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Posterior preparation for indirect restoration

A Project Submitted to The College of Dentistry, University of Baghdad, Department of conservative dentistry in Partial Fulfillment for the Bachelor of Dental Surgery

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Declaration

I certify that this project entitled “Posterior preparation for indirect restoration” was prepared by the fifth-year student

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CONTENTS

List of Figures

1.Introduction

The daily clinical use of posterior indirect adhesive restorations (PIAR) (Figure.1) is very frequent in cases of cavities with extended coronal destruction. (FEDERLIN2006,ROULET1997)The preparation for an adhesive partial restoration allows for a greater preservation of healthy tissue than one for a full-crown metalfree preparation.
(EDELHOF2009,ALFOUZAN2013,MURPHY2009)The typologies of cavities that have to be restored in the posterior area may have the following shapes once they are clean and prepared: inlay (a cavity that does not need any cuspal coverage), onlay (a cavity with coverage of one or more cusps), overlay (a specific onlay typology with complete cuspal cover- age), and veneerlay (an overlay with the involvement of the buccal wall and a preparation combined with a laminate veneer). In order to complete this type of indirect posterior restoration, it is appropriate to consider the full crown, as this procedure foresees the coverage of the full clinical crown. Modern dentistry offers many restorative solutions with various approaches and the use of a range of different materials. The advent of adhesive techniques and their predictability.(PEUMANS, M2003) has profoundly changed the clinical scenario, modifying some fundamental principles of classic dentistry. In the case of PIAR, these advantages are well represented. The use of adhesion in restoration has unquestionably led to some advantages, including conservation, sealing, function, and esthetics.

If PIAR follows specific clinical protocols a careful evaluation of the indications, a design of the preparation suitable to the clinical situation, the right choice of restoration materials, adequate dental impression taking and restoration manufacture, and an adequate cementation protocol it is possible to make a difference regarding the prognosis(BLATZ, M)and the comfort of the patient, in addition to an excellent esthetic integration. Our experience in daily clinical practice (as well as common sense) suggests that the uncoordinated use of isolated procedures cannot give a predictable result; rather, a consolidated and codified protocol is necessary to achieve this.

Figure. **1** Posterior indirect adhesive restorations (PIAR) made with layered resin-based composite material. The buccal parts are for a cuspal cover- age only, and the palatal surfaces are for a more extended coverage (Ferraris, 2017)

2. Posterior indirect adhesive restorations

2.1. Indications of indirect retorations

- Medium- to large-sized cavities where one or more cusps are missing.
- Cavities where the inclusion of at least one cusps is fitting to work on the guess of the complex reestablished tooth.
- Morphological alteration or potentially raising of the back occlusal vertical dimensions (OVO) in instances of oral recoveries on components where a full-crown rebuilding would be excessively in-vasive..
- Cracked tooth syndrome, when the symptomatology should be man-matured fully intent on keeping up with the vitality of the tooth.
- Multiple medium- to large-sized cavities in the same quadrant (even if indirect inlay restorations are not the first choice)(FERRARIS, F. 2017)

2.2 Contraindications of indirect restoration

- Deep subgingival preparations this is certifiably not a flat out contraindication, Deep subgingival preparations edges ought to be kept away from. These edges are hard to record with an impression and are challenging to finish. Moreover, attaching to enamel edges is enormously liked, particularly along gingival edges of proximal boxes(FERRARI1999, H PURK2006).
- Weighty occlusal forces Ceramic restoration efforts might break when they need adequate mass or are liable to exorbitant occlusal stress, as in patients who have bruxing or holding propensities(VAN DIJKEN2010)
- Powerlessness to keep a dry field(MEYER2006, EL-KALLA1997)

2.3 Advantages of indirect restoration

- Making an optimal life structures of occlusal surfaces,with great control of contact focuses and development profiles(VENEZIANI, M. 2017)
- the possible use of ceramic materials such as lithium disilicate-reinforced glass-ceramics(VENEZIANI, M. 2017)
- Photothermal treatment (130°C for 7 min) works on the level of change of the composite and the physiochemical properties of the reclamation
- The possibilityof an occlusion evaluation with an articulator(VENEZIANI, M. 2017)
- This strategy emphatically diminishes the restoring shrinkage that happens outside the cavity, working on the peripheral sealing. The last curing shrinkage is in the thin layer of resin cement(VENEZIANI, M. 2017)
- Biocompatibility and great tissue reaction: Ceramic materials are thought of as the most synthetically dormant of all materials. They are biocompatible and generally related with a decent delicate tissue reaction(ST JOHN2007)
- Most indirect strategies permit the manufacture of the rebuilding to be absolutely or to some extent appointed to dental lab technicians(FASBINDER2010) Such delegation considers more effective utilization of the dental specialist's time.
- Ceramic restorations are more wear safe than direct composite restorations efforts. Laboratory-processed composite restorartion wear more than ceramics, however not exactly direct composites in lab studies(FASBINDER2010)

2.4 Disadvantages of indirect restoration

- Short clinical track record:Indirect bonded toothcolored restoration have become somewhat famous just as of late and are as yet not put by a large number. Not many controlled clinical preliminaries are accessible, so the long-term durability of these restorations although expected to be great, isn't especially very much recorded(VAN DIJKEN1998, ARNELUND2004)
- Resin-to-resin bonding hardships: Laboratory-handled composites are profoundly cross-connected, so not many twofold bonds stay accessible

for chemical adhesion of the composite cement .Therefore the composite reclamation should be precisely scraped or potentially synthetically treated to work with attachment of the cement(AL-HIYASAT1999) .

- Wear of restricting dentition and restoration: Ceramic materials can cause inordinate wear of contradicting enamel as well as restoration. Late upgrades in ceramic production have decreased this issue, however ceramics,particularly if unpleasant and unpolished, can wear contradicting teeth and restoration(AL-HIYASAT1999)
- Low potential for repair-Indirect restorations, particularly ceramic inlays/onlays, are difficult to repair in the event of a partial fracture(VAN DIJKEN1998)
- Difficult intraoral polishing: Indirect composite restorations can be polished intraorally with the same instruments/ materials used to polish direct composites. Ceramics, on the other hand, are more difficult to polish after they have been cemented because of either limited access or lack of appropriate instrumentation(VAN DIJKEN1998)
- Diavergent wall of the restoration preparation lead to wedging effect which may increase fracture possibility(VAN DIJKEN1998)
- Increased cost and time.
- Technique sensitive.
- Weakness of ceramics:A ceramic restoration can crack on the off chance that doesn't give sufficient thickness to oppose occlusal forces or potentially that the restoration isn't properly supported by the cement medium and the arrangement. Breaks can happen either during attempt in or after cementation, particularly in patients who create abnormally high occlusal forces(MAGNE2010)

2.5 Direct composite vs indirect composite

2.5.1. Esthetic quality

With respect to color match and staining, a point by point report was given by Pallesen and Qvist, where inlay scored better compared to fillings. Shading match and staining of the edge were 44%-half individually for indirect inlay and 33%-26% for fillings which is accounted for as a huge contrast just for marginal staining, in favor fillings..

In the Cetin trial, at five-year evaluation, color match was predominately scored as Alpha for all groups. At the same time marginal discoloration was scored as Alpha for both direct and indirect composite restorations but there was statistical significant differences between two direct materials (AA 64%: AELITE Bisco, Schaumburg, IL, USA and TEC 95% Tetric Evo Ceram).

The meta-examination of Pallesen and Qvist and Cetin preliminarie ,indicated no statistically significant differences in the risk of shading match between the two strategies. Nonetheless, generally peripheral staining hazard proportion was measurably for direct inlay.

2.5.2. Marginal adaptation

Class II cavities were ready on 34 extracted human molar teeth. The cavities were arbitrarily isolated into two gatherings as indicated by the inlay fabrication. The main group was straightforwardly reestablished on cavities with a composite after isolation,The second group was in a indirect way reestablished with a similar composite material. Marginal adaptation were checked before cementation,restorations were established with a self adhesive resin cement (SmartCem2, Dentsply), marginal adaptation were again estimated with OCT. Direct inlay. introduced more minimal inconsistency than indirect inlay. The marginal discrepancy values were expanded after cementation refer to cement thickness(TÜRK2016)

2.5.3. Postoperative sensitivity

Regarding postoperative sensitivity, Cetin et al.reported sensitivity to 4% of the restorations (three indirect, one direct); however only one indirect inlay required canal treatment and replacement after two years.(CETIN2013)
Similarly, Pallesen and Qvist. found 7% and 10% of post-operative sensitivity for direct and indirect inlays respectively. The findings suggest that there is insignificant difference between the two methods(PALLESEN2003)

2.5.4. Secondary caries

In the Pallesen and Qvist study , a somewhat low recurrence of secondary caries was distinguished for the direct and indirect restoration.. All the more explicitly, two direct restorarion (4%) had been identified with secondary caries in the proximal gingival region at 5 and 9.2 years. Four indirect inlay (6%) in four teeth were determined to have secondary caries at 6.5, 6, 8 and 8.8 years individually. Cetin et al. in his RCT required substitution of just one direct composite restoration (member from TEC group) because of secondary caries, following three years. The meta-analysis. demonstrated no statistically huge in the risk ratio between direct versus idirect composite inlay in this perspective. Culster analysis was not performed for this boundary, as in Cetin et al. concentrate on just a single occasion was available. At last, in the Fennis et al. concentrate on secondary caries has been accounted for at only one indirect inlay(FENNIS2013)

2.6. Types of indirect posterior esthetic restoration

2.6.1. Conventional indirect restorations

2.6.1.1. Onlay

Are restorations that to some degree cover cusps, however not the entireocclusal surface. They are shown in class II cavities of large dimensions with lateral walls dividers to some extent supported without dentin cracks. On account of endodontically treated teeth, the presence of no less than one peripheral edge, and two well-supported axial walls in continuity with peripheral edge itself, are required.Both composite or ceramic can be utilized.(MAGNE2006)

Figure. 2 Inappropriate pre-existent restoration with fracture of the material and noticeable marginal infiltration. (Veneziani, 2017)

Figure. 3 Onlay cavity preparation with partial cuspid coverage after thorough cleansing of the decay and adhesive build-up.

Figure. 4 8-year follow-up with excellent preservation of the morphology, function, esthetics, and marginal integrity.(Veneziani, 2017)

2.6.1.2. Inlay

- Are restorations without cusp inclusion, and would be demonstrated in teeth with saved vitality in medium to enormous class II cavities (MO/DO, MOD), with all around protected buccal and oral walls. Composite is the best material. Presently, this kind of restoration is regularly performed with an direct procedure, hence getting similar predictability with a more conservative approach. (VENEZIANI, M. 2017)

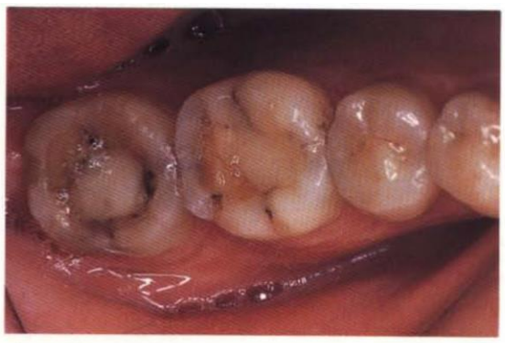


Fig 5 Preoperative view showing repeated failure of different restorations on mandibular molar, caused by patient's bruxing habits and opposing ceramic crowns.

Fig 6 Two occlusal inlays being tried in. Note apparent lack of color blend due to air refraction space.

Fig 7 Two simple restorations luted in position, restoring stiffness, tooth esthetics, and resistance to abrasion. Note color blend once composite resin is placed under porcelain.

2.6.1.3 Overlays

Are total cusp-coverage restorations,indicated in class II cavities of large dimensions with absence of support to axial walls and lack of marginal enamel and dentin (in vital teeth), and the deprivation of marginal ridge endodontically treated teeth, requires complete coverage, even with slight remaining residual walls of satisfactory thickness.Composite or ceramic can be utilized (VENEZIANI, M. 2017).

Ceramic (lithium disilicate glass-ceramic) is the best option material on account of various multiple restorations with wide coverage. Besides, dueto its major strength and capacity to settle the cusp, ceramic is the best option for teeth impacted by crack tooth syndrome,using it with an all out cusps covering (MAGNE2010)

Fig.8 E.Buildup in composite material and preparation of the molar for indirect restoration,**F.** Composite overlay. **G**, Adhesive cementation of the overlay. **H**, Clinical check. (VENEZIANI, M. 2017).

2.7. Types of preparation

2.7.1Proximal preparation designs

- There are three types of approaches for the interproximal areas according to the adhesthetics protocol: slot, bevel, and ridge up. (FERRARIS, F. 2017)
- Slot: a frequent interproximal preparation is represented by this design, which has a rounded shoulder (coherent with the shoulder preparation), generally of about 1 mm. One reason for this preparation being so widespread is because this type of shoulder is naturally determined after the excavation of an interproximal carious lesion, allowing for the creation of a central reconstruction to the dental crown. (FERRARIS, F. 2017)
- Bevel: a less intrusive preparation compared with the slot for reestablishing the interproximal region without going in too profoundly at the cervical level. This configuration offers a few benefits for a bevel preparation , for example, a surface of enamel, which improves the cement cementation system. This restoration is indicated when a broad restoration should be made to the interproximal region without a past carious lesion, and confined cervically contrasted with the contact region. (FERRARIS, F. 2017)

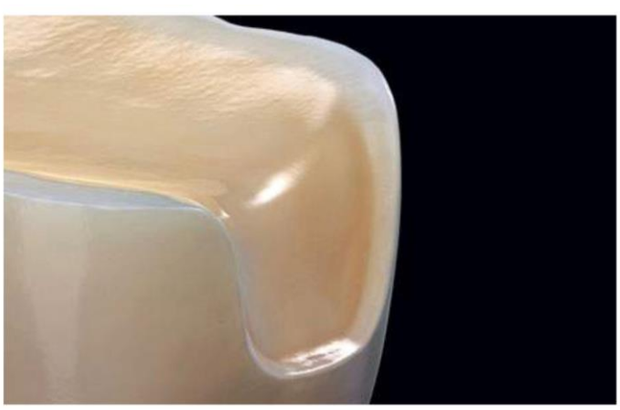


Figure. 9 Slot interproximal preparation. This kind of design is very common, especially when a previous carious lesion has affected the area. (Ferraris, 2017)

Figure. 10 Bevel interproximal preparation. This approach is more conservative compared with slot interproximal preparation.

- Ridge up: the ridge preservation variant of this approach allows for the maintenance of the integrity of the marginal ridge, while the ridge coverage variation takes into account insignificant surface preparation , saving the contact area that has not clearly experienced carious lesions. Considering that the ridge is one of the main underlying components as to the respectability of the nonvital tooth, in instances of diminished thickness of the adjacent cusps one can select a cuspal coverage with the maintenance of the edge. The indication for this type of preparation is a cuspal coverage with the purpose of structural protection, but with a good integrity of the ridge and the absence of cavitated carious lesions(NG, Y. L.2010)

Figure 11 Ridge up interproximal preparation. The most conservative approach for the ridge when a cuspal coverage(Ferraris, 2017)

Figure. 12 Ridge up interproximal preparation. the ridge is slightly prepared.(Ferraris, 2017)

2.7.2 bevel preparation

Is like the butt joint but with the significant distinction of the existance of a inclined bevel, for the most part of 45 degrees or more, for a normal length of 1 to 1.5 mm, which can be more extended in exceptional cases. This beveling is commonly present on the buccal side, however can likewise be on the palatal side (eg, in cases where the cracking of the enamel within the preparation should be included or when more thickness and support is required for a restoration on a working cusp). Where there is a bevel overall boundary, the variation of a full bevel can be thought of. (VENEZIANI, M. 2017)

Figure.13 Bevel preparation. This kind of design is a variant of the butt joint, where it is possible to create a bevel (usually between 1 and 1.5 mm in length) on one or more surfaces. In this case, it is evident on the buccal side.(Ferraris, 2017)

Figure.14 (Ferraris, 2017) Shoulder preparation. A rounded shoulder characterizes this preparation design. The depth of the shoulder is usually around 1 mm

Indications for a bevel preparation:

- Esthetic need for a more gradual integration of the restoration-tooth transition.
- Wider surface of external enamel, which enhances adhesive cementation procedures.
- To create more space for the restoration in the peripheral zone.

2.7.3 butt joint preparation

The butt joint requires minimal preparation and is therefore suitable for adhesive techniques. It is represented by an occlusal reduction that follows the evolution of the cusps and the main sulcus, so is generally flat but with an inclined surface. At the level of the finishing line, the butt joint should have an inclined trend toward and follow the occlusal surface, which is then made more horizontal.
Indications for a butt joint preparation:

- Cuspal reduction to protect the teeth from the occlusal load.
- Cuspal fracture in the area of the occlusal third (or middle third, in some cases).
- Presence of strong abrasions/erosions of the occlusal surface (with the
  - possibility of increasing the vertical dimension). (FERRARIS, F. 2017)

Figure 15 Butt joint preparation, which is not flat but mainly follows the inclination of the occlusal plane. The more peripheral margins (buccal and lingual) have a more horizontal design Butt joint preparation, which is not flat but mainly follows the inclination of the occlusal plane. The more peripheral margins (buccal and lingual) have more horizontal design(Ferraris, 2017)

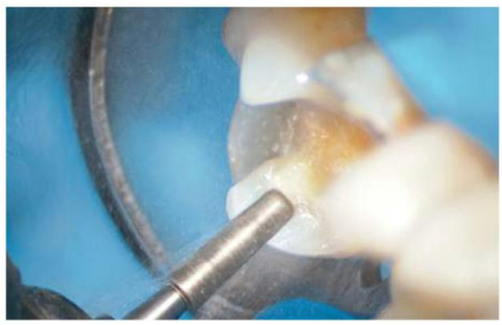


Figure 16 Occlusal reduction for a cuspal coverage when the residual thickness is not considered adequate for a medium to long term prognosis. This kind of bur should have depth mark (Ferraris, 2017)

2.7.4 shoulder preparation.

The shouulder is a preparation defined by a rounded shoulder that develops on the design's periphery. The build-up (or block out) represents the center component, which is usually formed of a resin-based material. The shoulder is around 1 mm thick, allowing for the thickest enamel thicknesses conceivable, which improves adhesive cementation techniques. A mathematically determined bur with a slightly tapered shape and rounded inner corner must be used to manage the finishing line. (FERRARIS, F. 2017)

Indications for a shoulder preparation

- Previous cuspal fracture to the cervical third (or medium third in some cases), and then, by effect, the central build-up automatically defines the peripheral shoulder design.

- Where a greater structural protection is required for a cusp coverage with a cervical grasp. (FERRARIS, F. 2017)

Figure.17 Adhesive phases on a devitalized molar prepared for an overlay. The butt joint design repre- sents the cuspal coverage for three cusps, and the shoulder was performed on the distopalatal cusp where a fracture had occurred

Figure. 18 The overlay made on a mixed preparation(butt joint and shoulder) prior to cementation.

2.8. New cavity design (MorphologyDriven Preparation Technique)

The principles of traditional cavity design were derived from preparations meant for indirect non-adhesive restorations.These were characterized by a cavity design that ensured retention by the placement of shoulders, occlusal slots,and eventually pins, which could expose sound dentin with a significant loss of structural tissue . Apart from this,conventional preparations did not consider the real morphostructural and histoanatomical course in the tooth crown. (VENEZIANI, M. 2017)

Moreover, no clear data are reported in the literature about the correct level of the shoulders on the axial walls, leaving clinicians the task of preparing them according to their clinical experience. Furthermore,the traditional cavity design is not completely suitable for adhesive cementation because of the presence of isthmuses, shoulders, and rounded angles.Also, the width of the shoulders and of the onlays themselves seems to be excessive, and leads to an inadequate degree of luting composite conversion. (VENEZIANI, M. 2017)

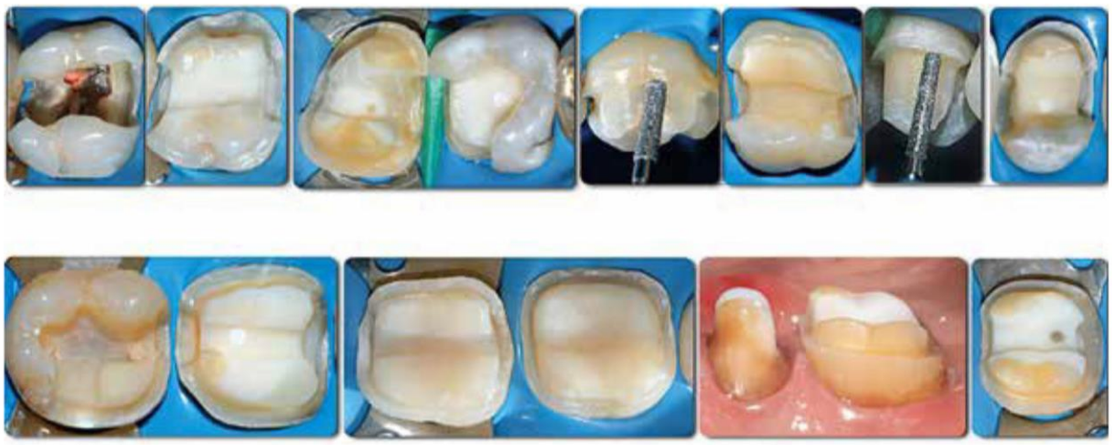


Figure.19 Clinical examples of old, conventional adhesive preparations of maxillary and mandibular molars and premolars.**(Veneziani,2017)**

The principles of MDPT are intended to Achieve these improvements

• To minimize as much as possible the loss of healthy tooth tissue by reducing the areas of dentin exposure.

• To guide tissue reduction of the occlusal surface with depth cuts or, better still, with a silicone index for thickness control.

• To reduce the width of the margins prepared as a shoulder, where indicated.

• To define a margin design that could improve the quality of the adhesion, optimizing the cutting of the enamel prisms and creating a greater surface of enamel.

- To improve the smooth insertion of the restoration during cementation
  To improve the esthetics of the transition zone between the tooth and the restoration(figures 48-52). (VENEZIANI, M. 2017)

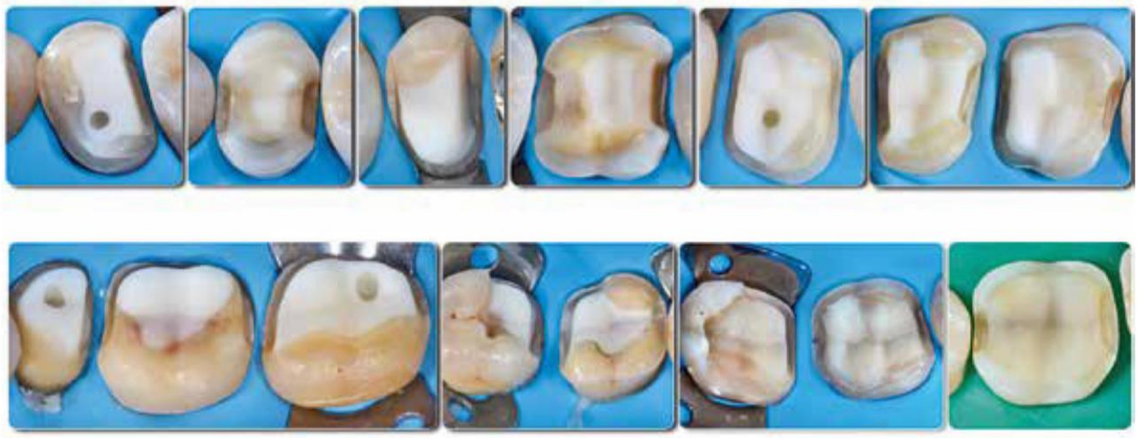


Figure.20 Clinical examples of new MDPT for adhesive restorations of maxillary and mandibular molars and premolars.(Veneziani, 2017)

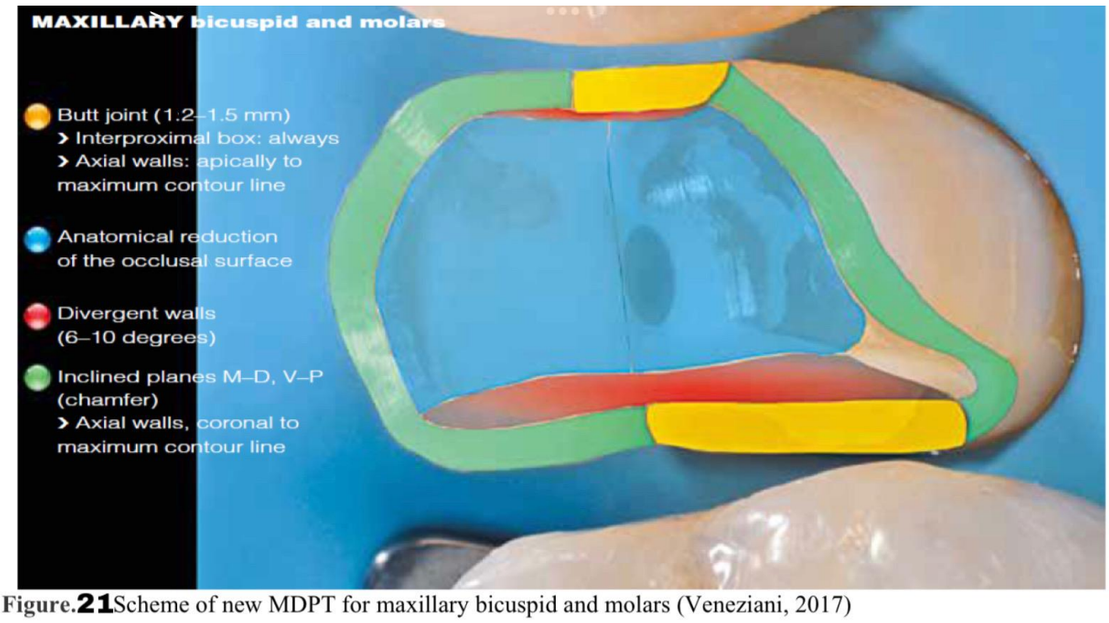


Figure.21 Scheme of new MDPT for maxillary bicuspid and molars (Veneziani, 2017)

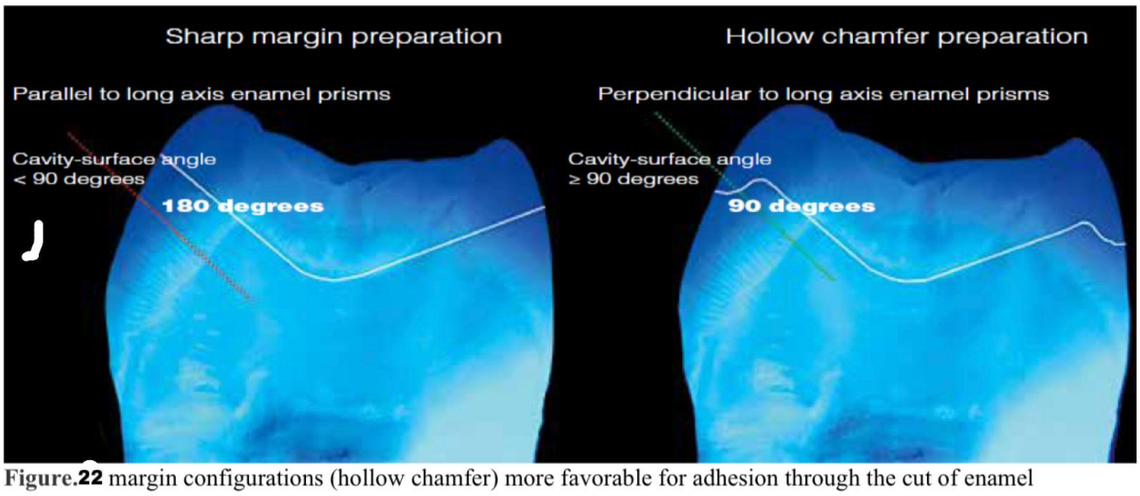


Figure.22 margin configurations (hollow chamfer) more favorable for adhesion through the cut of enamel prisms perpendicular to their longitudinal axis.(Veneziani, 2017)

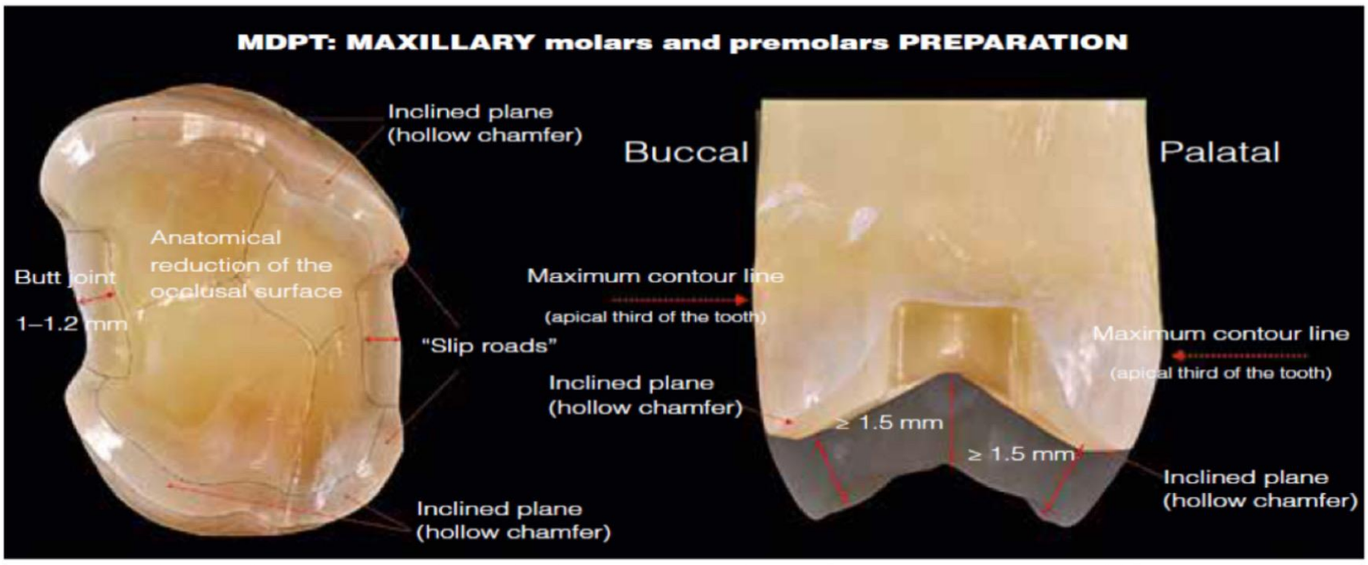


Figure.23 Scheme of preparation with MDPT for maxillary molars and premolars(Veneziani, 2017)

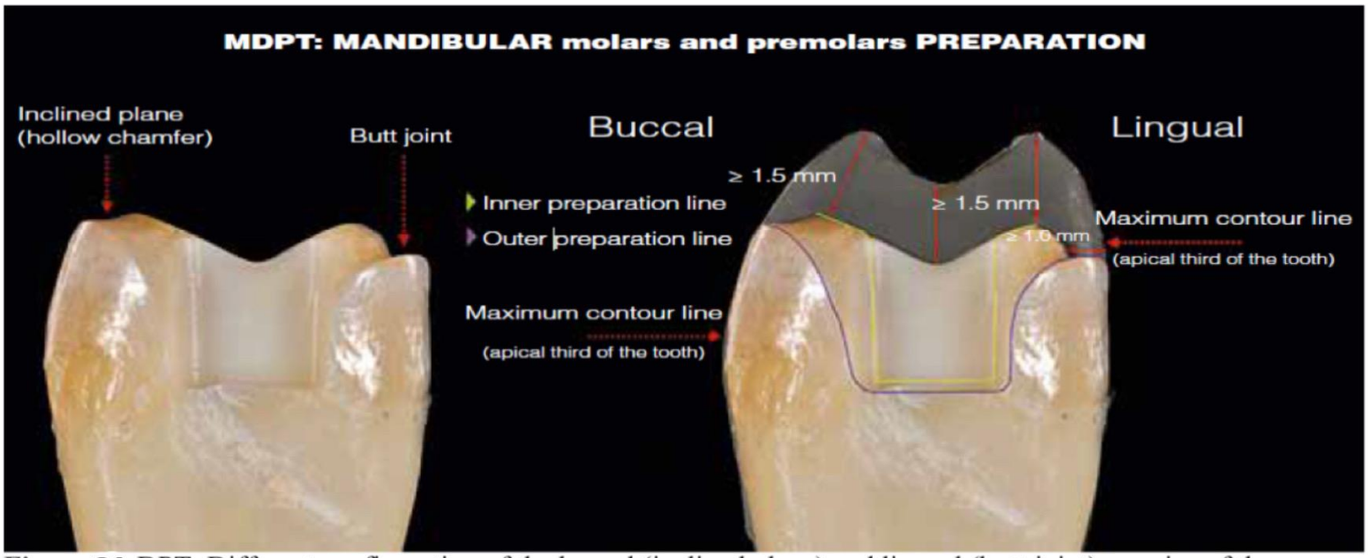


Figure.24 DPT: Different configuration of the buccal (inclined plane) and lingual (butt-joint) margins of the mandibular molar, according to the tooth maximum contour line.(Veneziani, 2017)

2.9. Newly developed indirect restorations

2.9.1 Overlay-veneer (or “veneerlay”)

This is done when a restoration incorporates the occlusal surface and extends to the entire buccal surface, either for cosmetic or functional reasons. It is used to treat teeth in esthetic areas (often maxillary premolars) that have severe hard tissue loss, are significantly discolored, and are resistant to bleaching. Ceramic is the gold standard material (lithium disilicate). (VENEZIANI, M. 2017)

Figure25 Maxillary bicuspid with previous composite restoration and signs of occlusal wear.

Figure26 Vestibular side with inadequate esthetic integration(Veneziani, 2017)

Figure. 27 Partial preparationwith coverage ofocclusal and buccal aspect in insulated field (Veneziani, 2017).

Figure 28 Lithium disilicate pressed overlay veneer (IPSe.maxPress). (Veneziani, 2017)

2.9.2 Occlusal-veneer (or “table-top”):

This is a non-retentive, thin (1 to 1.2 mm) bonded posterior occlusal partial-coverage preparation. It's best used when the occlusal surface is already eroding or when the vertical dimension needs to be raised in clinical restorative treatments.[15,28] When compared to ceramic occlusal veneers, an in vitro fatigue research found that CAD/CAM superthin (0.6 mm) composite resin occlusal veneers had much superior fatigue resistance. (VENEZIANI, M. 2017)

Figure.29 and **Figure .30**Maxillary and mandibular arches before treatment. There is a clear need to completely rehabilitate the arches because of inadequate restorations, abrasions, wear, and tooth discoloration(Veneziani, 2017)

Figure.31 Diagnostic wax-up of the maxillary and mandibular arches. Thereafter, a direct adhesive mock-up will be performed in the mandibular arch, (Veneziani, 2017)

Figure.32 First phase of rehabilitation of the mandibular arch on the lateral-posterior side with occlusal increasing the vertical dimension.veneer of teeth 34, 35, 44, 45, and 46. Tooth 36 is a metal-free crown on an implant.

Figure 33 Detail of minimally invasive preparations occlusal(Veneziani, 2017)

Figure34 The ultra-thin lithium disilicate pressed veneer (IPS e.max Press) of quadrant 4 after cementation

2.9.3 Long-wrapoverlay

The entire occlusal surface is restored in this procedure. Depending on hard tissue loss and soft tissue profile, it can extend to the buccal and/or palatal-lingual axial walls. In the presence of significant carious lesions, abrasions, biocorrosions, or fractures involving the exterior surfaces, it is indicated in teeth that require complete cuspal coverage extended to axial walls. Ceramic (lithium disilicate) is the preferred material, though composite can only be recommended as a less expensive alternative. (VENEZIANI, M. 2017)

Figure.35 axillary bicuspid endodontically treated with significant loss of dental tissue.

Figure.36 Preprosthetic adhesive reconstruction made of composite with a fiber post(Veneziani, 2017)

Figure 37 Preparation for the adhesive crown. (a) Occlusal view. (b) Buccal view. Slightly supragingival margin allows for the insulation of the field with rubber dam.(Veneziani, 2017)

2.9.4 Additional overlay

This is a full-coverage or partial-coverage restoration that is done without the need for tooth preparation. In cases of anatomic repair of teeth with tissue loss due to erosion/abrasion or occlusal vertical dimension growth, it is advised. Ceramic (lithium disilicate) is the gold standard material, but composite can also be used. (VENEZIANI, M. 2017)

Figure 38 Implantprosthetic replacement of the maxillary right molar after sinus lift. The opposing molars are extruded and require require occlusal plan remodeling (Veneziani, 2017)

Figure.39 To make the rehabilitation of sectors1 and 4 easier, and to partially offset the deep bite, the vertical dimension was increased with the excution ofadditional overlays on the posterior teeth, and additional palatal veneer on the anterior teeth.(Veneziani, 2017)

Figure 40 A detail of teeth 26 and 27 with an excellent morphological functional esthetic integration

Figure .41 The maxillary arch after the rehabilitation (Veneziani, 2017)

2.10. Operative procedures for the indirect technique

2.10.1. Analysis of cavity factors and indications for restoration:

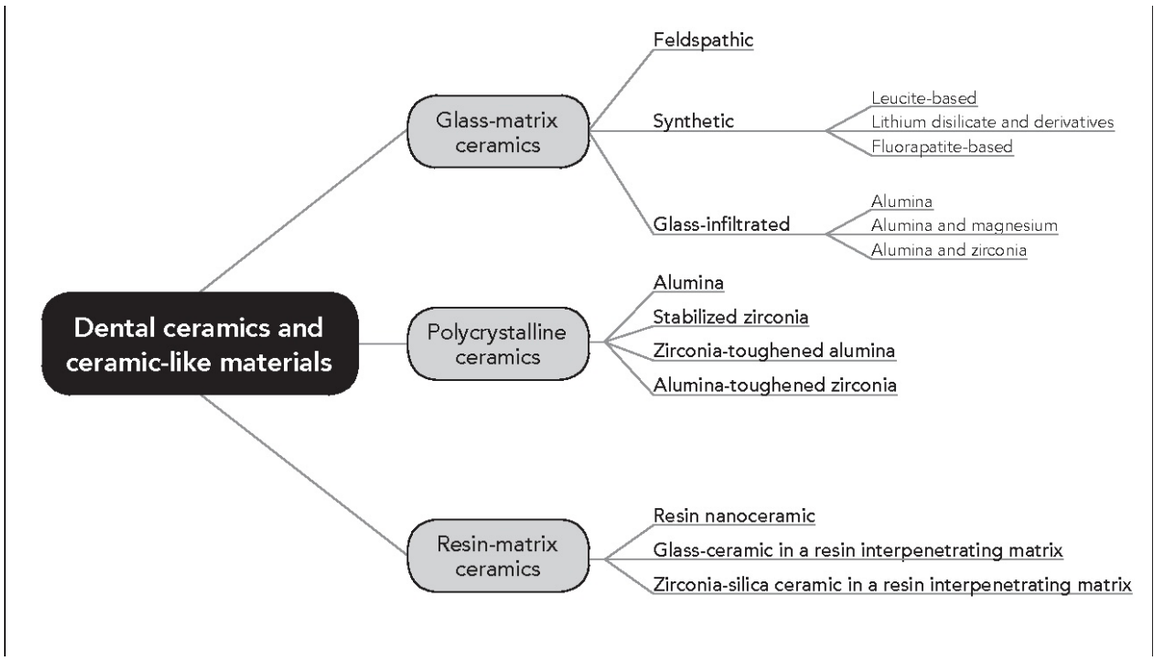
1. Anamnesis and objective exam. Useful in order to become aware of the restorative history and previous coronal fractures.
2. Complete removal of eventual decayed tissues and previous restorations.
3. Analysis of cavity factors.
4. Identifying, in order of importance,the presence of interproximal dentin,proximal residual ridges,roof of the pulp chamber,and residual cuspal walls.[8]

The hierarchy of importance indicated above is relevant in order to preserve the tooth, with the interaxial dentin being the most critical feature to consider and the remnant cuspal walls being the least significant.(RE, D.2006)

- Generally, if the cuspal thickness of the vital tooth (measured at the thinnest point and in axis with the cuspal apex) is < 2 mm, a cuspal coverage is suggested.(DIETSCHI, D1997)
- For non-vital posterior teeth, the thickness limit is 3 mm.(BECCIANI, R2002)
- Non-functional narrow cusps (those with a thickness smaller than the aforementioned values) are significantly more delicate, and thus require extra care. To eliminate enamel fractures and marginal deficiencies when employing adhesively bonded restorations, the thin cusps should be entirely covered or reduced.(KRIFKA, S.2009)
- The remaining cusp wall thickness of nonfunctional cusps of adhesively bonded restorations should have a thickness of at least 2.0 mm to avoid cracks and marginal deficiency.(Helvey GA2014)
- In order to meet the cavity design, the central isthmus to the cavity must have a minimum thickness. It is recommended that it be no less than 2 mm, which makes sense given the restoration's resistance, especially after cementation. (DIETSCHI, D1997)

2.11. Materials of indirect restoration

Classifying ceramic restorative materials into three families
(Fig 42) (Helvey GA2014)
, based on the presence of specific attributes in their formulation, as follows:



Because of the adhesive retention of indirect restoration ,only the etchable ceramic material are used for such type of restorations .so the material that can be used as follow :

2.11.1.Glass-Matrix Ceramics

2.11.1.1 Feldspathic

(Eg, IPS Empress Esthetic, IPS Empress CAD, IPS Classic, Ivoclar Vivadent; Vitadur, Vita VMK 68, Vitablocs, Vident) This traditional group of ceramics is based on a ternary material system composed of clay/kaolin (hydrated aluminosilicate), quartz (silica), and naturally occurring feldspar (a mixture of potassium and sodium aluminosilicates). Potassium feldspar (K2A12Si6O16) forms leucite crystals (crystalline phase), which, depending on the amount, not only increase the intrinsic strength of the restoration, but also make this porcelain suitable for veneering metal substructures (coefficient of thermal expansion approximately 10% or less below that of the Substructure) These materials are still

used as a veneering material on metal alloy and ceramic substrates and as an esthetic material bonded onto tooth structure. (Helvey GA2014)

2.11.1.2 Synthetic:

leucite-based :(eg, IPS d.Sign, Ivoclar Vivadent; Vita VM7, VM9,

VM13, Vident; Noritake EX-3, Cerabien, Cerabien ZR,
Noritake)

lithium disilicate and derivatives:
3G HS, Pentron Ceramics; IPS e.max CAD, IPS e.max Press, Ivoclar Vivadent; Obsidian, Glidewell Laboratories; Suprinity, Vita; Celtra Duo, Dentsply);

fluorapatite-based:
(eg, IPS e.max Ceram, ZirPress, Ivoclar Vivadent)

To remain less dependent on natural resources of raw materials and their inherent variations, the ceramic industry has begun to use synthetic materials. The composition varies among manufacturers, but commonly includes silicon dioxide (SiO_2), potassium oxide (K_2O), sodium oxide (Na_2O), and aluminum oxide (Al_2O_3). Their glass phases may be combined with apatite crystals, in addition to leucite, for thermal expansion compatibility with metals and for improved strength. When used as a veneer material on all-ceramic frameworks, these materials are modified to match the coefficient of thermal expansion of their respective frameworks (eg, Vita VM7 and Cerabien for polycrystallinalumina and glass-infiltrated ceramics, and VM9, Cerabien ZR, IPS e.max Ceram for polycrystalline zirconia). (Helvey GA2014)

2.11.1.3 Resin-Matrix Ceramics

This category comprises materials with an organic matrix highly filled with ceramic particles. The presence of an organic matrix would theoretically exclude resin-matrix ceramic materials from the authors' classification proposal if the traditional definition of ceramics were considered: "nonmetallic inorganic materials usually processed by firing at a high temperature to achieve desirable properties." (Ahlberg2003)

However, resin-matrix ceramics are being included because the 2013 version of the ADA Code on Dental Procedures and Nomenclature defines the term porcelain/ceramic as "pressed, fired, polished, or milled materials containing predominantly inorganic refractory compounds—including porcelains, glasses, ceramics, and glass-ceramics." (Ahlberg2003).
Therefore, the materials presented in this section do fit into this category because they are composed predominantly (> 50% by weight) of refractory inorganic compounds, irrespective of the presence of a less predominant organic phase (polymer).

Manufacturers suggest a wide range of indications for these ceramiclike materials in restorative dentistry. This is quite a change with respect to the former version of the referred code (2012), which defined porcelain/ceramic as "non-metal, non-resin inorganic refractory compounds processed at high temperatures (600°C/1,112°F and above) and pressed, polished, or milled, including porcelains, glasses, and glass-ceramics." (Ahlberg2003)

However, despite the controversies associated with the definition, the manufacturers' rationale to develop resin-matrix ceramic materials was to
(1) obtain a material that more closely simulates the modulus of elasticity of dentin when compared to traditional ceramics,
(2) develop a material easier to mill and adjust than glass-matrix ceramics (eg, synthetic ceramics of the lithium disilicate family) or polycrystalline ceramics, and
(3) facilitate repair or modification with composite resin. Resin-matrix ceramic composition varies substantially, but they are specifically formulated for CAD/CAM. Currently, the resin-matrix ceramic materials can be divided into several subfamilies, according to their inorganic composition, as follows:

1.Resin nanoceramic

(Lava Ultimate, 3M ESPE) It consists of a highly cured resin matrix reinforced with approximately 80% by weight nanoceramic particles. The combination of discrete silica nanoparticles (20 nm diameter), zirconia nanoparticles (4 to 11 nm diameter), and zirconia-silica nanoclusters (bound aggregates of nanoparticles) reduces the interstitial spacing of the filler particles, enabling this high nanoceramic content (information from 3M ESPE). (Ahlberg2003)

2 Glass ceramic in a resin interpenetrating matrix

(Enamic, Vita) This is typically composed of a dual network: a feldspathic ceramic network (86% by weight / 75% by volume) and a polymer network (14% by weight / 25% by volume). The specific composition of the ceramic part is 58% to 63% SiO2, 20% to 23% Al2O3, 9% to 11% Na2O, 4% to 6% K2O, 0.5% to 2% B2O3, less than 1% of Zr2O and CaO. The polymer network is composed of urethane dimethacrylate (UDMA) and triethylene glycol dimethacrylate (TEGDMA). The manufacturer refers to this as a hybrid ceramic. (Ahlberg2003)

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