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Partial Coverage Restorations
INLAY
ONLAY

Dr V. Matsubara

LEARNING OUTCOMES

- Explain the differences between inlays and onlays.
- Discuss material options for inlays and onlays.
- Outline the clinical indications and contraindications for inlays and onlays.
- Evaluate the advantages and disadvantages of partial-coverage ceramic restorations.
- Compare the use of direct composite versus indirect composite restorations.
- Describe the key features of tooth preparation for inlays and onlays.
- Review different techniques for temporizing inlay and onlay preparations.

Inlay and Onlay

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Indirect dental restorations

- Dental restoration made outside of the mouth to correspond to the form of the prepared tooth.
- Cemented or bonded onto the tooth.

At least 2 appointments required:

- 1st Tooth preparation + impression/scan + temporarization
- 2nd Try-in, Insertion

Inlay and Onlay

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Inlay:

- Fixed intracoronal restorations that fit within the anatomic contour of the clinical crown.
- Relies on the strength of the remaining tooth structure for support and retention

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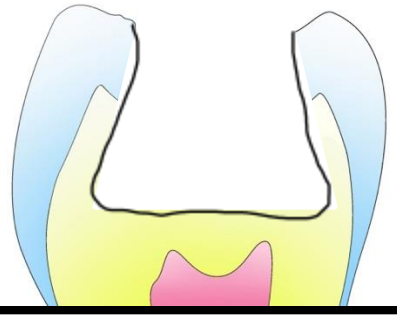
Onlay:

- Partial-coverage restoration that restores one or more cusps and adjoining occlusal surfaces; or the entire occlusal surface
- Retained by mechanical and/or adhesive means

Inlay and Onlay

Inlay

Onlay



- Inlay ‘fits into’,

- Onlay ‘fits onto’
- Incorporates cuspal coverage

The **Extent of Tooth Structure Loss** requiring replacement will define the need for an INLAY or ONLAY or a Full crown.

ONLAY - the need for **tooth protection** with **CUSPAL COVERAGE** whilst trying to avoid a traditional full crown

Contemporary Fixed Prosthodontics, 4 ed

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INLAY

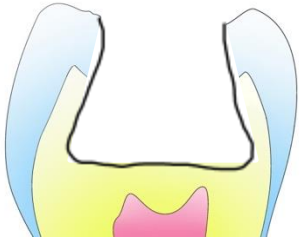
Indications:

- Moderate-sized cavities **confined within the cusps**.
- Teeth with at least **one sound marginal ridges**.
- Replacement of **small defective restorations** (amalgam or composite) in the occlusal area.
- Restorations requiring **better marginal fit and durability** than direct composite or amalgam.
- Cases where **occlusal anatomy and contact points** need precise reproduction.

Contraindications:

- Extensive tooth destruction involving cusps.
- Poor isolation or moisture control for bonding.
- MOD cavities with weak cusps

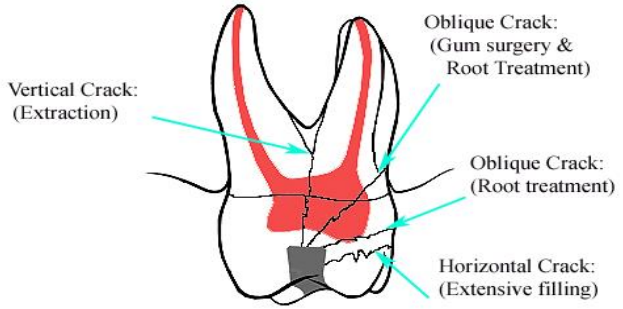
Inlay and Onlay



ONLAY

Indications:

- Large cavities involving **one or more cusps**, but **enough tooth structure (enamel) remains** for bonding.
- Teeth with **fractured or weakened cusps** that need protection.
- Replacement of **defective large restorations**.
- Restorations of **endodontically treated teeth** when sufficient tooth structure is still present
- Situations where **full crowns** are not indicated to preserve tooth structure (conservative preparation).
- Replacement of a large MOD amalgams due to **poor aesthetics**



Contraindications:

- Teeth with severely compromised - lack of sound enamel for a predictable bonding
- Severe parafunctional habits

Inlay and Onlay

Tooth Structure Removal Associated with Various Preparation Designs for Posterior Teeth

Edelhoff & Sorensen 2002

- Typodont teeth:

maxillary and mandibular premolars and molars were prepared in various crown preparation designs: MO/DO/MOD inlays, MOD onlay, partial crown, full crown.

- Mean tooth structure removal was assessed by gravimetric analysis

Results:

- Inlays (MO): 27.2%
- Full crown preparations: 67.5-75.6% (depending on the type of margin preparation)

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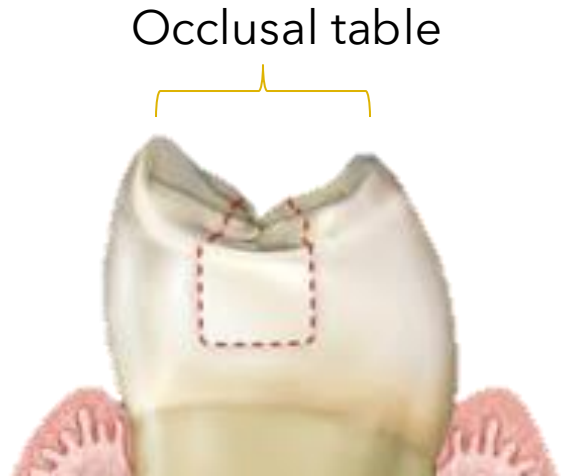
Inlay x Onlay

Depend on the extension of the restoration:

- When the width of an intracoronal cavity exceeds 1/2 the distance of the cusp tips, an onlay or crown is probably more suitable
- Cuspal coverage is needed for endodontically-treated tooth

THINGS TO CONSIDER:
- enamel bonding vs dentin bonding
- variance in bonding to different qualities of dentin
- possibility of limited retentive form



Inlay and Onlay

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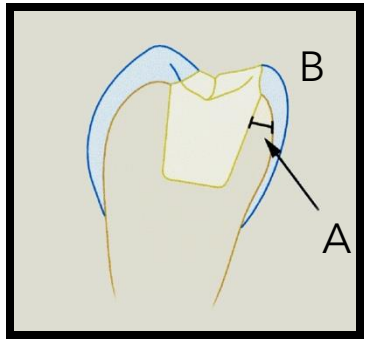
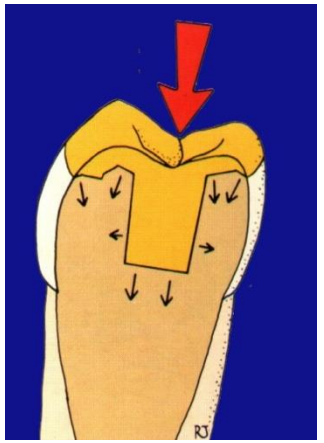
Inlay x Onlay

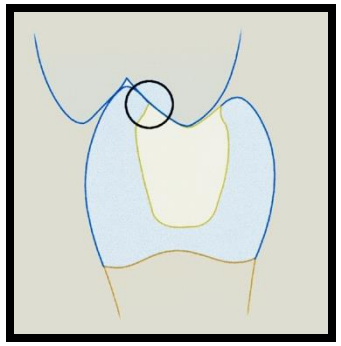


A) Tooth structure less than 2 mm

B) Low quality of the enamel covering the cusp - unsupported enamel are likely to fracture under occlusal load

Cuspal coverage





Occlusal contacts on the margin of the preparation

Inlay and Onlay

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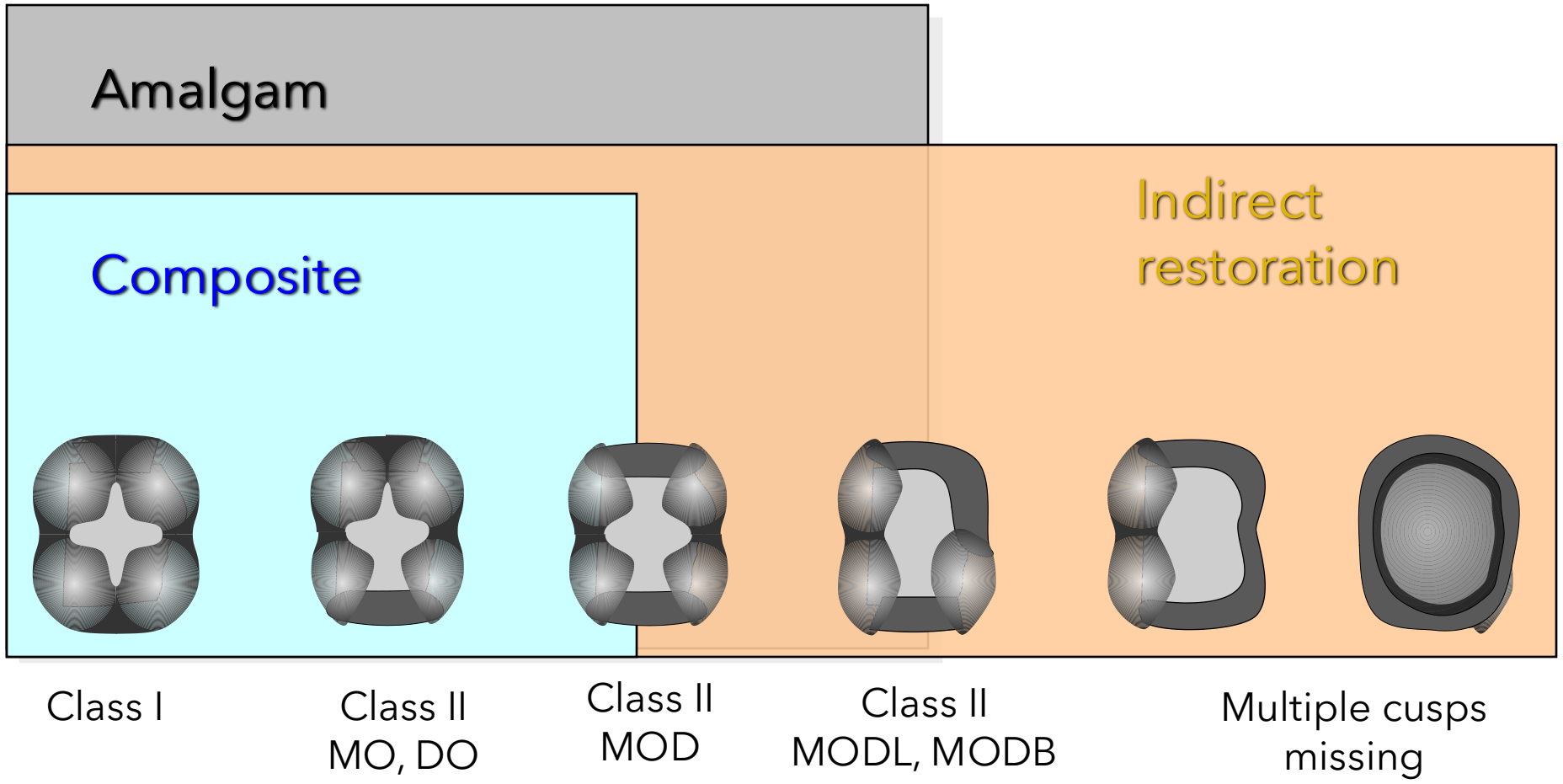
Clinical Rationale

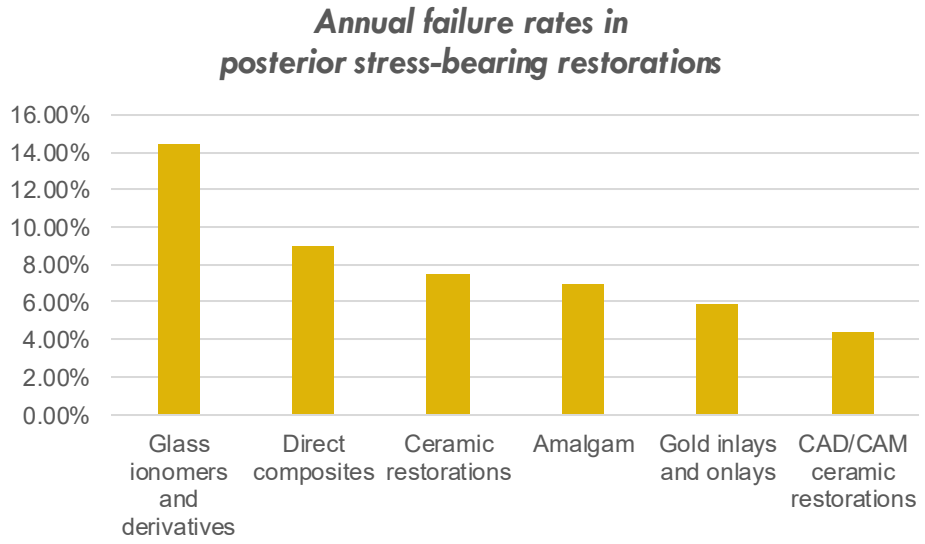
Generic approach



Inlay and Onlay

Clinical Rationale

Longevity of restorations in posterior teeth and reasons for failure



Main reasons for failure: secondary caries, fracture, marginal deficiencies, wear, and postoperative sensitivity.

Hickel R, et. al.: J Adhesive Dent 2001

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Material / Fabrication method

- Precious alloys: Gold / Cast
- Indirect composite resin (polymer-based) / CAD-CAM (chair side or lab)
- Ceramic:

Feldspathic, Leucite-reinforced ceramic, Lithium disilicate, Polymer-infiltrated ceramic, Alumina-based and Zirconia / Sintering, hot pressing, chairside CAD/CAM and laboratory CAD/CAM)

- Survival rate: similar
- Deterioration: Gold < Ceramic < Composite

Abduo et al. 2018, Angeletakia et al 2016

Inlay and Onlay

Longevity of ceramic onlays: A systematic review

Abduo et al. 2018

- No indication that one ceramic material performs better than another, and the fabrication methods appear to minimally influence the ceramic onlay performance.
- Survival rate: medium-term studies (2–5 years) - 91–100%
  long-term studies (more than 5 years) - 71– 98.5%

- Common cause of failure:
  1st Ceramic fracture
  2nd Debonding
  3rd Caries

- Deterioration of ceramic onlays : marginal integrity, margin discoloration, surface roughness, color match and anatomical form
  - Most common: loss of marginal integrity
  - Second: margin discoloration

Inlay and Onlay

CAD/CAM polymer-based material – indirect composite restorations

- Indirect CAD/CAM resin composite materials - higher edge stability than ceramics, permitting restorations with very thin margins.
- CAD/CAM composites: more homogenous and more abrasion-resistant restorations than direct composite resins.
- Ceramics are generally superior to CAD/CAM polymer-based materials in terms of flexural strength, abrasion resistance and discoloration rates, whereas CAD/CAM polymer-based materials are more antagonist-friendly

Pressable lithium disilicate ceramic versus CAD/CAM resin composite restorations in patients with moderate to severe tooth wear: Clinical observations up to 13 years

EDELHOFF ET AL. 2023

- Pressed LD single-tooth restorations showed lower long-term failure rates than RC.
- CAD/CAM RC restorations showed higher abrasion and significantly higher discoloration rates
- RC restorations exhibited more material fractures
- Despite the technical problems, the survival rate for both was 100%

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Direct composite vs Indirect composite restorations

DIRECT (Posterior composites)

- Restores aesthetic and functionality
- More affordable – single appointment
- Maximum preservation of tooth structure (minimally-invasive dentistry)

- Relatively short lifespan: microleakage, secondary caries, staining, factures
- Relies on remaining tooth structure for strength and integrity of restoration
- Incomplete polymerization
- Polymerisation shrinkage
- Degrade chemically in the oral environment*
- Lower wear resistance
- Contacts & contours technique sensitive

Angeletaki et al. 2016

* Chemical agents found in saliva, food and beverages.
- Intermittent exposure occurs during eating or drinking until teeth are cleaned.
- Continuous exposure may occur as chemical agents can be absorbed by adherent debris (such as calculus or food particles) at the margins of restorations or be produced by bacterial decomposition of debris.

Yep 2008 Chemical degradation of composite restoratives

Inlay and Onlay

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- Lower wear resistance
- Contacts & contours technique sensitive

INDIRECT (Composite)

- Complete polymerization
- Less porosity
- Better control of contours & contacts
- Better Marginal Adaptation and bond strength
- Easier to repair (vs ceramic)

- Less conservative (vs direct)
- More expensive (vs direct)
- Unpredictable color stability (vs ceramic)
- Inferior mechanical properties (vs ceramic)
- More wear and risk of fracture (vs ceramic)

Angeletaki et al. 2016

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CERAMIC ONLAY/INLAY

Advantages

- Superior aesthetics – excellent translucency, shade stability, and enamel-like appearance.
- High wear resistance – maintains anatomical form over time.
- Excellent biocompatibility – inert and tissue-friendly.
- Resists surface degradation and staining.
- High compressive strength – suitable for posterior load-bearing areas when properly bonded.

Disadvantages

- Brittleness – prone to fracture under high occlusal stress if preparation or bonding is inadequate.
- Irreparable – if fractured, usually requires replacement.
- More invasive preparation – requires slightly more tooth reduction to allow adequate ceramic thickness.
- Technique-sensitive bonding – requires resin cementation.
- Higher cost – material and laboratory fees are more expensive.

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Clinical long-term results and 10-year Kaplan-Meier analysis of Cerec restorations

Reiss & Walder 2000

- Inlays and onlays were manufactured using the Cerec technique (one single appointment CAD-CAM)
- The clinical success was documented continuously for 9 to 12 years after the placement.

Results

- Probability of survival decreased to 90% after 10 years and 84.9% after 11.8 years
- Restoration size and outline did not affect success rate
- Premolars better than molars
- Vital teeth better than non vital

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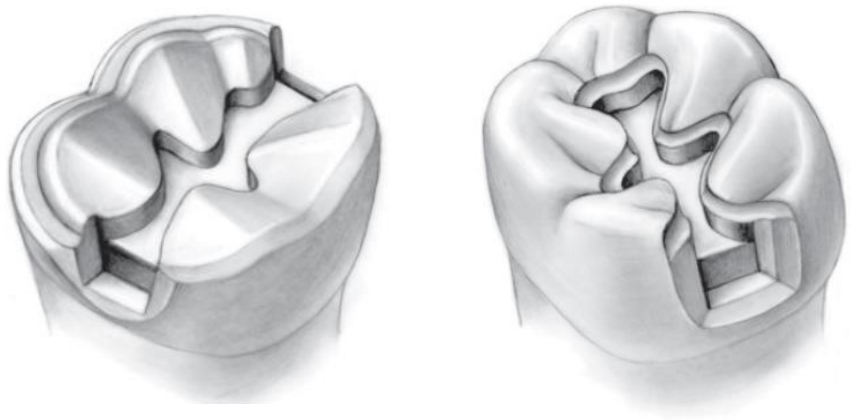
TOOTH PREPARATION

*Preparation guidelines for ceramic inlays/onlays differ from those for cast gold



Box style – Conventional preparation

Curved preparation – morphology driven preparation

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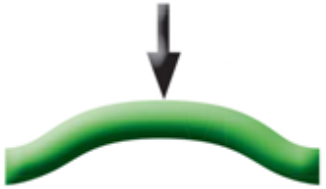
CERAMIC RESTORATIONS – PRINCIPLES OF PREPARATION

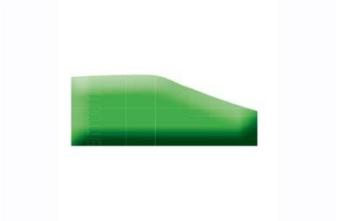
FAVORABLE DESIGNS



Compressive stress

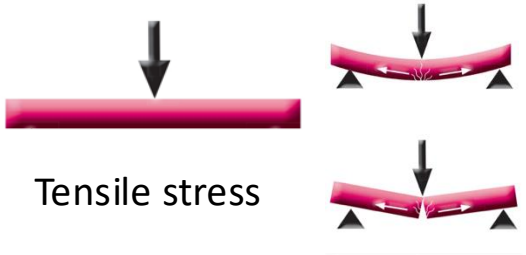
Curved transition

Simple geometry

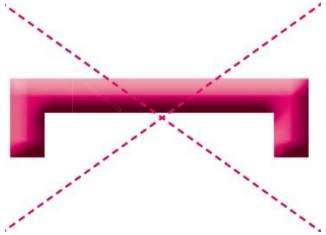


Gradual cross sectional transition

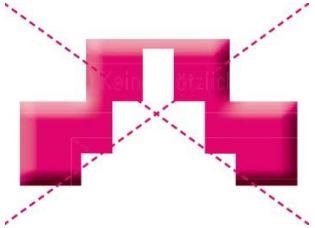
UNFAVORABLE DESIGNS



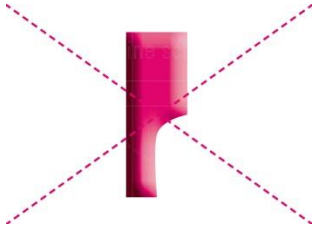
Tensile stress



No sharp edges



No complex geometry



No abrupt cross sectional transition

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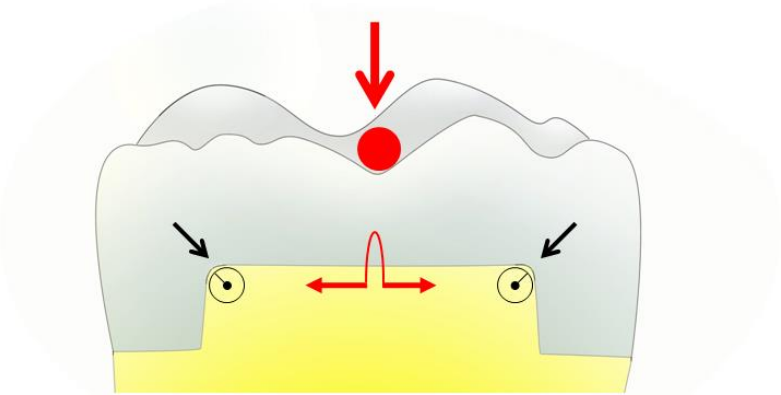
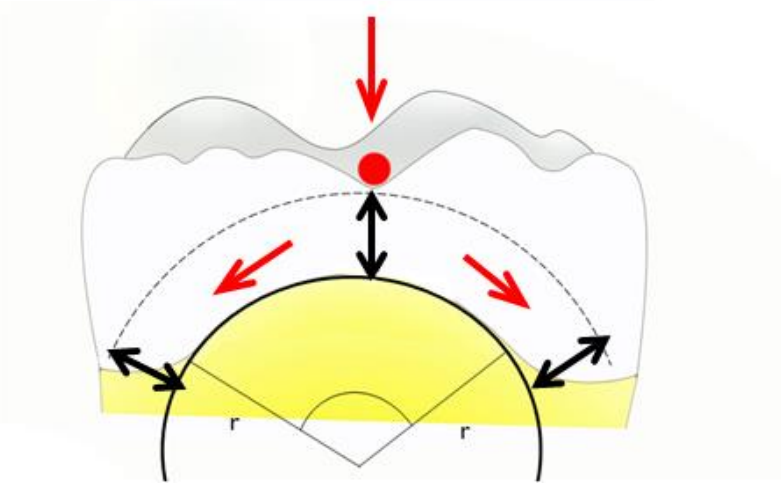
CERAMIC RESTORATIONS – PRINCIPLES OF PREPARATION



Box style preparation tends to produce tensile stresses on the internal surface



Curved preparation tends to produce compressive stresses on internal surface

Arnetzl GB & Arnetzl G 2006

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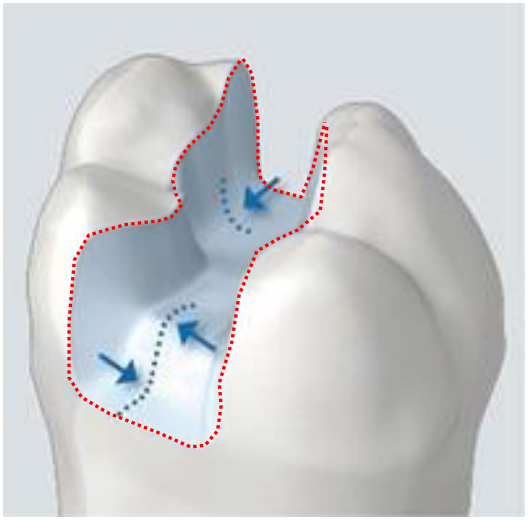
CERAMIC ONLAY AND INLAY



- No sharp internal line angles or points, only curved transitions
- The prep extension depends on the extension the previous restoration or the caries lesion .

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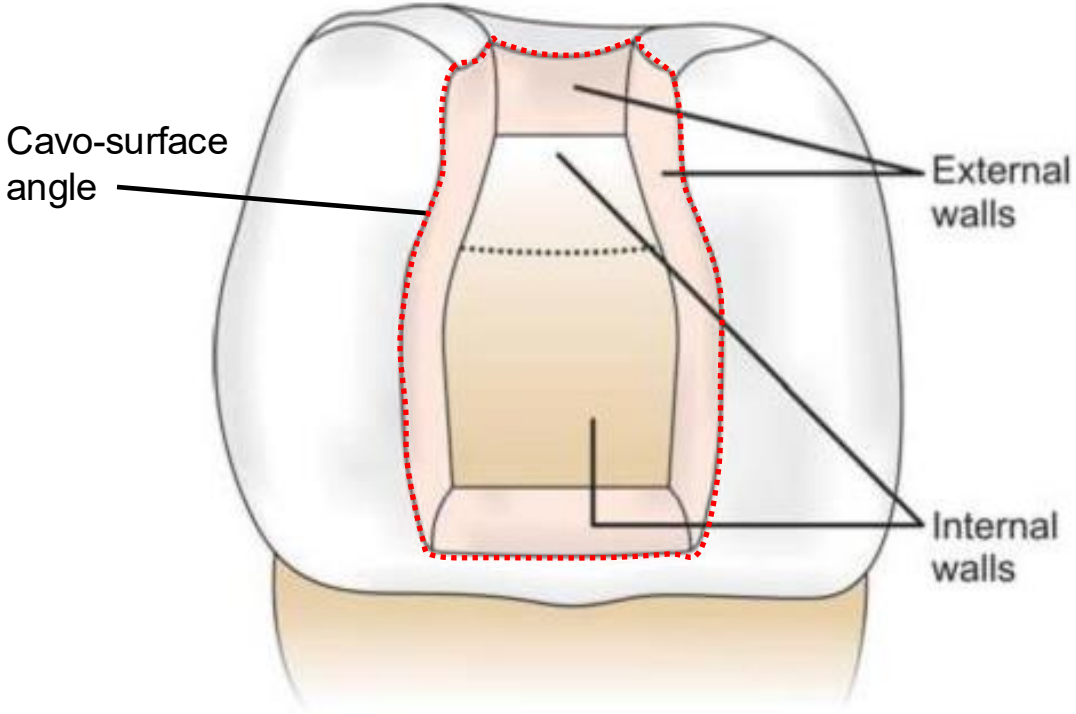
CERAMIC ONLAY AND INLAY



- All cavo-surface angles need to be **sharp, well defined**
- **Butt joint** (90°)

Hopp and Land 2013

Inlay and Onlay

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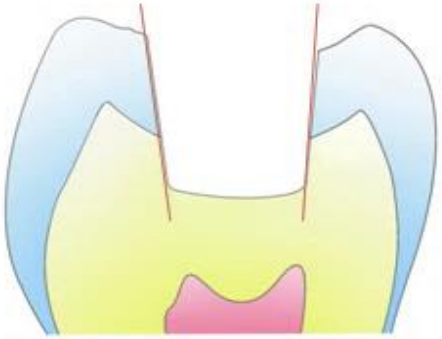
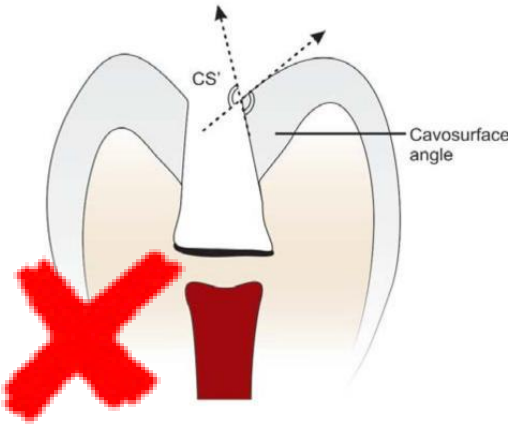
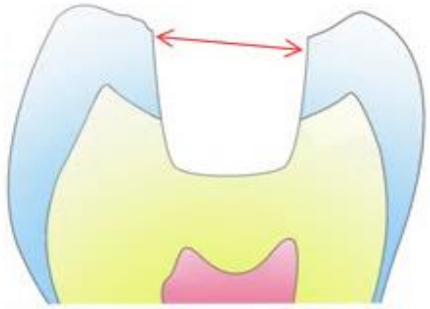
CERAMIC ONLAY AND INLAY



Angle of divergence > 10^0



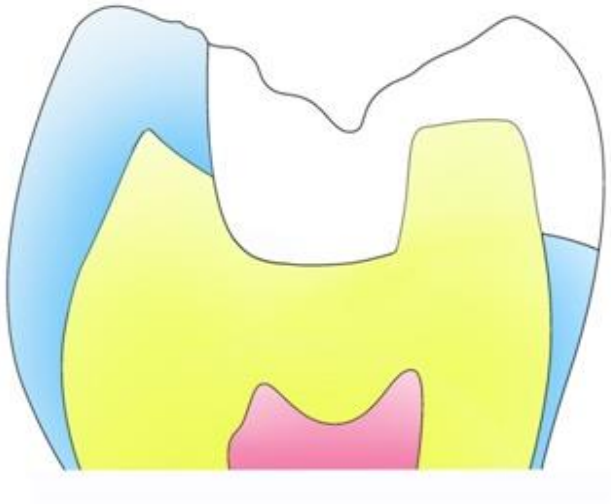
- Greater than or equal to 10 degrees of divergence on buccal and lingual walls
- 10 to 12 degrees of axial wall convergence

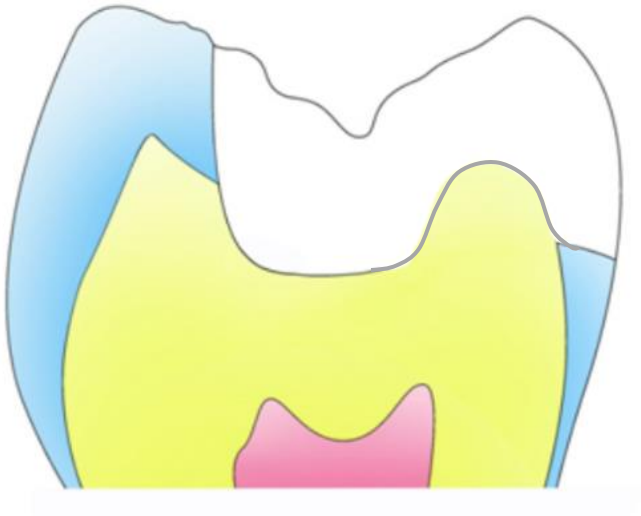


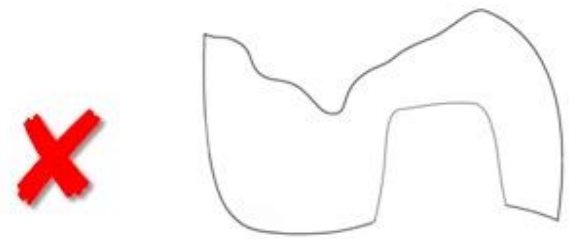
Isthmus width minimum 2.0mm

Hopp and Land 2013

Inlay and Onlay

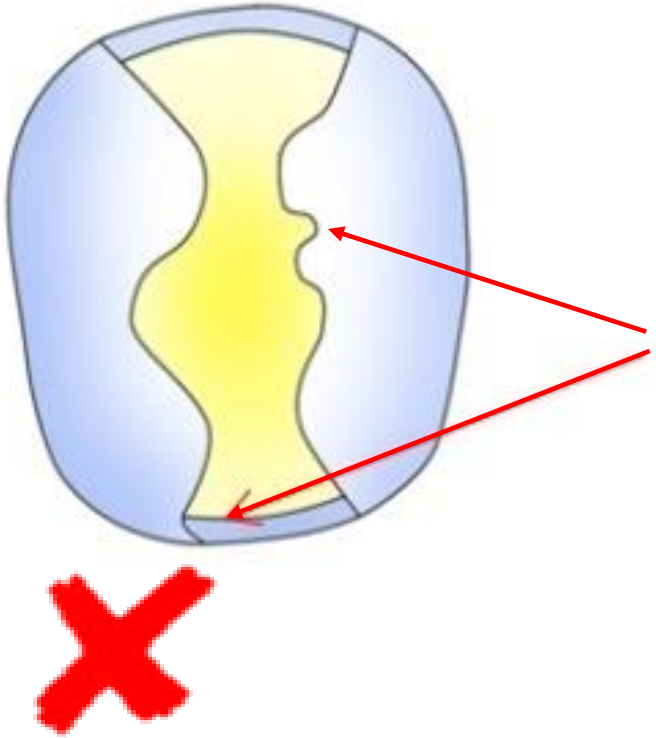


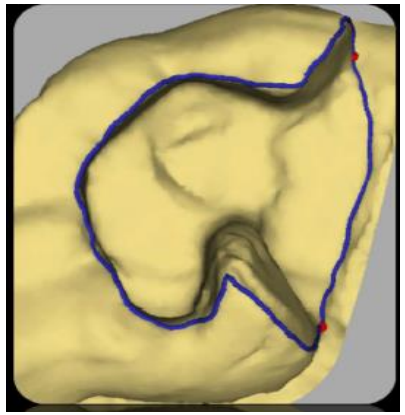


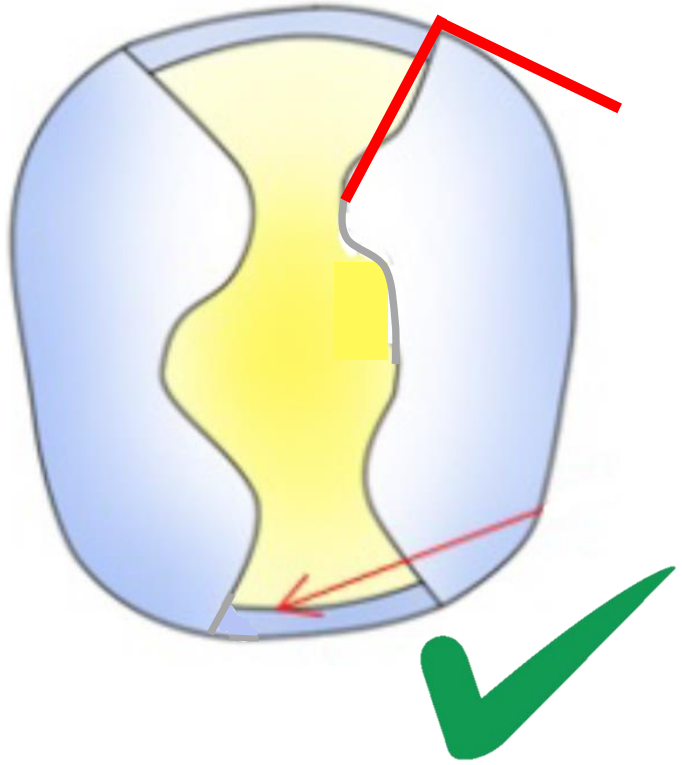


- Avoid complex internal geometry to the preparation
- Transition of material thickness should be gradual not abrupt

Inlay and Onlay



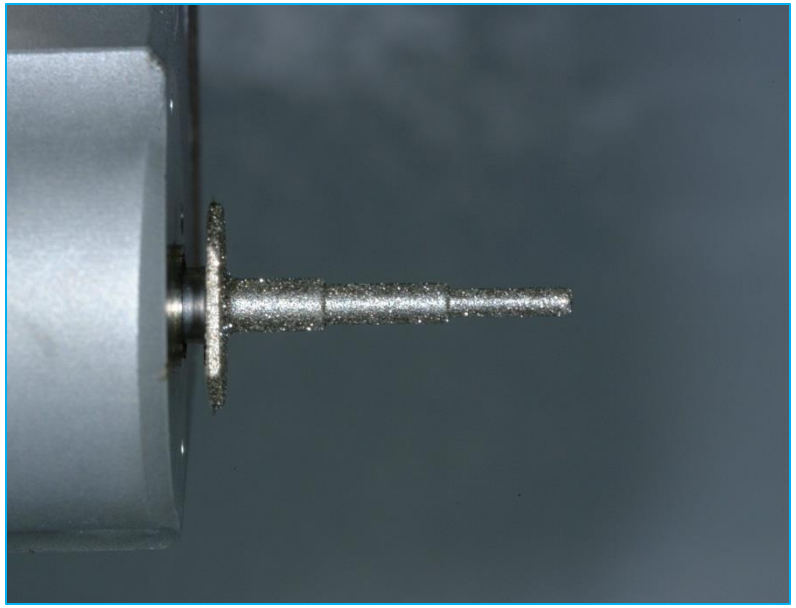




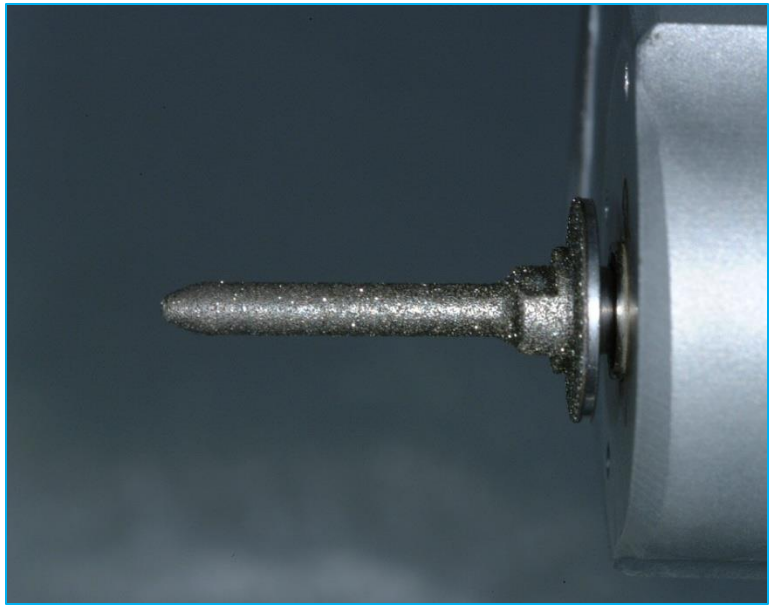
- No acute angles within preparation
- Smooth flowing margins
- No additional retention features
- No tooth structure without support

- Obtuse external line angles

Inlay and Onlay



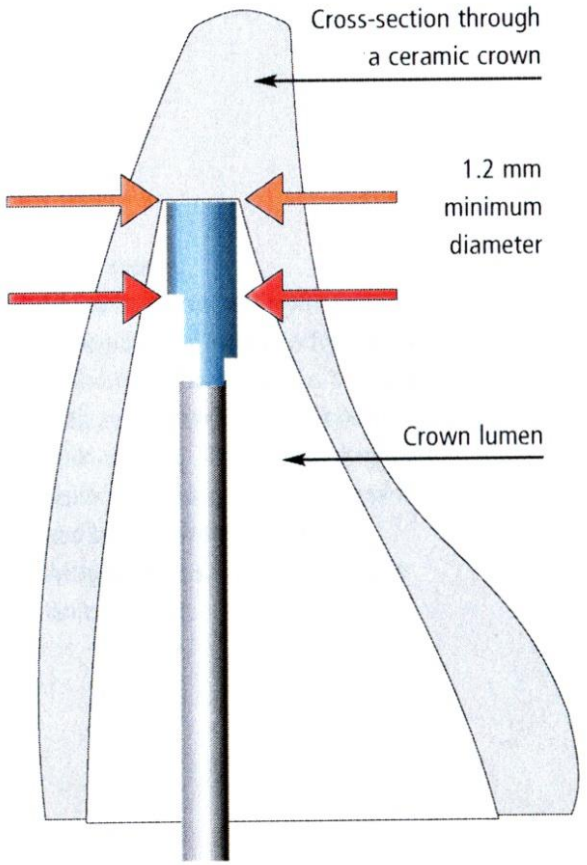
1.0 mm step bur

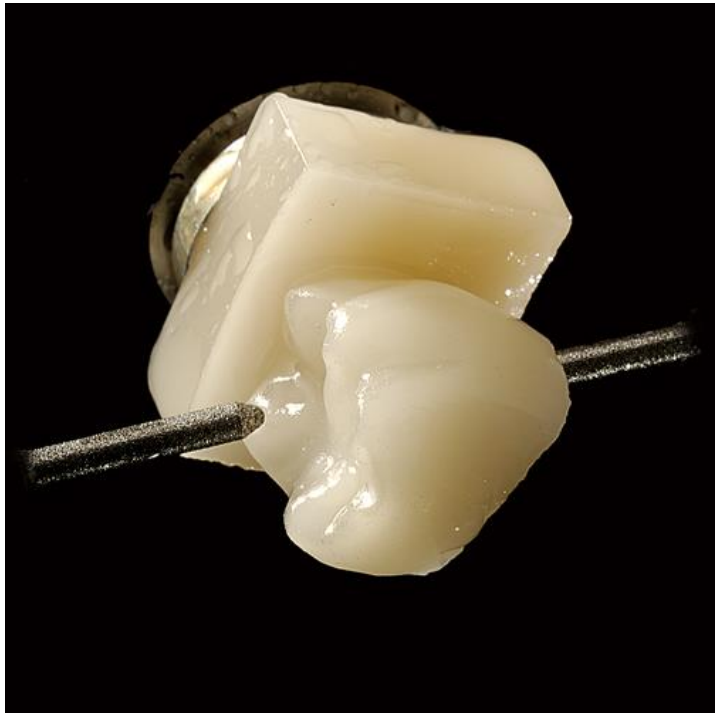


1.5 mm cylinder bur

CEREC 3 milling unit

Inlay and Onlay

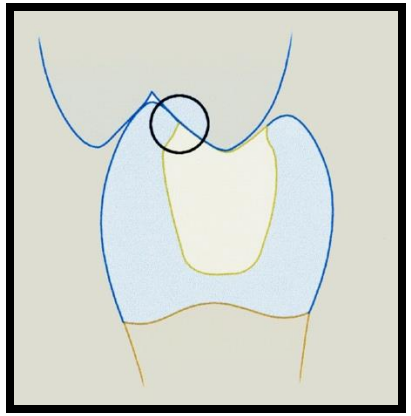




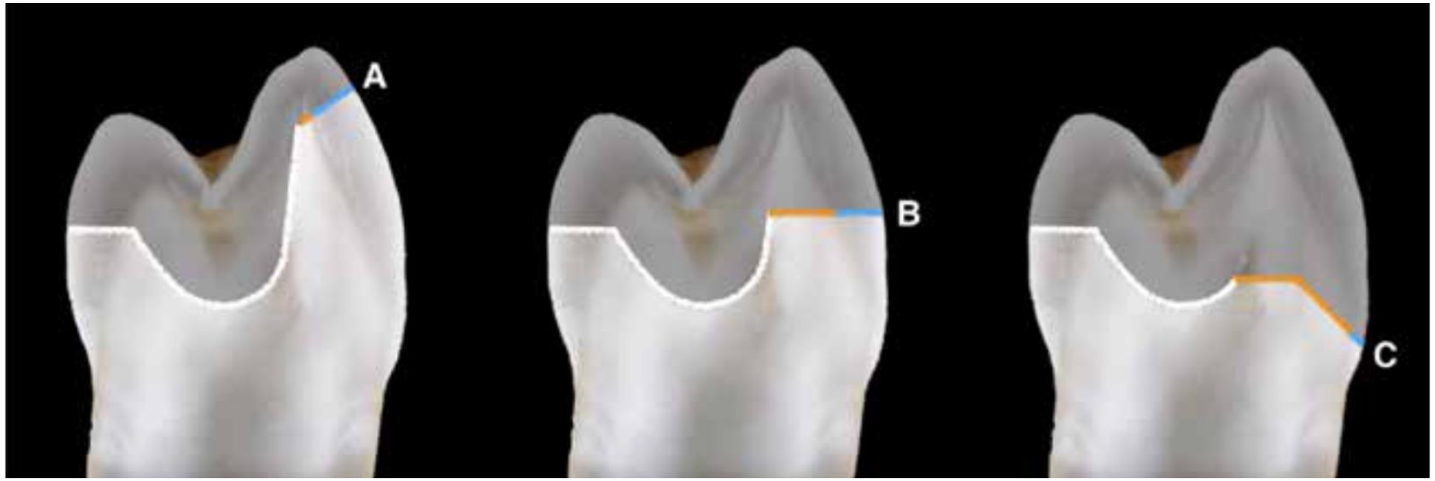
Reich S & Hofman J

Inlay and Onlay

Position of Buccal margin



Avoid contact points

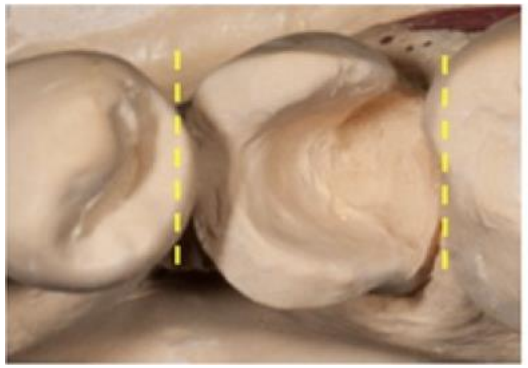


(a) Ultraconservative buccal cusp coverage.
(b) Conventional buccal cusp coverage.
(c) Full buccal cusp coverage (VONLAY).

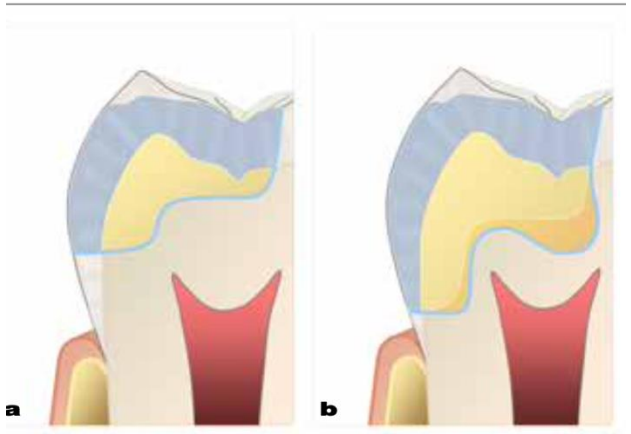
For aesthetics: the simplest and most ideal situation is for the restoration margins to be located in the incisal or cervical thirds.

Rocca et al 2015

Inlay and Onlay



- Absence of contact between the preparation and the adjacent teeth.



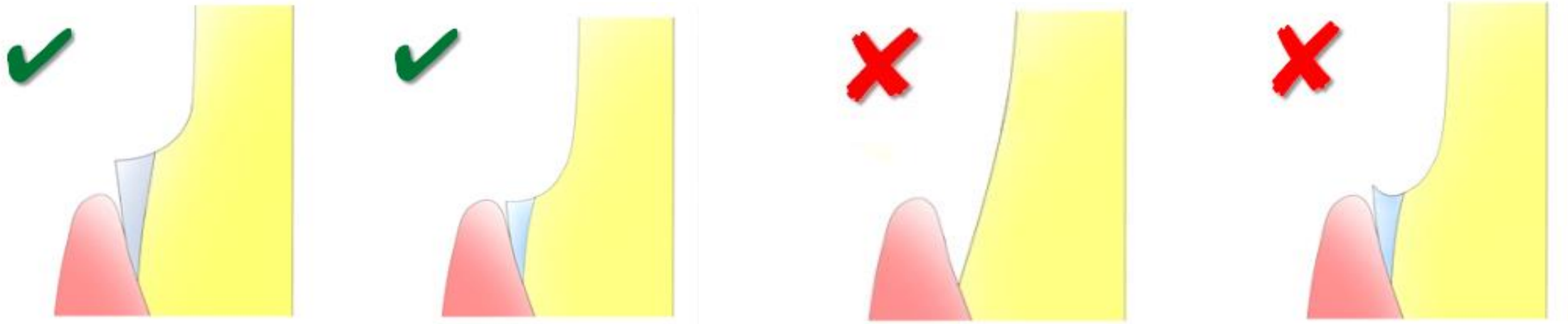
- Drop down the margins in order to obtain an optimal, natural proximal emergence profile of the future restoration.

Eg: closing diastemas

Inlay and Onlay

Margins

- **No** aspect of the margin should be located in an **undercut and no unsupported enamel**



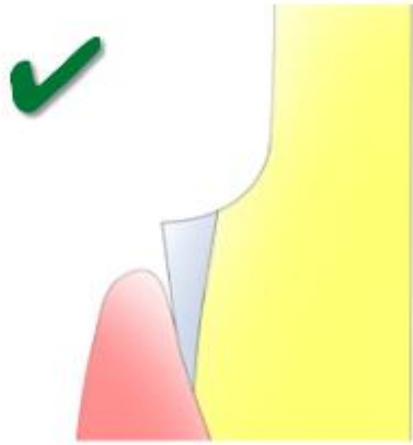
Deep Chamfer, Modified Shoulder
Supra or equigingival

Feather edge
Subgingival

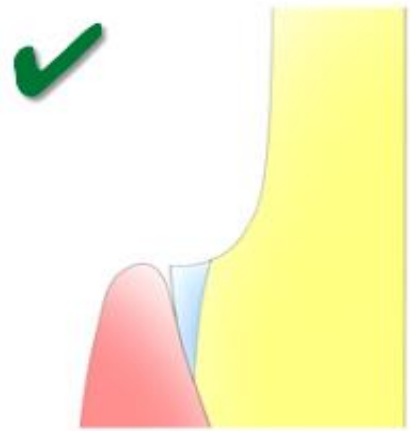
"Gutter" margin preparation

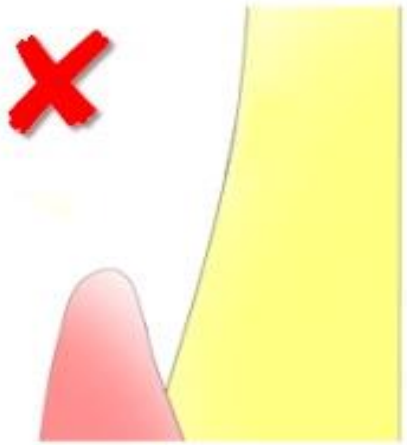
Inlay and Onlay

Margins

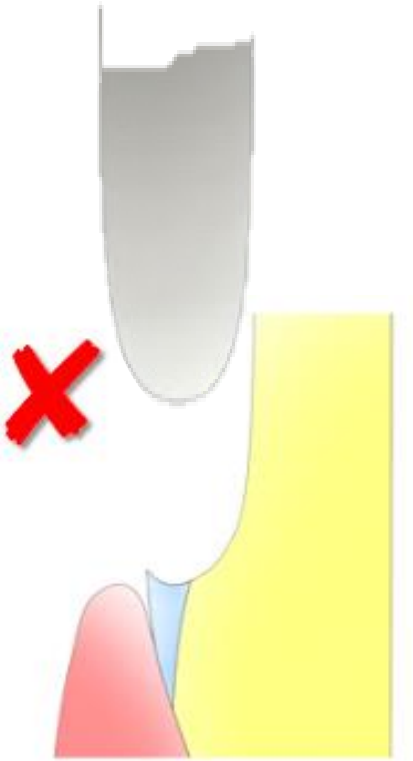


Deep Chamfer, Modified Shoulder
Supra or equigingival





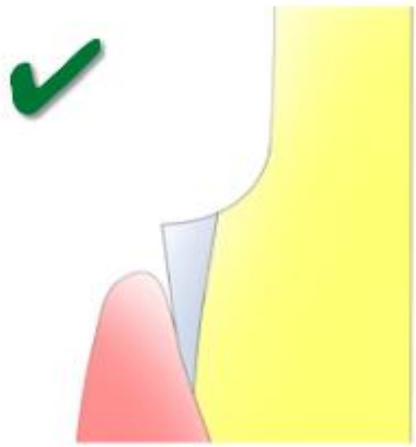
Feather edge
Subgingival



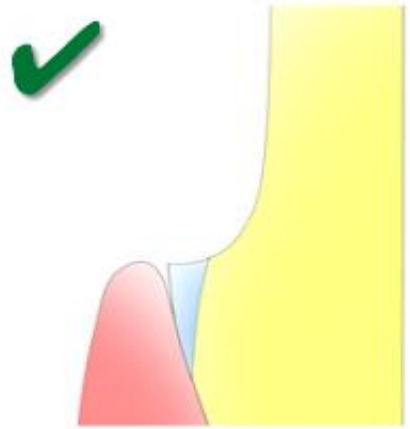
"Gutter" margin preparation

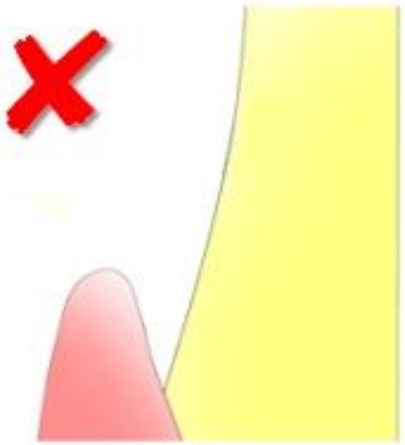
Inlay and Onlay

Margins



Deep Chamfer, Modified Shoulder
Supra or equigingival





Feather edge
Subgingival

"Gutter" margin preparation

Inlay and Onlay

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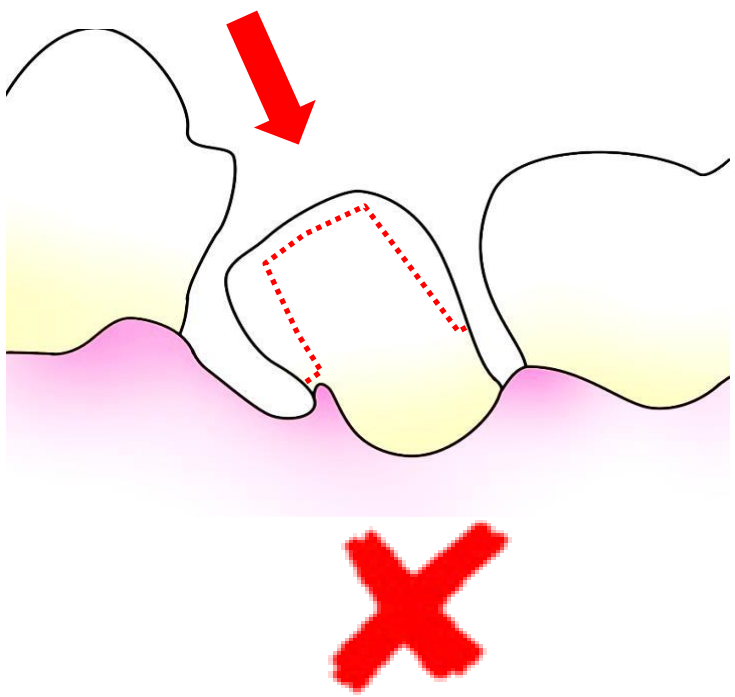
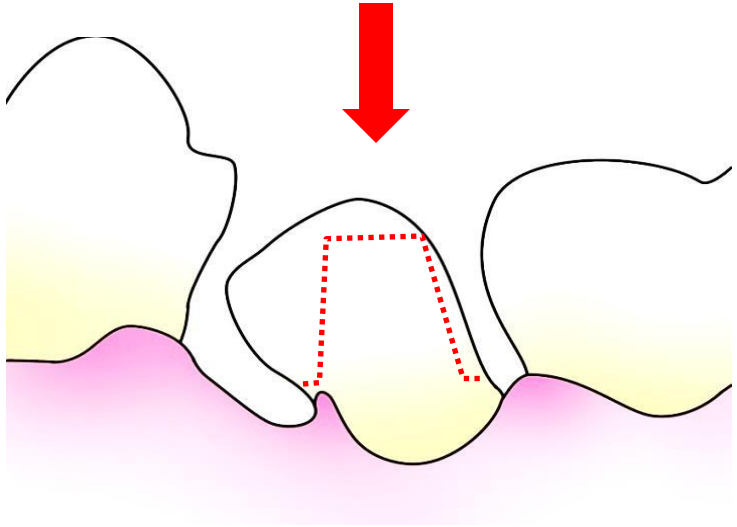
Path of Insertion





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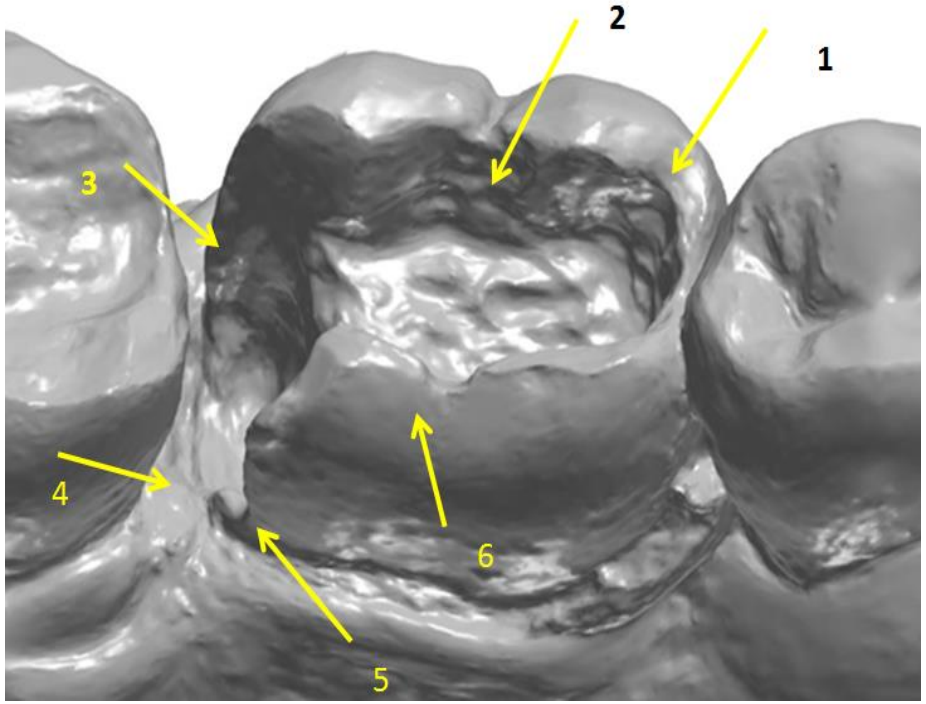
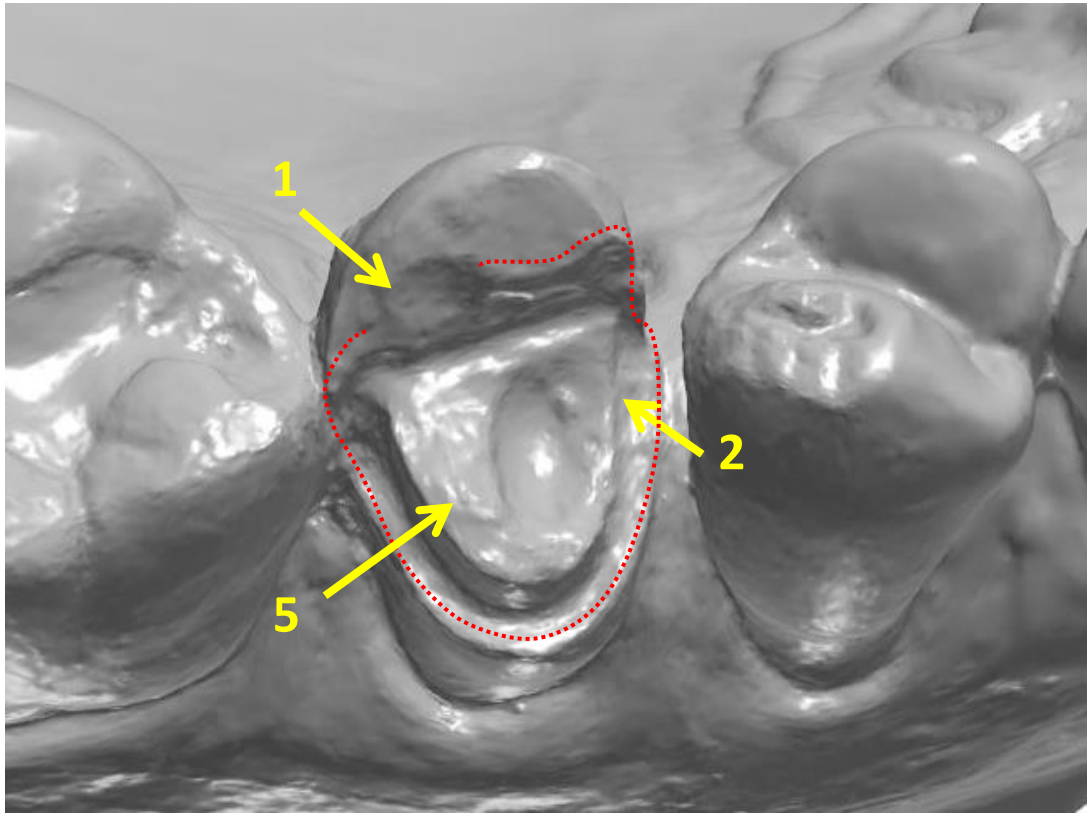
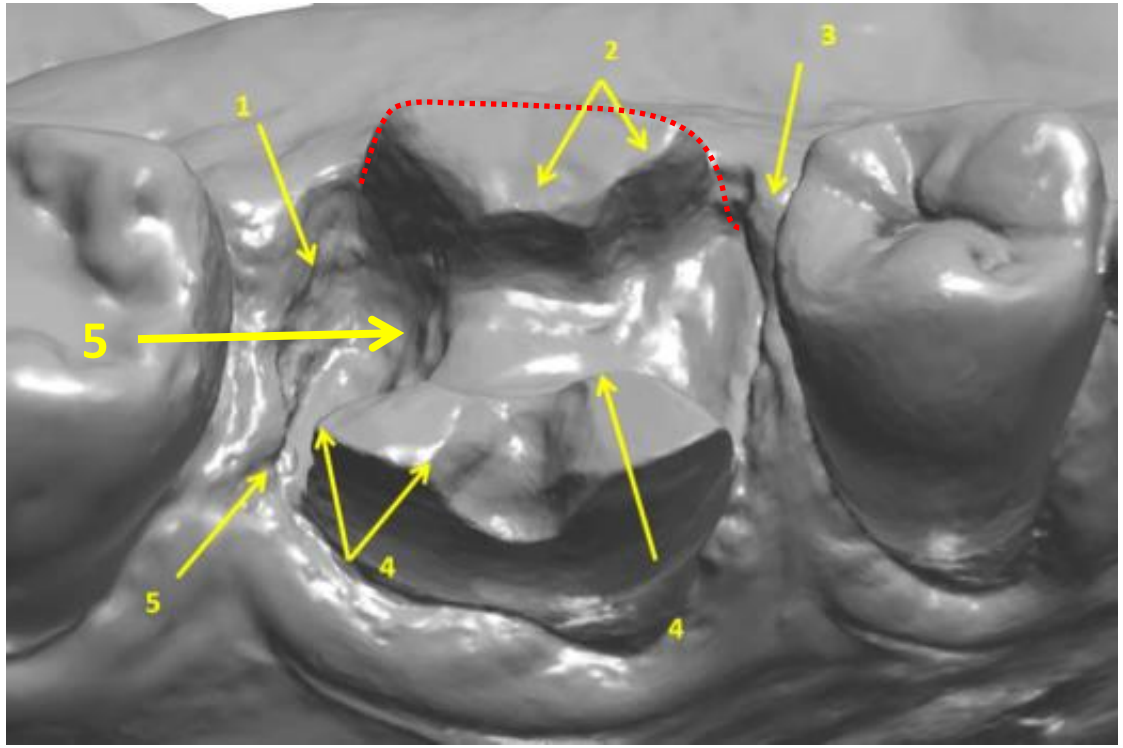
- Smooth surfaces



Finishing of preparation should be with a bur with a grit size of no more 50 microns (Red band)

Inlay and Onlay





Accessibility of subgingival margins

Inlay and Onlay

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Morphology Driven Preparation

- Bonded restorations
- **Immediate dentin sealing** and **cavity design optimization** (after tooth preparation):
  - -avoid unnecessary removal of tooth structure
  - -protect the pulpodentinal structures from any con- tamination/disturbance during temporarization
  - -stabilize and improve the adhesive interface quality.
- **Deep Margin Elevation**

(Old) Conventional Preparation

- Cemented or bonded
- Deep occlusal box
- Width of occlusal isthmus ≥ 2 mm
- Geometrical reduction
- More suitable for indirect non-adhesive restorations.

Veneziani 2017

Inlay and Onlay

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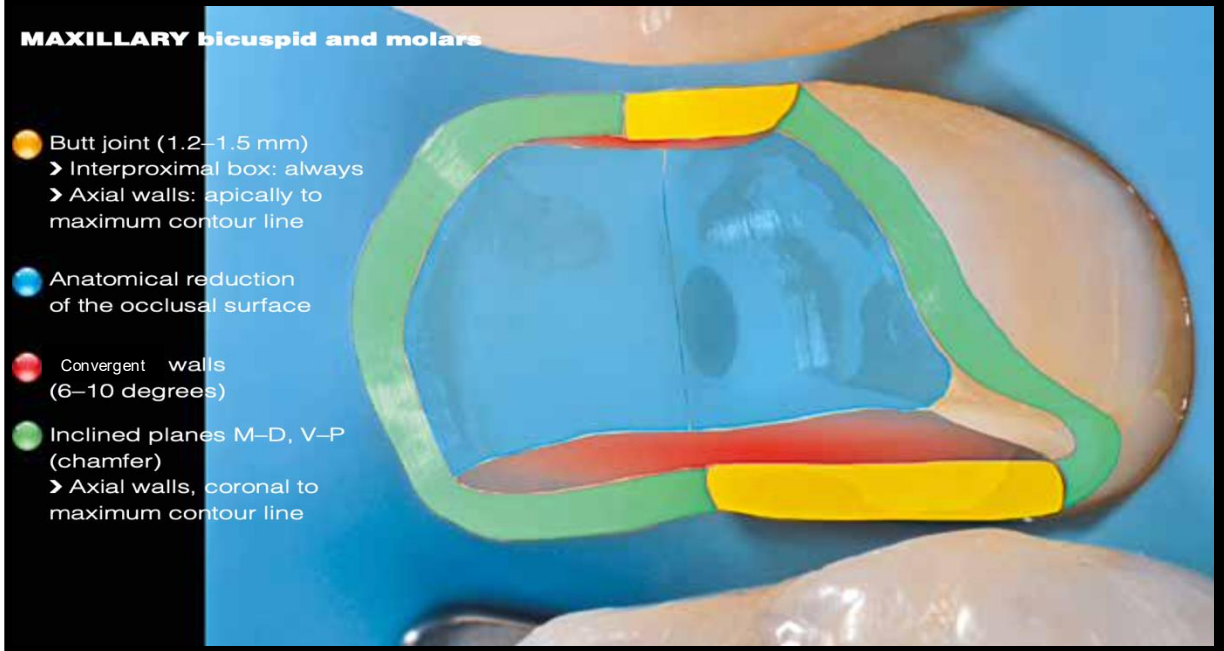
Morphology Driven Preparation



Veneziani 2017

Inlay and Onlay

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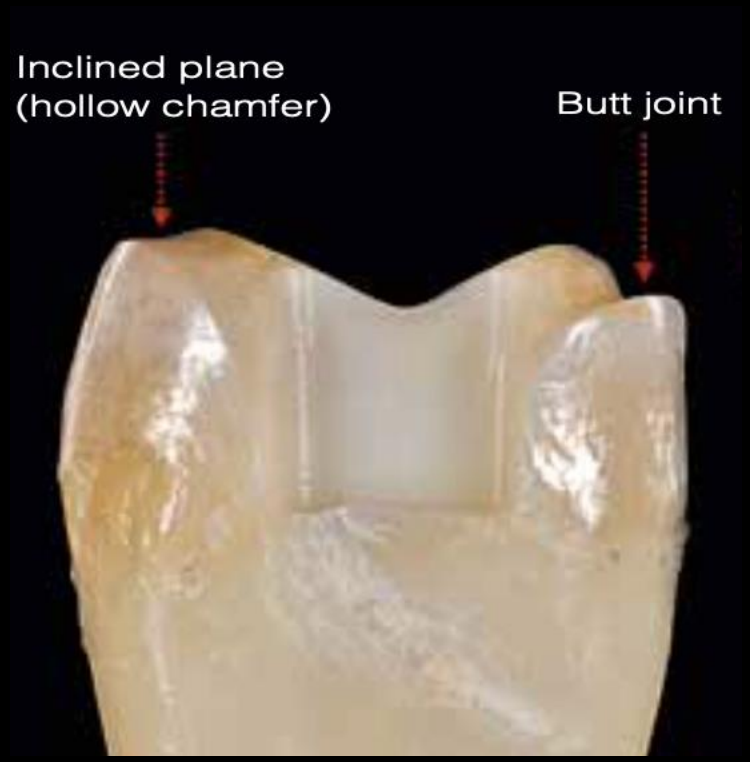
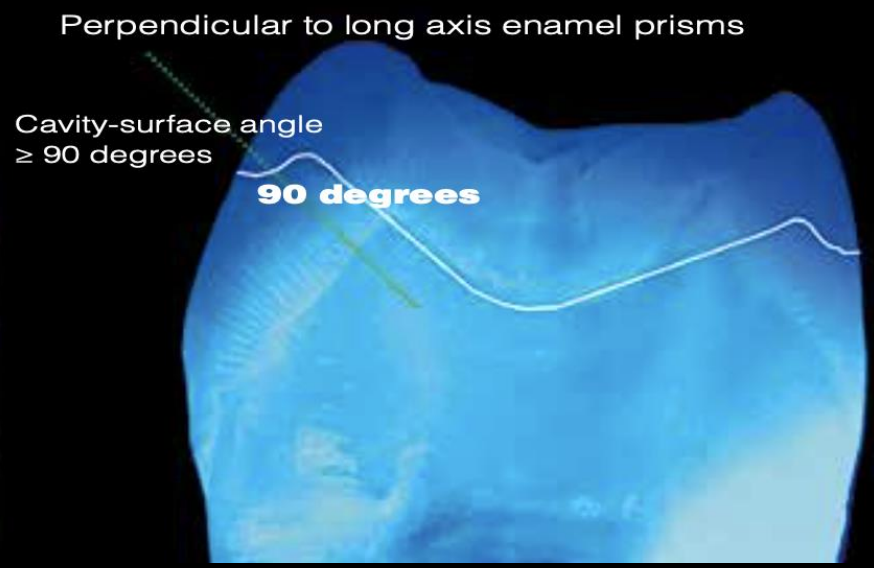
Morphology Driven Preparation





Veneziani 2017

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Morphology Driven Preparation

Veneziani 2017

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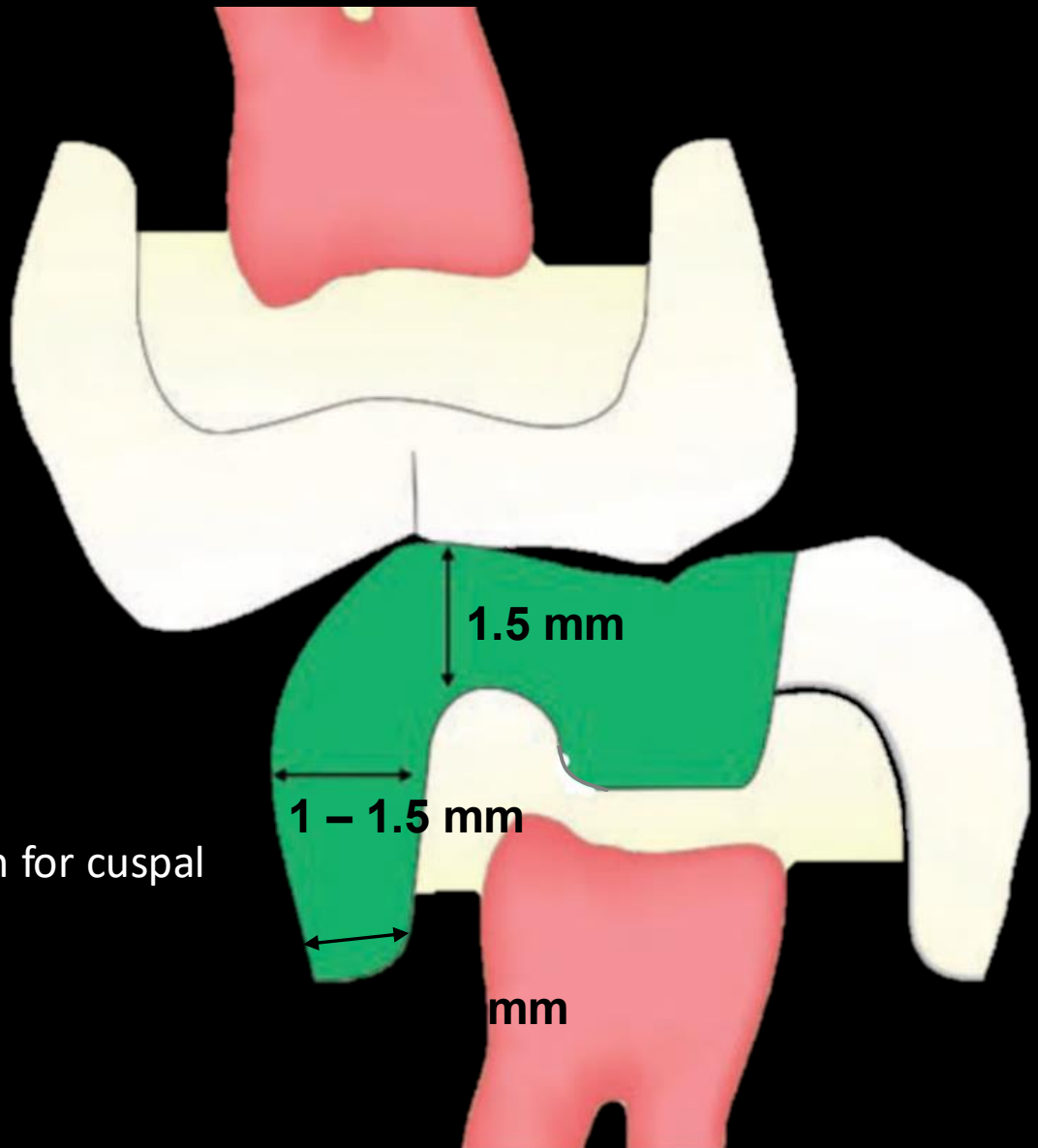
AMOUNT OF REDUCTIONS



- 1 to 1.5 mm of axial wall reduction
- 1.5 mm at least of occlusal reduction for cuspal coverage
- Margin 1 mm if present

Inlay and Onlay

Checklist before before impression or scanning:

1. Well defined sharp margins
2. No undercuts, no sharp internal line angles
3. Smooth surface
4. Accessibility to all margins, especially subgingival margins
5. Absence of contact between the prep margin and the adjacent tooth.
6. Adequate interocclusal space.

Inlay and Onlay

Interim Restoration

Non-cemented “semi-rigid” light-curing resin

Telio
Ivoclair

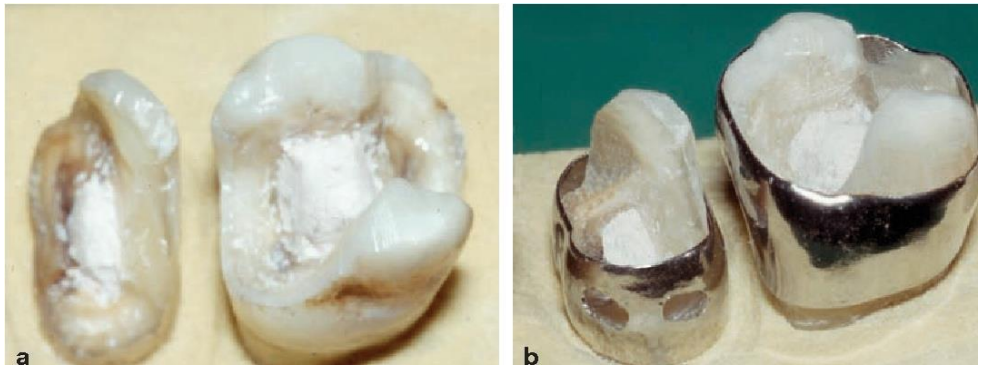
Prep isolated with Vaseline at the periphery and over the axial walls before applying the material

Rocca et al 2015

Inlay and Onlay

Interim Restoration

Self-curing material



Jensen 2007

Inlay and Onlay

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DIRECT TECHNIQUE

Bis-Acryl composite

Partial Coverage Restorations

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- Abduo and Sambrook. Longevity of ceramic onlays: A systematic review J Esthet Restor Dent. 2018 May;30(3):193-215.
- Edelhoff et all. Pressable lithium disilicate ceramic versus CAD/CAM resin composite restorations in patients with moderate to severe tooth wear: Clinical observations up to 13 years. J Esthet Restor Dent. 2023;35:116–128.
- Hickel and Manhart. Longevity of restorations in posterior teeth and reasons for failure J Adhes Dent. 2001 Spring;3(1):45-64.
- Reiss and Walther. Clinical long-term results and 10-year Kaplan-Meier analysis of Cerec restorations. Int J Comput Dent. 2000 Jan;3(1):9-23.
- Arnetzl & Arnetzl. Biomechanical examination of inlay geometries--is there a basic biomechanical principle?. Int J Comput Dent. 2009;12(2):119-30.
- Edelhoff & Sorensen. Tooth structure removal associated with various preparation designs for posterior teeth. Int J Periodontics Restorative Dent. 2002 Jun;22(3):241-9.
- Hopp & Land. Considerations for ceramic inlays in posterior teeth: a review. Clinical, Cosmetic and Investigational Dentistry 2013:5 21–32
- Rocca et al. Evidence-based concepts and procedures for bonded inlays and onlays. Part II. Guidelines for cavity preparation and restoration fabrication. Int J Esthet Dent. 2015;10(3):392-413.
- Veneziani. Posterior indirect adhesive restorations: updated indications and the Morphology Driven Preparation Technique. INT J ESTHETIC DENT 12:2 2017
- Edelhoff et. All. Clinical performance of occlusal onlays made of lithium disilicate ceramic in patients with severe tooth wear up to 11 years. Dental Materials. 35:9, 2019, Pages 1319-1330