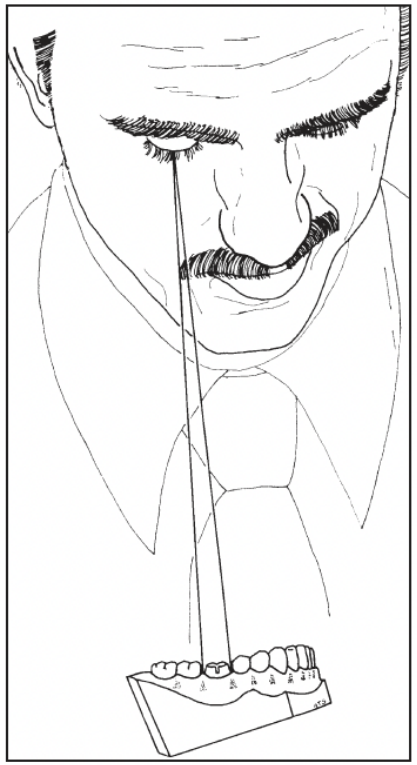


Fig 9-13 To examine a preparation for undercuts, one eye should be closed.

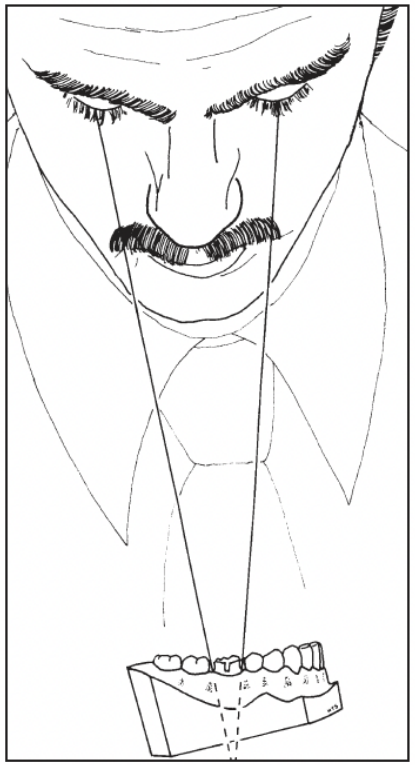


Fig 9-14 If both eyes are open when the preparation is viewed, undercuts may remain undetected.

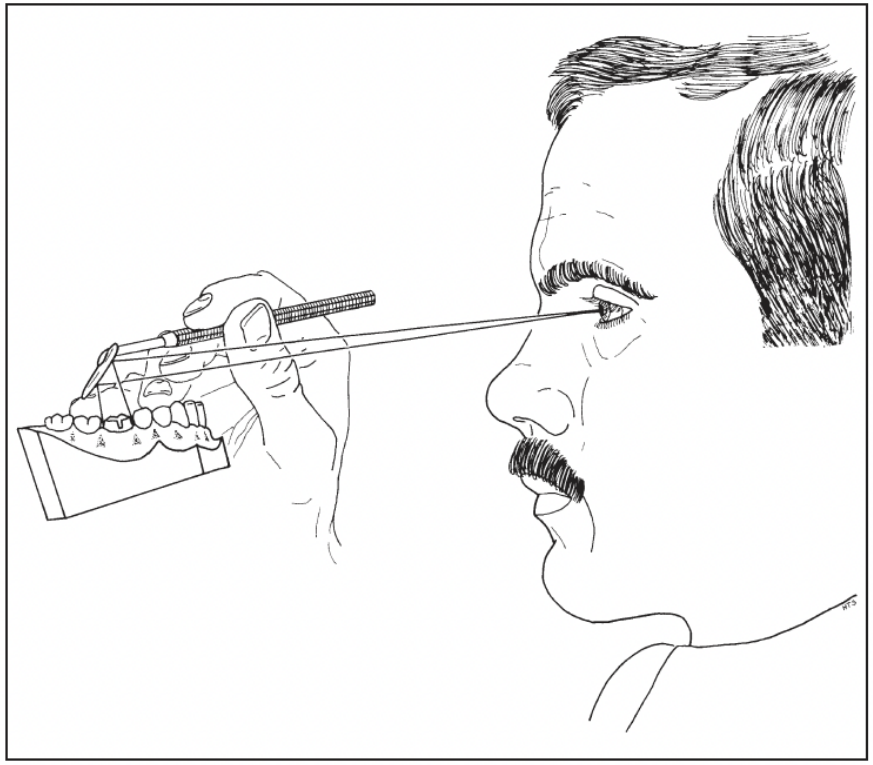


Fig 9-15 Preparations in the mouth are viewed through a mouth mirror using one eye.

Principles of Tooth Preparations

Factors influencing Retention and Resistance:
Taper and **Length of axial walls**

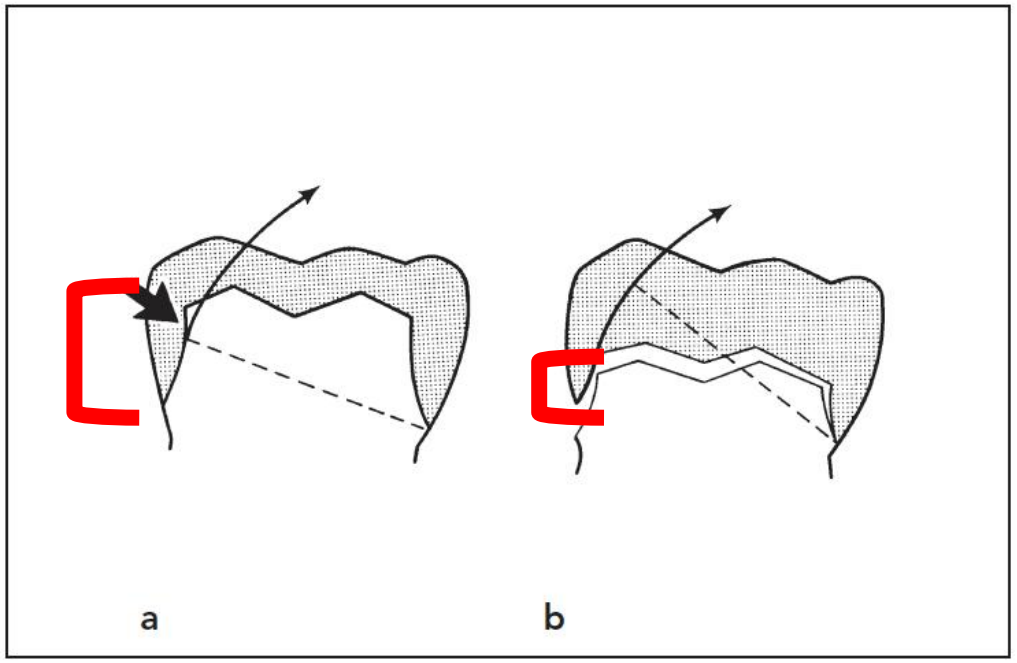


Fig 9-9 The preparation with longer walls *(a)* interferes with the tipping displacement of the restoration better than the short preparation *(b)*.

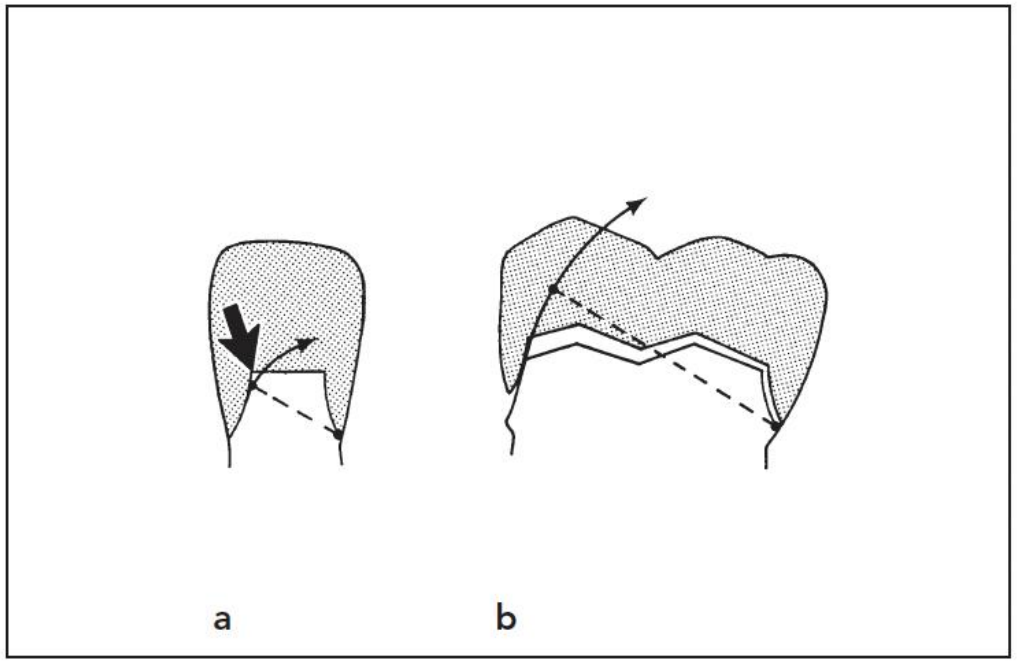


Fig 9-10 A preparation on a tooth with a smaller diameter *(a)* resists pivoting movements better than a preparation of equal length on a tooth of larger diameter *(b)*.

Fundamental of Fixed Prosthodontics

Principles of Tooth Preparations

Factors influencing Retention and Resistance:
Taper and **Length of axial walls**

What can we do to increase retention/resistance?

- Grooves and boxes

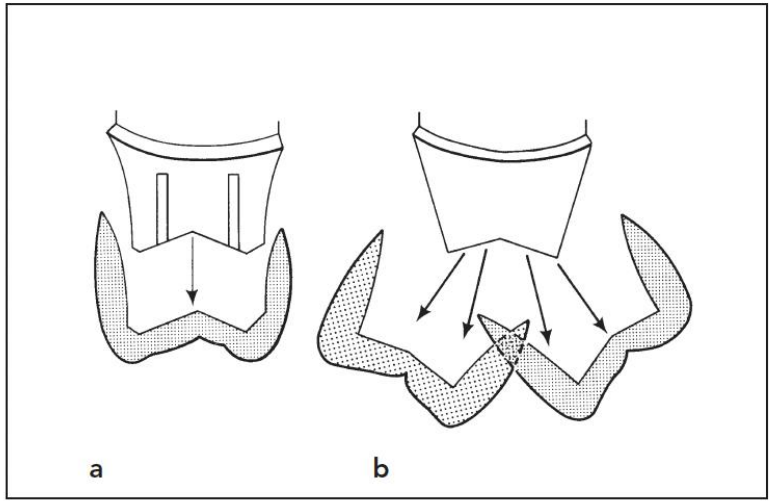


Fig 9-6 *(a)* By limiting the paths of withdrawal, retention is improved. *(b)* A preparation with unlimited freedom of displacement is much less retentive.

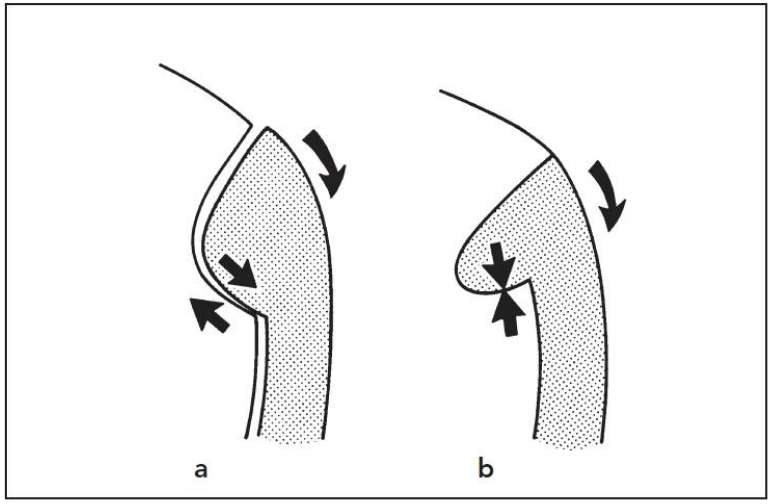


Fig 9-7 *(a)* The walls of a groove that meet the axial wall at an oblique angle do not provide the necessary resistance. *(b)* The walls of a groove must be perpendicular to rotating forces to resist displacement.

BUT USE WITH CARE!

Fundamental of Fixed Prosthodontics

Principles of Tooth Preparations

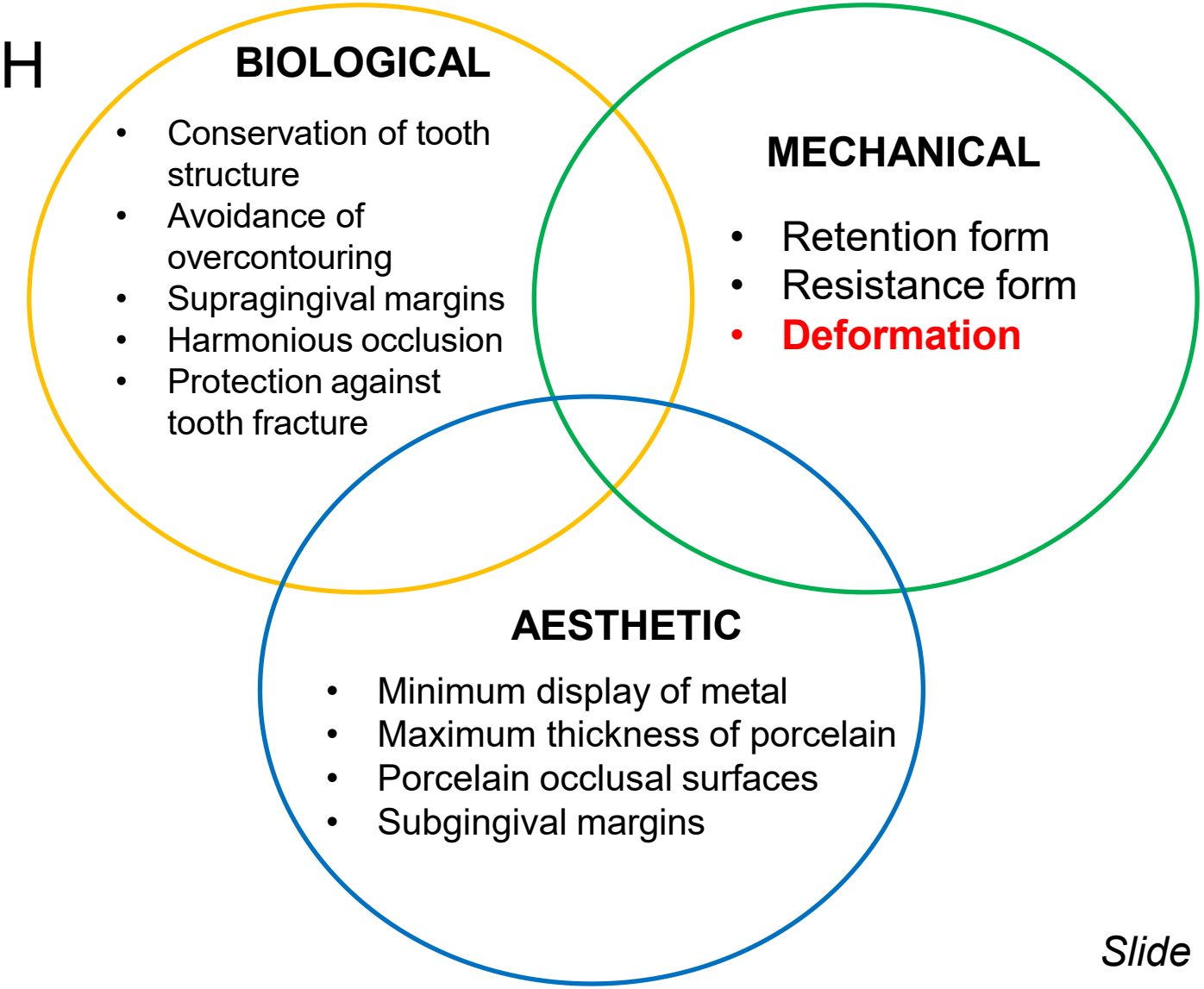
Other factors that influence retention and resistance:

a. Magnitude of the dislodging force
b. Geometry of tooth preparation (MOST IMPORTANT, YOU DIRECT IMPACT THIS)
c. Roughness of fitting surface of restoration
d. Material being cemented
e. Properties of luting agent

Principles of Tooth Preparations

ABUTMENT TOOTH

- Principles of tooth preparation
- Partial or complete preparation



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Principles of Tooth Preparations

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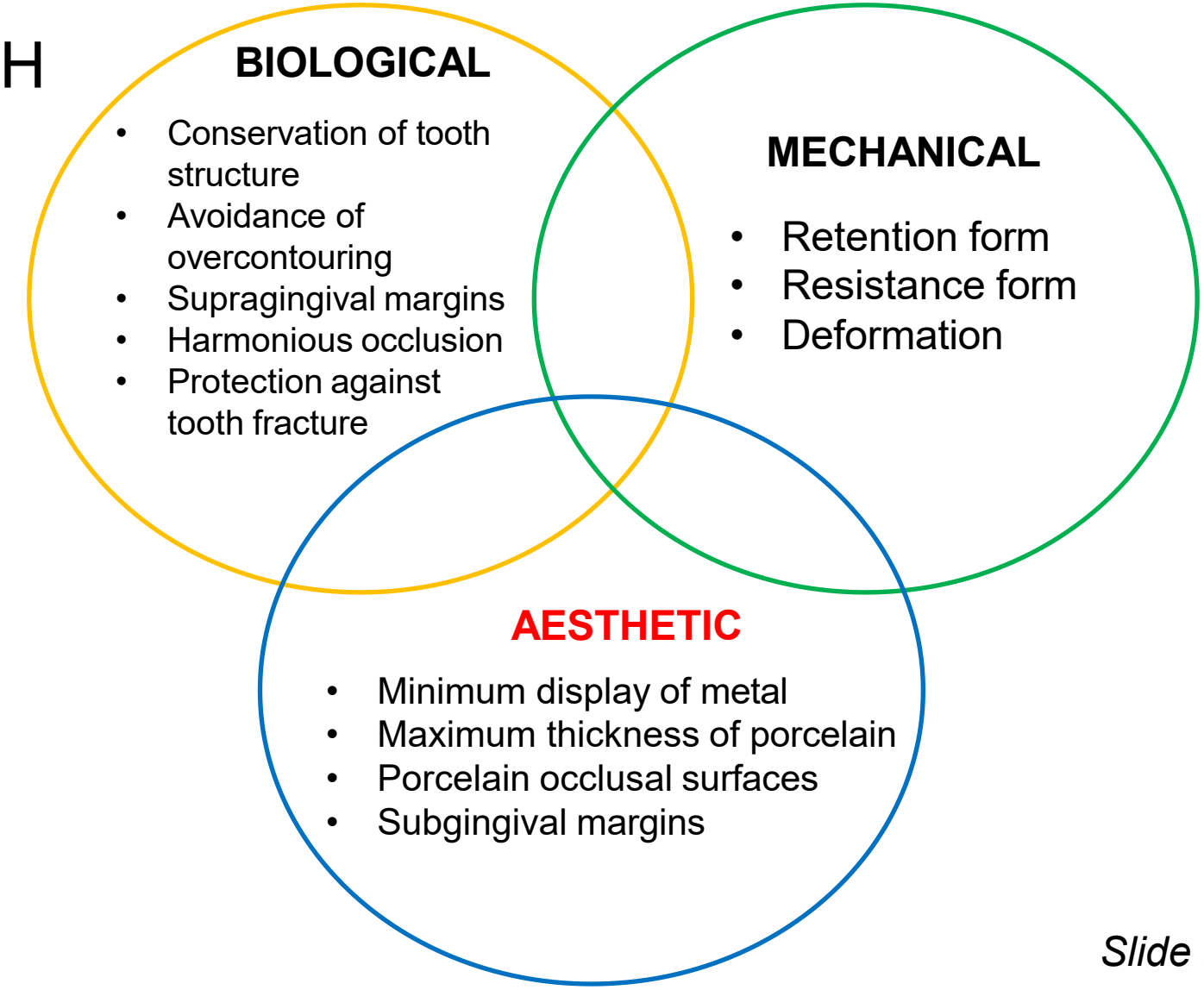

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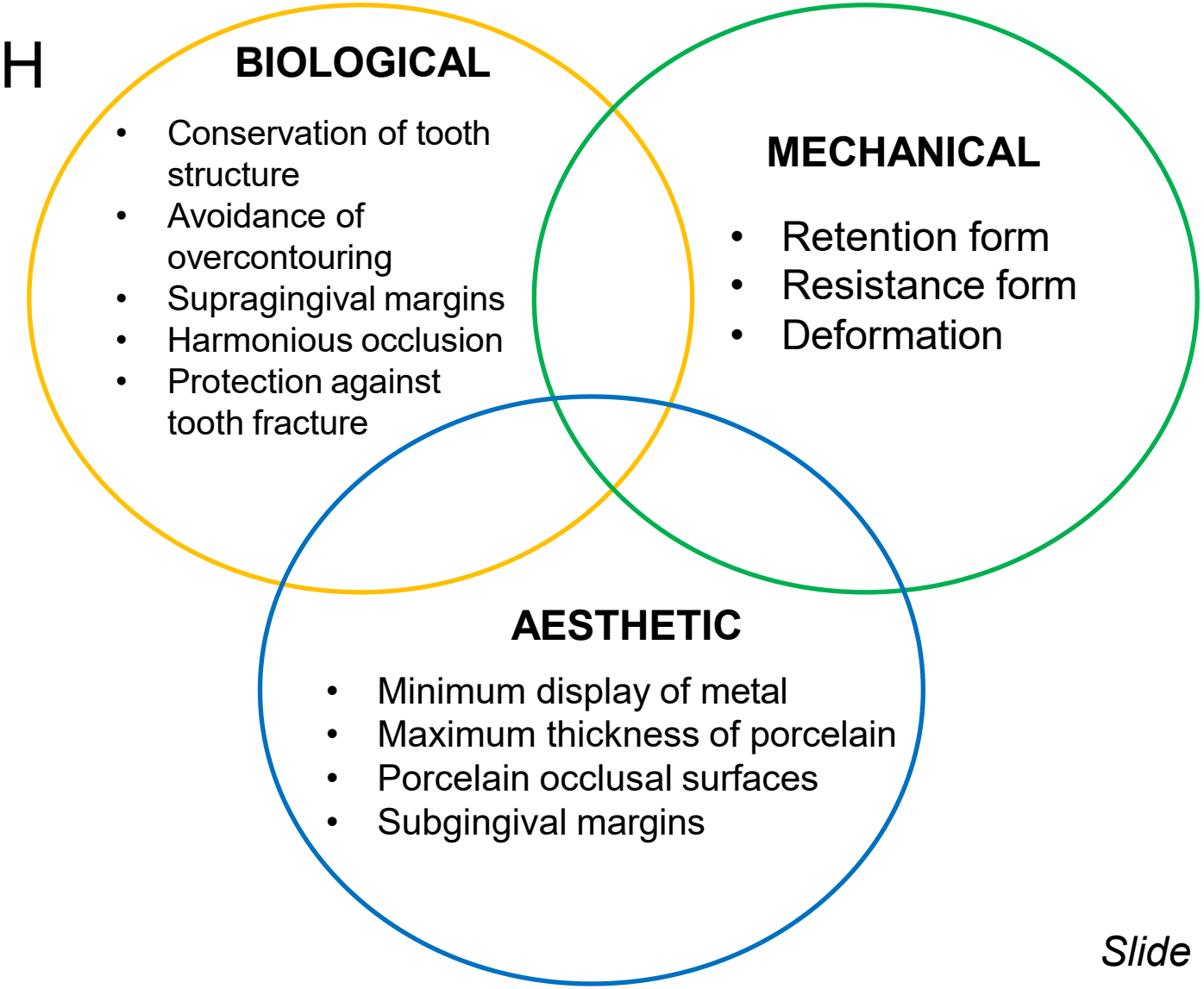

Slide by Dr Matsubara

Principles of Tooth Preparations

Any questions? Please email me,
or come up to me in CSSL.