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How to get optimal proximal contact in posterior composite restorations

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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Certification of the Supervisor

I certify that this project entitled **" How to get optimal proximal contact in posterior composite restorations** "was prepared by the fifth-year student **Farah sarmad saed** under my supervision at the College of Dentistry/University of Baghdad in partial fulfillment of the graduation requirements for the Bachelor Degree in Dentistry.

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Date: 24/4/2022

بسم الله الرحمن الرحيم

(فَسَتَذْكُرُونَ مَا أَقُولُ لَكُمْ ۚ وَأُفَوِّضُ أَمْرِي إِلَى اللَّهِ ۚ إِنَّ اللَّهَ بَصِيرٌ بِالْعِبَادِ)

صَدَقَ اللهُ العَظِيمُ

Dedication

I'd like to dedicate this project to my MOM and DAD without both of them I would never make it to this point.

Acknowledgment

First, I want to thank Allah s.w.t for giving me the strength and ability to finish this work.

I would like to express my gratitude to Assist. Prof. Dr. Raghad Alhashimi, Dean of College of Dentistry, University of Baghdad and Assist. Prof. Dr. Anas Falah Chairman of Conservative Department for his continuous care.

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Farah

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Introduction

In 1962 Dr. Ray Bowen developed a new type of material known as composite resin . The main innovation was a resin matrix of Bisphenol-A-Glycidyl Methacrylate (Bis-GMA) and a fillers agents (silica,quartz,glass)**(Robert , 2006).**

Composites have become one of the most widely used esthetic restorative materials. Dental composites, or resin-based composites, are synthetic materials that combine polymeric matrix with a dispersion of glass, mineral, or resin filler particles and/or short fibers by coupling agents. Just like dental amalgam, they are used to restore tooth structure lost through trauma, caries, or other diseases. Composites can also be used as cements to cement crowns and veneers, etc.

While the amalgam is phasing out in dentistry, traditional composites contain relatively large particles of ground amorphous silica and quartz, which gives them good mechanical properties but makes the surface of the restoration more likely to become rough from daily abrasion. In addition, many failures of composite restoration are seen at the interface between tooth and composite due to shrinkage or adhesive failure. To overcome this, microfilled composites, Nanofilled composites, and other hybrid composites were developed, using much smaller particles (at the same time with a large variety in size) to fill in the matrix. With these developments, smoother surfaces are achieved, wear resistance is increased, and shrinkage is decreased without compromising the mechanical and physical properties **(Xu *et al*., 2013).**

Aims of the study

In clinical practice, obtaining physiologic proximal contact points is essential for protection of balance and harmony of the stomatognathic system. Consequently, challenges have emerged due to the technique sensitivity of the restorative procedures of posterior proximal resin composite restorations.

Good proximal contact is important for :

1. maintaining and stabilizing the dental arch.
2. A well-functioning dentition.

Chapter one: Review of literature

1. Posterior Composite

When esthetic dentistry began its evolution, the posterior teeth were considered unimportant. As patient expectations have increased, more focus has been placed on the esthetic contribution of posterior teeth With the mechanics of mandibular function, as humans speak, laugh, and exhibit the behaviors considered human , the incisal edges of the lower anterior teeth and the occlusal surfaces of the posterior teeth are critical **(Bernardo *et al*., 2007).**

Table (1) shows the advantages and disadvantages of posterior composite.

Advantages	Disadvantages
1) Esthetics: Composite resins are available in several shades and tints which enable the dentist to place highly esthetic restorations in posterior teeth.	**1) Polymerization shrinkage:** Inspite of the various improvements in composite resins, polymerization shrinkage occurs during setting.
2) Conservation of tooth structure: Composite resins require adhesive cavity preparations. The adhesive cavity preparation involves minimal cavity preparation only to remove caries and fragile enamel. Preparations for composite resins are narrower, shallow, with rounded internal line angles and do not require extension for prevention. Thus the cavity preparation is also less complex.	**2) Secondary caries:** Marginal gaps form in composite resin restorations due to polymerization shrinkage. This can lead to secondary caries formation. Hence there is a need to regularly monitor patients with posterior composite restorations.
3) Adhesion to tooth structure: Composite resins can be adhesively bonded to the prepared cavity. This provides good marginal seal and reinforcement of the remaining tooth structure.	**3) Post-operative sensitivity:** This is a common problem with posterior composite restorations. The reasons attributed for this are polymerization shrinkage causing gaps which could result in rapid movement of dentinal fluid and thus sensitivity. Cuspal deformation is also possible due to polymerization shrinkage which can cause cracks in the tooth structure that lead to postoperative sensitivity.
4) Insulation: Composite resins have low thermal conductivity due to which they provide good insulation against temperature changes.	**4) Reduced wear resistance:** Composites with lower filler content like microfilled composites exhibit greater wear while those with higher filler content and particle size of 1 to 3um exhibit lesser wear. Still studies report that wear of composite resins used for posterior restorations is greater than those of amalgam restorations.
5) No galvanism: Since they do not contain any metal composite resins do not produce any galvanism.	**5) High coefficient of thermal expansion:** As compared to that of the tooth structure, composite resins exhibit high coefficient of thermal expansion. This reduces with increase in filler content. Still this mismatch is a factor in marginal gap formation.
6) Radiopacity: Composite resins have adequate radiopacity to enable their visualization in radiographs.	**6) Technique sensitivity:** There should be no room for error while placing composite restorations. Every step should be meticulously performed to achieve optimal results. Hence, chair time is increased for composite resin restorations than for amalgam restorations.

Table (1) the advantages and disadvantages of posterior composite .

1.1. Indications for direct posterior composite restorations:-

1. Incipient Class I cavities which can be restored by pit and fissure sealants.
2. Small carious lesions that allow conservative preparation and preventive resin restorations.
3. Moderate sized Class I and Class Il cavities which do not have heavy occlusal contacts.
4. In areas where esthetics is highly important like in premolar and first molar regions.
5. Class I or II restorations which can be properly isolated.
6. As a foundation or core for a full crown restoration.
7. In patients with good oral hygiene and low caries rate.

1.2. Contraindications for direct posterior composite restorations:-

1. In patients with poor oral hygiene and high caries activity.
2. For posterior areas where adequate isolation is not possible.
3. When multiple large restorations have to be placed and contact areas are on regions of occlusal contact.
4. Patients with grinding habits or bruxism.
5. When the cavity extends Subgingivally.

3. C-Factor in CL I and CL II Composite restorations

The configuration factor or C-factor is defined as the ratio of restoration's bounded surfaces to unbounded surfaces (free).

Proper adhesion of restoration requires mechanical interactions and/ or chemical adhesion at the interface between the dental substrate and the restorative material. All current restorative resins shrink during curing ,producing internal stresses. This polymerization shrinkage will produce gaps in the interfacial contact if the adhesive strength is exceeded. What occurs at the interface between the tooth and the restorative material during polymerization is a complex process. Polymerization contraction induces stress, if this stress exceeds the elastic limit of the composite resin, plastic deformation occurs during the early phases of polymerization, the elastic limit is still low and plasticity is not opposed to stress. The internal structure of the composite is not damaged since lengthening polymer chains can still change their position and orientation. This deformation is known as flow. As the resin continues to cure . contraction and flow decrease gradually as hardness increases .This results in a stress increase that causes loss of adhesion and bond failure. These stresses are sufficient to produce cohesive failure in both the restoration and the enamel. The magnitude of flow (i.e., plastic deformation) depends on the type of composite resin and the cavity configuration. As the bonded surface increases, flow is severely diminished, and the contraction stresses can exceed the adhesion strength **(Davidon *et al*., 1987).**

class I cavity preparation exhibits 5 surfaces that will be bonded to by the future adhesive restorative dental material mesial,distal,buccal,lingual and the floor of the preparation; the c-factor would thus be 5. If the restorative material is added to the cavity preparation in one application, this high c-factor will put sufficient stress on the restorative material and increase the likelihood of post-operative pain and sensitivity and early failure.

While in class II cavity preparation ,C-factor will be less than class I and less stress exhibits on restoration.

C-Factor can reduced by using:

- Layer of flowable composite.
- Incremental buildup**(Feilzer *et al*., 1984).**

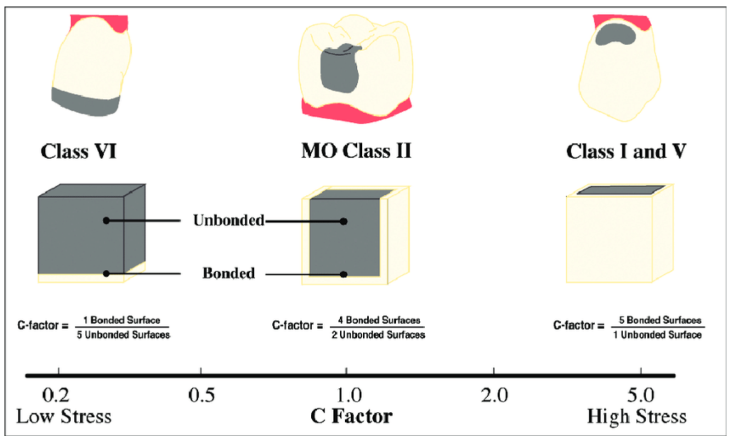

Figure (1-1): Examples of how the C-factor changes with different preparation designs (modified after Feilzer & others 37).

3. Development of cavity design in:

3.1. Amalgam

Restoration of posterior teeth, and compared with other available materials, amalgam is relatively low cost**(Tobi *et al*., 1999).**

Preparation requires mechanical undercuts to provide retention; however, preparation techniques are generally less technically demanding compared to those for indirect restorations. The lack of requirement for bonding makes amalgam more forgiving in situations where isolation is compromised. It can be successfully utilized in a wide range of situations, from the smallest Class V to full occlusal restoration of molars. With the advent of amalgam bonding agents, amalgam restorations may now also be bonded to dentin and enamel, which creates a hybrid layer , a technique that has been shown to lead to successful outcomes**(Browning *et al*., 2000).**

The tooth preparation not only must remove the fault in the tooth and remove weakened tooth structure, but its form must also allow the amalgam material to function properly. The required tooth preparation form must allow the amalgam to (1) possess a uniform specified minimum thickness for strength (so that it will not Hex and fracture under load), (2) produce a 90-degree amalgam angle (butt-joint form for maximum edge thickness) at the margin, and (3) be mechanically retained in the tooth **(Fig 1-2)(Ben-Amar *et al*., 1995).**

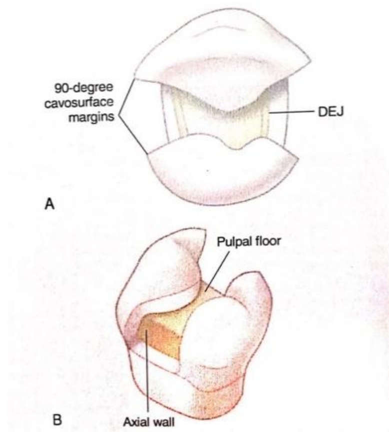

Figure (1-2): (A and B diagrams of class II amalgam tooth Preparations illustrating uniform pulpal and axial wall depths,90-degree cavosurface margin and occlusal convergence of walls).

3.2. Composite

Most composite resin restorations are placed directly. Due to the material's ability to bond to tooth structure, preparations can be more conservative than those required for amalgam (which in general require mechanical retention) or for indirect restorations (which require a tapered path of insertion). They can also be fabricated in the laboratory and resin-bonded in a way similar to ceramic restorations **(Bernardo *et al*., 2007).**

3.2.1. In CL I direct composite restorations:

As a general rule, the tooth preparation for direct posterior composites involves:

(1) creating access to the faulty structure, (2) removal of faulty structures (caries lesion, defective restoration, and base material, if present), and (3) creating convenience form for the restoration. When placing most posterior composites, it

is not necessary to incorporate mechanical retention features in the tooth preparation **(Peumans *et al*., 2014).**

Small to moderate Class I direct composite restorations may use minimally invasive tooth preparations and do not require typical resistance and retention form features. Instead, these conservative preparations typically result in more flared cavosurface forms without uniform or flat pulpal or axial walls. The initial pulpal depth is determined only by the selective removal of carious tooth structure, and there is no minimal thickness of restorative material requirement to limit bulk fracture **(Peumans *et al*., 2010).**

3.2.2. In CL II direct composite restorations:

An assessment of the expected tooth preparation extensions (outline form) should be made and a decision rendered on whether or not an enamel periphery will exist on the tooth preparation, especially at the gingival margin. The expected presence of an enamel periphery strengthens the choice of composite as the restorative material because bonding to enamel is more predictable than bonding to dentin.

Especially along the gingival wall of the proximal preparation. If the preparation is expected to extend onto the root surface, potential problems with isolation of the operating area, adequate adhesion to the root dentin, and adequate composite polymerization exist. Good technique and proper use of the material may reduce these potential problems, but deep subgingival extension onto the root surface may be a contraindication for using composite resin as a posterior teeth restorative material.

The preoperative occlusal relationship of the tooth to be restored must also be assessed. The presence of heavy occlusal contacts may indicate that wear may be more of a consideration. Also, preoperative wedging in the gingival embrasure of the proximal surfaces to be restored should occur. Placing wedges, biting rings, or both before tooth preparation begins the separation of teeth, which may be beneficial in reestablishing the proximal contact with the composite restoration **(van Dijken *et al*., 2014).**

3.2.2.1.Tooth Preparation of CL II composite restoration

Similar to the tooth preparation for Class I direct composite restorations, the tooth preparation for Class Il direct composites involves (1) creating access to the faulty structure, (2) removal of faulty structures (the caries lesion, defective restoration, and base material, if present) and (3) creating the convenience form for the restoration. Retention, as with Class I restorations, is primarily obtained by bonding, so it is not necessary to use mechanical retention features in the tooth preparation for Class Il composite restorations. Obtaining access to the defect may include removal of sound enamel to access the caries lesion. The extension of the preparation is therefore ultimately dictated by the extension of the fault or defect.

It is usually not necessary to reduce sound tooth structure to provide "bulk for strength" or to provide conventional retention and resistance forms.

Small Class I direct composite restorations are often used tor primary caries lesions, that is, initial restorations. A small round or elongated pear-shaped diamond or bur with round features may be used for this preparation to remove the carious tissue or faulty material from the occlusal and proximal surfaces. To help prevent damage to the adjacent teeth and promote initial interproximal separation, wedges with or without stainless steel barriers may be utilized. The initial separation provided by wooden wedges will facilitate matrix placement in conservative preparations as well as result in tighter interproximal contacts. The pulpal and axial depths are dictated only by the depth of the lesion and are not necessarily uniform. The proximal extensions likewise are dictated only by the extent of the lesion but may require the use of another instrument with straight sides to prepare walls that are 90 degree or greater **(Fig 1-3)**. The objective is to remove the caries lesion or defect conservatively, as well as any friable tooth structure.

Another conservative design for small Class II composites is the box-only tooth preparation **(Fig 1-4)**. This design is indicated when only the proximal surface is detective, with no lesions on the occlusal surface. A proximal box is prepared with a small, elongated pear-shaped or round instrument, held parallel to the long axis of the tooth crown. The instrument is extended through the marginal ridge in a gingival direction aiming at the center the proximal caries lesion or defect. The axial depth is dictated by the extent of the caries lesion or fault. The form of the box depends on which instrument shape is used. The facial, lingual and gingival extensions are dictated by the extension of the caries lesion of defect. No beveling or secondary retention is indicated.

The tooth preparation for moderate to large Class II direct composite restorations has features (resemble a more traditional Class II amalgam tooth preparation and may include an occlusal step and of the caries lesion. A proximal box depending on find location, extension, and depth of caries lesion. The occlusal portion of the Class II preparation is prepared similarly as class I preparation .

The primary differences are related to technique of incorporating the faulty proximal surface. Preoperatively, the proposed facial and lingual proximal extensions should be visualized .

Initial occlusal extension toward the involved proximal surface should go through the marginal ridge area at initial pulpal floor depth, exposing the DEJ.

The DEJ serves as a guide for preparing the proximal box portion of the preparation**(Wirsching *et al*., 2011).**

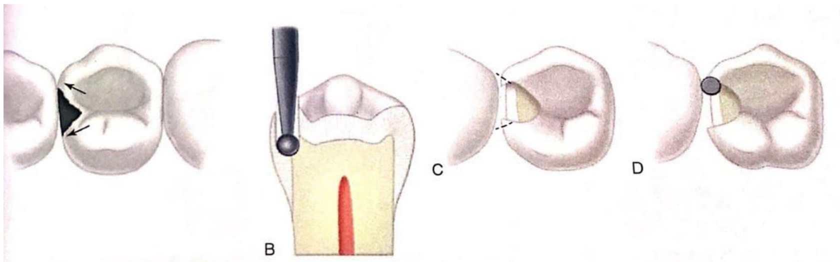

Figure (1-3): (class II direct composite tooth preparation. A, Preoperative visualization of faciolingual proximal box extensions. Arrows indicate desired extensions. B, Round or oval, small elongated pearl instrument used. C and D, Facial, lingual, and gingival margins may need undermined cavosurface enamel (indicated by dotted lines) removed with straight-sided thin and flat-tipped rotary instrument or hand instrument.).

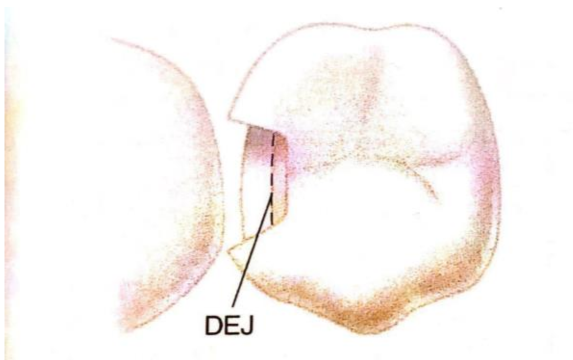

Figure (1-4): (box only class II composite preparation).

4. Band selection

Proximal tooth surfaces are an area of variable breadth that performs important functions:

- Physiologic preservation of tooth tissue.
- Protection of underlying periodontal structures.
- Transfer of masticatory force from tooth to tooth.

Contact area location, cervico-occlusal extension, and anatomical profile can be assessed both radiographically and clinically **(Fig 1-5)**. The proximal surface curves in both the buccopalatal/lingual and cervico-occlusal directions. The tightness of the interproximal contact area and anatomical variability of proximal curvatures can be reproduced by means of direct reconstruction using preformed sectional matrices with multiple convexities **(Nugala et al., 2012).**

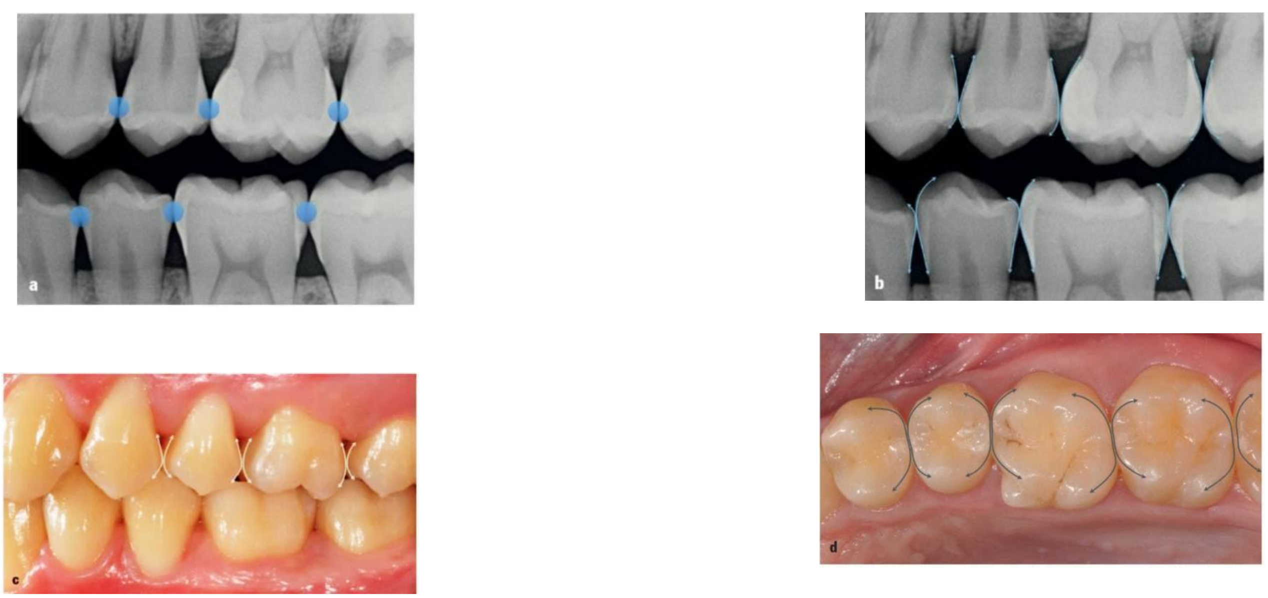

Figure (1-5): ((a) Contact points. (b) Cervico-occlusal curvature. (c and d) Contact area as well as cervico-occlusal and buccolingual extension and anatomical profiles can be clinically assessed.)

4.1. Matrices

A matrix acts as a support for restoration material during proximal wall construction. It carries anatomical information spanning an area from the proximal cervical margin to the top of the marginal ridge **(Patras *et al*., 2013) .**

Given its non-anatomical nature, band matrices have proven less effective in establishing correct contact areas than sectional matrices with multiple convexities used with external (eg, Tofflemire, Waterpik) and automatic stabilization systems **(Wirsching *et al*., 2011).**

Figure (1-6): ((a) Using a band matrix involves two problems: (1) more occlusal position of the contact point (red circle); (2) marginal ridge displaced toward the adjacent tooth. (b) Using a sectional matrix allows the contact point/area and marginal ridge to be properly positioned (purple circle).)

Band and sectional matrices are made out of steel or acetate. Clinical and in vitro studies reveal no difference in marginal seal quality in Class II restorations, whether performed with acetate or metal matrices**(Cenci *et al*., 2006) .**

The emergence profile created using band matrices is flat and oblique, the contact area is carried toward the occlusal surface, and the marginal ridge crest is displaced toward the proximal wall of the adjacent tooth , creating a greater fracture risk in the marginal ridge**(Gomes *et al*., 2015).**

The contact area established between the premolars tends toward the occlusal surface; the position of the contact area between premolars and molars and between molars and molars tends toward the cervical area .For both premolars and molars, the marginal ridge curves toward the center of the occlusal surface and allows masticatory forces to be discharged axially because it is close to the tooth's center of gravity. Sectional matrices are shaped with multiple convexities so that they resemble the proximal emergence profiles of proximal teeth. They are the only matrices able to simulate the cervico-occlusal and buccolingual curvature typical of premolars and molars in a relatively natural manner . Interproximal tooth convexities display considerable intra-individual and interindividual anatomical variability, and the best sectional matrix must be chosen for each individual clinical case based on a rational approach. Depending on the manufacturer, sectional matrices can come in different heights (3.5 to 7.5 mm), thicknesses (0.025 to 0.04 mm), and curvatures **(Fig 1-7)**. Some steel matrices have a coating that prevents the composite from sticking to the matrix surface . However, ordinary steel matrices are more than sufficient for the task**(Loomans *et al*., 2008).**

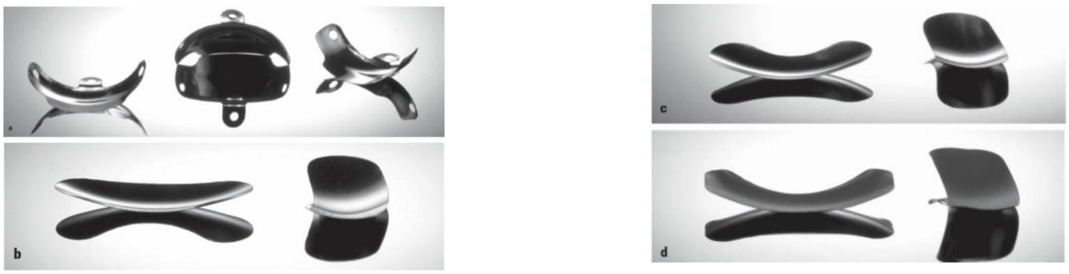

Figure (1-7): ((a to d) Sectional matrices come with different profiles and convexities depending on the manufacturer.)

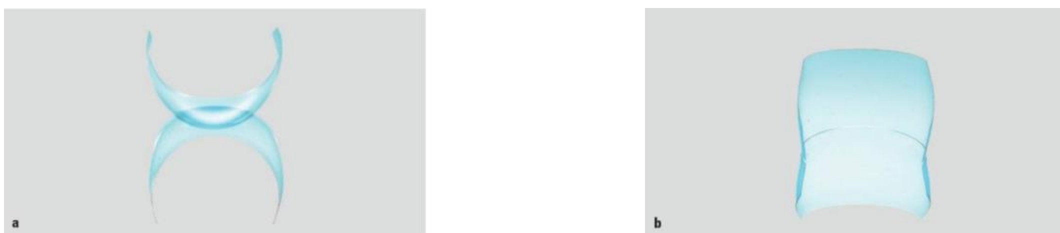

Figure (1-8): ((a and b) Sectional matrix in preformed acetate.).

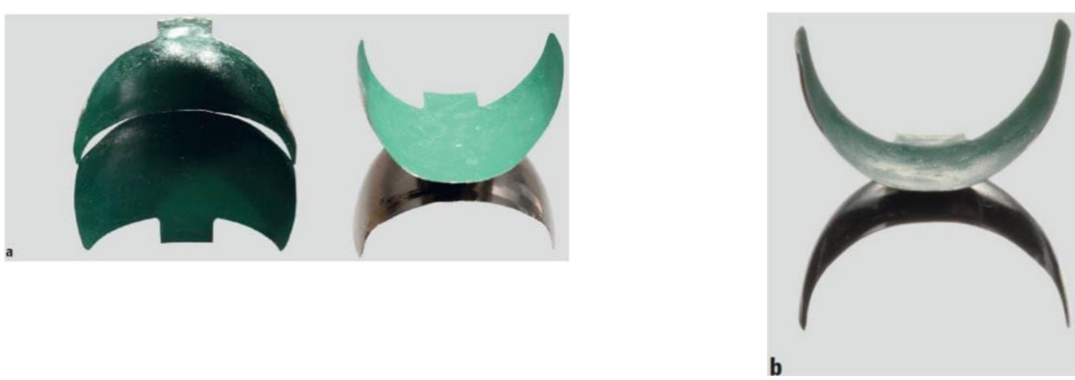

Figure (1-9): ((a and b) Sectional matrix with nonstick treatment. Buccopalatal and cervico-occiusal curvatures are very pronounced).

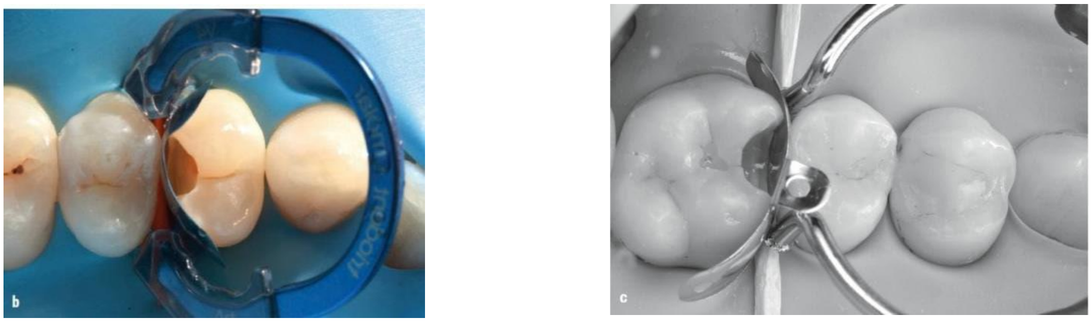

Figure (1-10): (Steel sectional matrices.).

4.1.1. Choosing a sectional matrix

Metal matrices are the best choice as far as material is concerned. Acetate matrices do not allow the marginal fit to be checked as accurately given the lack of optical contrast. The choice of sectional matrix is determined by matching the matrix's point of maximum convexity with the tooth's maximum circumference, which establishes the contact area. This measurement can be taken using a periodontal probe that records the distance between the gingival sulcus with inverted dam and the tooth's maximum interproximal circumference, which is used to establish the contact area **(Figs 1-11a and 1-11b)**. The measurement is transferred to the chosen matrix, and the practitioner checks that it matches the point of maximum curvature **(Fig 1-11c)**. If two adjacent interproximal cavities are present **(Figs 1-12)**, two adjacent sectional matrices are positioned. The future contact area is evaluated and considered in the context of neighboring contact areas **(Gomes IA *et al*., 2015).**

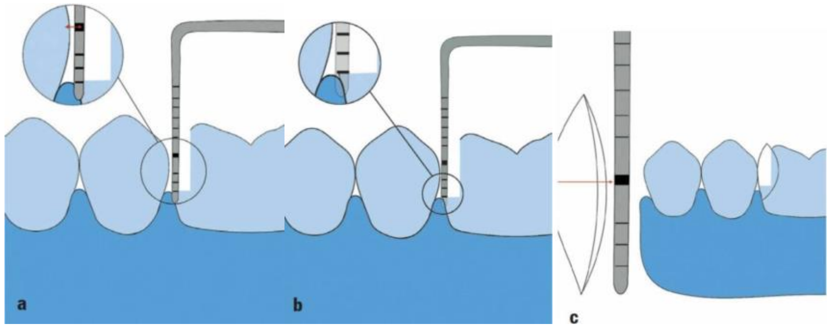

Figure (1-11): ((a) A periodontal probe is used to measure the distance between the gingival sulcus and the maximum proximal circumference of the adjacent tooth. (b) The probe must penetrate 1 mm into the sulcus to allow for the matrix being seated in the gingival sulcus when the dam is in place. (c) If the recorded measurement and the correlating measurement on the matrix match, the chosen matrix is suitable.)

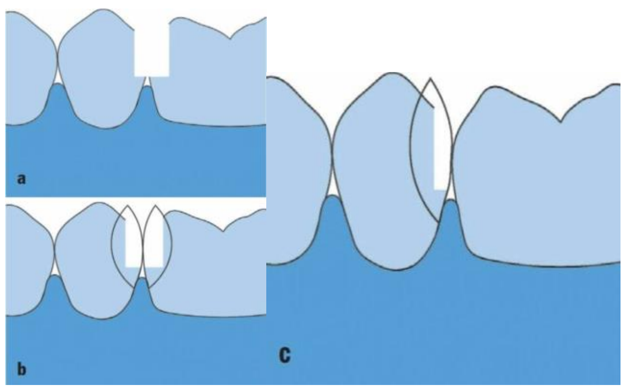

Figure (1-12): ((a and b) With adjacent Class 2 cavities, two identical matrices are positioned facing one another, adjusting the contact area height to approximate that of the nearest contact areas. The first cavity conversion to Class 1 (using CBT) is carried out with both matrices in place. (c) Once the first CBT has been performed, the matrix is removed from that tooth, and the other cavity is converted to Class 1.)

4.2. Wedges

Are made out of wood or plastic. The latter can be regular or anatomical. The cross section of a wedge is always triangular. Wedges essentially perform four functions:

1. Stabilize the matrix.
2. Adapt the matrix to the step to avoid over contours or under contours.
3. Simplify sectional matrix insertion.

4. Assist the separator ring in temporary movement of the teeth between which it is positioned **(Fig 1-13).**

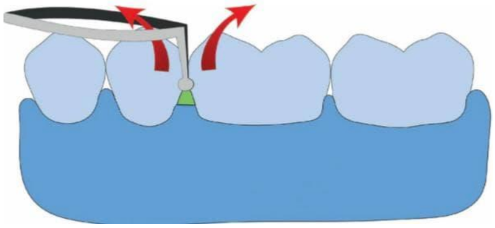

Figure (1-13): (Temporary orthodontic movement (red arrows) induced by a wedge and separator ring.).

After reconstruction, separator ring removal will reposition the teeth to establish interproximal contact with appropriate tightness. The wedge generally must be inserted where the embrasures are wider to leave enough space for the square end of the wedge, which is usually in a palatal to buccal direction **(Fig 1-17)**. Regardless of insertion direction, the important thing is to ensure the wedge and matrix are a perfect fit to correctly restore the interproximal profile **(Fig 1-14)**. The wedge tip and square end should be equally exposed on both sides (buccal and palatal/lingual) of the interproximal area to allow correct interaction with the separator ring **(Raghu *et al*., 2011).**

When a wooden wedge is positioned, it first can be soaked in water-soluble liquid soap to help prevent rubber dam displacement **(Fig 1-16).**

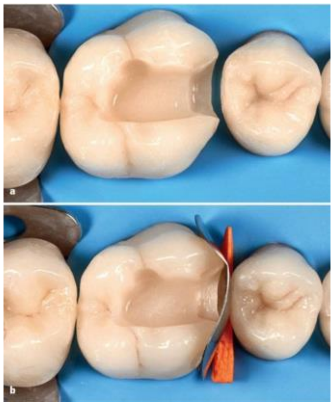

Figure (1-14): ((a and b) The wedge is usually inserted from the side where the embrasures are wider).

Figure (1-15): ((a and b) Even if the wedge is not inserted where the embrasures are wider, a predictable point of contact can still be obtained).

Figure (1-16): ((a and b) Before a wooden wedge is used, it can be soaked in liquid soap (water-soluble) to help it slide over the rubber dam and prevent its displacement).

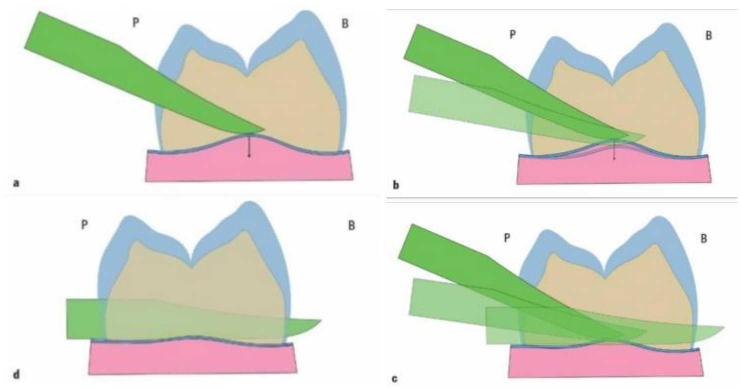

Figure (1-17): ((a to d) Wooden wedge insertion stages from palatal (P) to buccal (B)).

4.2.1.Wooden wedges

Wooden wedges are the most commonly used wedges. They were the first available on the market and are still probably the most reliable. They are used to fit the sectional matrix to the cervical shoulder and operate as separation instruments. One very useful aspect of wooden wedges is that they soak up water, expand, and swell, which improves the marginal fit of the matrix. By exerting thrust between the teeth, they bring about minimal, gradual displacement without damaging periodontal tissues. Inserting a wedge between two teeth produces a lever effect. The teeth are subject to a thrust that extrudes them slightly from the gingiva. The separator ring exercises significant temporary orthodontic separation. The combined action of both instruments produces a very tight contact area. The cross section is triangular at the tip and along the body and square or rectangular at the end. The square cross section of the rear part allows the wedge to achieve a stable grip when tweezers are used for insertion and removal. The flat part of the tweezer grip exercises thrust against the flat rear part of the wedge **(Wirsching *et al*., 2011).**

Commercially available wooden wedges are color coded, which varies from manufacturer to manufacturer and grades them according to size (height and width). Some wedges are the same height but different widths (rectangular cross section), while others are the same width but different heights (rectangular cross section). Some are the same height and width (square cross section). Smaller wooden wedges are very useful for pediatric patients and in all cases where the interproximal space is very tight. A standard wedge can be modified by creating an intermediate bulge using Howe or universal pliers.The tips of the Howe pliers are rounded with a flat working part, which is ideal for flattening the wedge tip and body. This modification will ensure smooth insertion and a more decisive thrust, which will make for a better sectional matrix seal. This procedure is appropriate for specific anatomical configurations of the cervical shoulder that occur on the mesial surfaces of maxillary premolars. Modifying the tip alone creates access without interference, maintaining a more consistent thrust on the cervical shoulder**(Patras *et al*., 2013).**

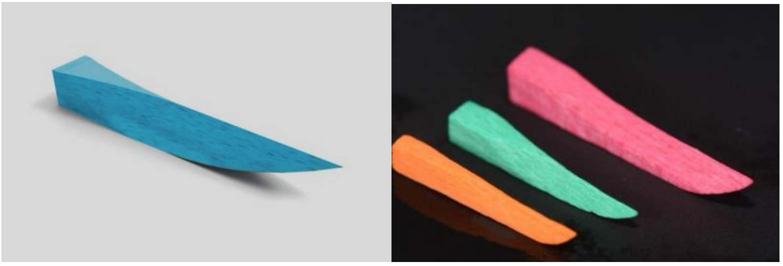

Figure (1-18): (wooden wedges).

4.2.2.Plastic wedges

Plastic wedges can be standard or anatomical. Standard wedges are overly rigid and do not adapt to the tooth anatomy. Sometimes they are equipped with a carry handle that simplifies the positioning procedure. Like wooden wedges, they are color coded and graded according to size. An anatomical wedge cannot absorb water and expand, but its anatomical shape makes up for this shortcoming because it is well suited to the gingiva (it does not compress the papilla) and the specific anatomical shape of the cervical shoulder.

Fender Wedges are plastic wedges that are equipped with a matrix plate and are only recommended for use when preparing a Class II box-form preparation (or box). While the wedge protects the dam, the matrix plate protects the adjacent tooth from iatrogenic damage. Alternative methods for preventing damage to neighboring teeth are available **(Gomes *et al*., 2015).**

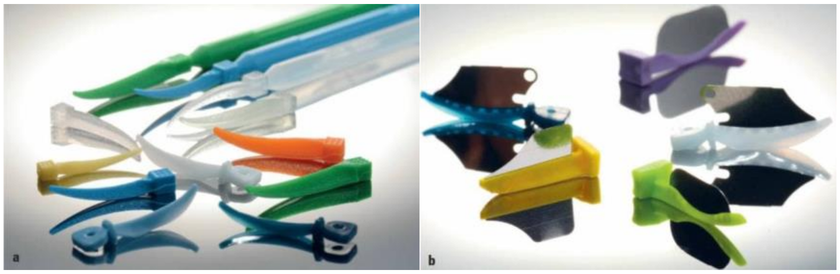

Figure (1-19): ((a) Plastic wedges. (b) Fender Wedges.)

One recently introduced type of plastic wedge is equipped with silicone wings that expand into the available space.

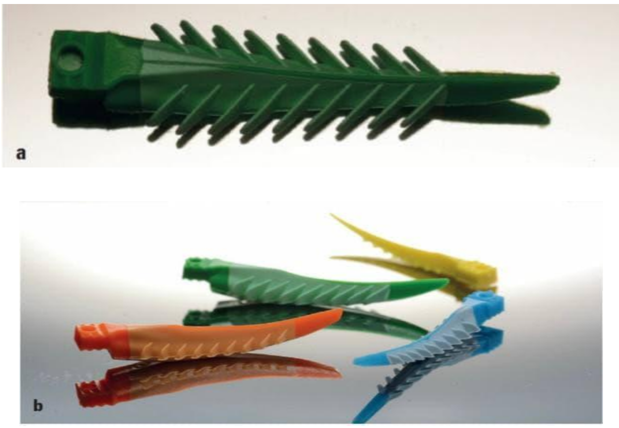

Figure (1-20): (Expansion wedges. (a) Occlusal view. (b) These wedges are color-coded according to size, trom smallest to largest: vellow, blue, orange, and green.)

Their ability to adapt to the cavity margin makes them a practical choice in cavities with a concave cervical shoulder.

4.3. Separator Rings

Correct use of sectional matrices and separator rings helps achieve a tight proximal contact area and a well-defined anatomical contour to minimize the use of rotary instruments during finishing **(Santos, 2015).**

The separator ring essentially performs two functions:

1. Temporary orthodontic tooth separation to resolve the problem of the gap left by the sectional matrix following removal
2. Allowing a sectional matrix to be fitted to the buccal and linguopalatal walls.

Separator rings tend to lose their elastic memory with use. The arms must be compressed and moved together periodically to reactivate the elastic memory. When the ring presses and adapts the end of the matrix, the mesial part bends closer to the adjacent tooth, with which a contact area will be established.

4.3.1.Standard separator rings

Standard rings are the most versatile and can be adapted to any clinical situation. Short arms are ideal for single Class II restorations. Long arms are useful for long teeth and multiple Class II cavities when they are fitted to overlap with short-armed rings .

First-generation rings offered limited separating power and were subsequently improved to overcome this drawback. They can be positioned in three different ways, according to cavity design. This allows the sectional matrix to be fitted more effectively to the residual buccal and lingual walls.

Figure (1-21): ((a to c) Gold rings. These standard rings offer strong separating power. (d) A short gold ring and overlapping long ring. (e and f) Another standard ring with flat ends. (g and h) Different types of standard separator rings. Some have reinforced loops for increased separating power.)

4.3.2.Positioning a standard separator ring

- Ends interposed between the matrix and wedge :

  This is the ideal positioning, wedge deformation as a result of the bending induced by the separator ring arms improves cervical adaptation of the matrix, while the position of the ends on the outer sides of the box walls improves buccal and palatolingual matrix adaptation.

Figure (1-22): (The ends of the standard separator ring are between the matrix and wedge).

- Ends of both arms above the wedge :

  This method is ideal for cavities with a small proximal . The ring closes, imposes a separation force, and seals the sectional matrix tightly. This type of positioning must be avoided at all costs for wide box preparations because the ring arms would close on the matrix, bending it toward the cavity. If reconstructed, the emergence profile of the proximal wall would be irregular, without contact with the neighboring tooth.

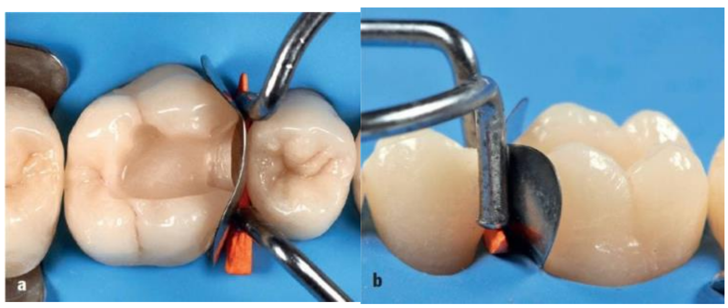

Figure (1-23): ((a and b) The ends of the standard separator ring are above the wedge)

- Placement of one or both ends behind the wedge :

  This solution is preferable when the box is very wide at the buccal and/or palatal level and the separator ring end could collapse into the cavity if interposed between the matrix and the wedge. This placement type is also recommended with a very apical cervical shoulder because the deformation induced by the ends on the wedge often allows a better fit.

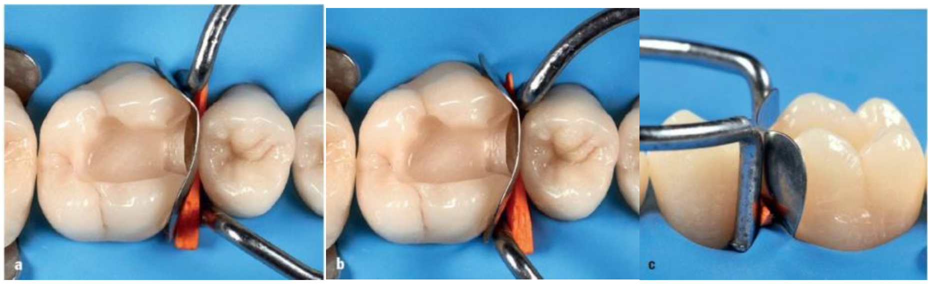

Figure (1-24): ((a to c) The ends of the standard separator ring are behind the wedge.

4.3.3.Resin and silicone separator rings

Separator ring systems feature rigid resin or silicone ends and are equipped with two V-shaped indentations to house the wedge tip and end. Structural parts that come into contact with the matrix and adjacent tooth are shaped to allow anatomical adaptation of the matrix to the external walls of the box. These separator rings are usually much more powerful than standard rings. However, they can only be placed in one position. This cannot be altered strategically as in the case of standard rings. Another limitation is that they can be unstable in short or small teeth or teeth that have not completely erupted.

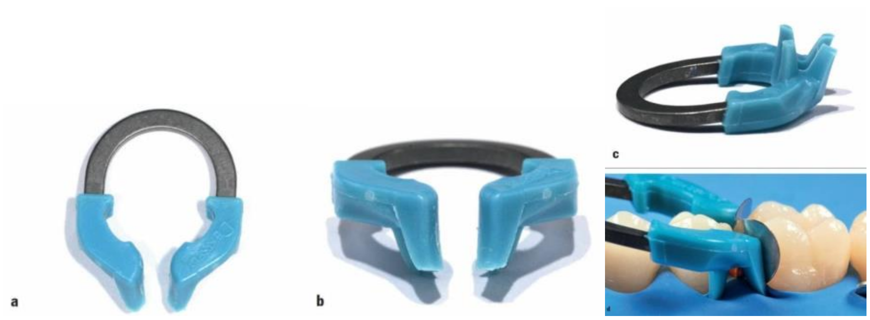

Figure (1-25): ((a to c) Nickel-titanium (Ni-Ti) separator ring with resin ends. Powerful and stable. d) Positioned over a wooden wedge).

Figure (1-26): ((a to c) Ni-Ti separator ring with silicone ends. (d and e) These rings are strong, and the silicone ends allow the matrix to adapt fairly well to the axial walls.)

Figure (1-27): ((a to i) Separator rings with silicone ends of progressively increasing size.

Some ring loops are plastic coated to increase the rigidity of the ring and its spring-loaded effect. Silicone-coated ends deform to fit to the sectional matrix, improving adaptation and reducing the time to trim away any excess. Regardless of ring type, the purpose of all rings is to separate teeth to accommodate the sectional matrix **(Cho *et al*., 2010).**

Figure (1-28): ((a to c) A host of separator rings are available, each claiming to be the best. (d to r) Regardless of type, all share the common goal of separating the teeth orthodontically for a limited time and adapting the matrix to the box.)

5. Technique of etching in CL II

The use of the etch-and-rinse (total-etch) technique , in which enamel and dentin are etched simultaneously, involves the application of 37% phosphoric acid to enamel for 20 – 30 seconds, followed by rinsing and thorough drying.

Self-etch adhesives do not require a separate etch-and-rinse step, because the adhesive is self-etching and includes the etchant.

Many prefer the selective etch technique over total-etch to reduce the possibility of postoperative tooth sensitivity **(Strassler, 2006).**

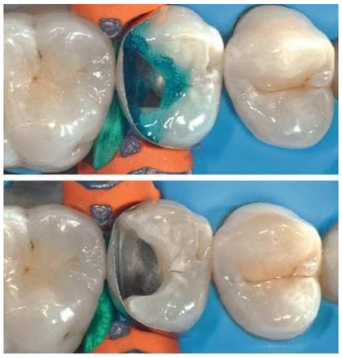

figure (1-29): (selective etching).

Figure (1-30): (total etching).

6. Technique of bonding in CL II

The smear layer obstructs the entrances of dentinal tubules, decreasing dentin permeability by up to 86% **(Pashley *et al*., 1978).**

This layer must be removed or made permeable to allow interaction between the monomers and the dentinal surface. Based on the approach to smear layer removal, dental adhesives can be grouped into two major types **(Van Meerbeek *et al*., 2003)**:

(1) etch-and-rinse adhesives .

(2) self-etching or etch-and-dry adhesive.

Etch-and-rinse adhesives These adhesives use a strong acid (usually 35% to 37% phosphoric acid at a pH of approximately 0.9) to completely etch enamel and dentin, followed by a water rinse to remove the acid from the tooth surface. They formerly were known as total-etch adhesives.

The adhesive then fills enamel and dentin porosities created by the etching procedure **(Pashley *et al*., 2011).**

Self-etching or etch-and-dry adhesives. These systems use a non-rinsing solution of acidic monomers to dissolve the smear layer on enamel and dentin surfaces **(Van Meerbeek *et al*., 2011)**

Because the self-etching or primer agent is simply air dried, they are also called etch-and-dry adhesives **(Breschi *et al*., 2008).**

7. Technique of restoration in CL II

7.1. Centripetal buildup technique:

first by creating a very thin proximal layer **(Fig 1-31)** the internal curing of this layer is affected which can strengthen the composite and cut down cervical gap that could form **(Von Beetzen *et al*., 1993).**

Furthermore, even if such gap does develop, the next consecutive layer which is condensed toward the gingival floor is likely to fill gap since the continuity of space created is not occluded **(Ericson *et al*., 1991).**

Once the second step of the procedure is completed and peripheral composite envelope is created, the cavity is managed as a simple Class I cavity .

This technique employs thin metal matrix bands and wooden wedges eliminating the need for transparent matrix bands, which may not provide firm contact areas and anatomical proximal contours and are cumbersome to use for many practitioners. Finally, the centripetal buildup technique is very conservative with preservation of sound tooth structure; it is not time-consuming and it is easy to implement **(Coli *et al*., 1993).**

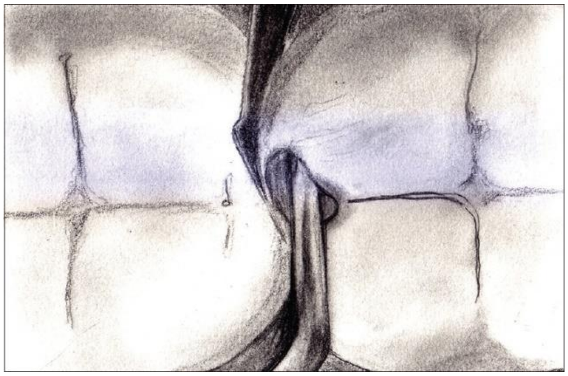

Figure (1-31): (Centripetal buildup technique showing proximal composite semitransparent layer placed toward the matrix band using composite).

7.2. Snowplow

In this technique, flowable composite resin is placed in the proximal box and composite resin is packed on top of the flowable and then cured. The depth of cure in this technique may be hindered especially if the initial increment of flowable and the composite is greater than 2mm. In this case, light penetration through the combination is poor, the bond is weakened and increased marginal leakage may occur.

7.3. Open Sandwich

This technique is used in high caries-risk individuals where a resin-modified glass ionomer (Fuji II LC) or densely-filled GI (e.g. Fuji IX) is used to fill the proximal box to the level of the pulpal floor **(Andersson-Wenckert *et al*., 2004).**

Note that a glass ionomer restorative material is used, not a base material which produces increased fractures in the restoration compared to the restorative material **(Opdam *et al*., 2007).**

The fluoride release around the margins of the proximal box protects approximately 3 mm around the restoration which helps protect against recurrent gingival caries **(Gaengler *et al*., 2001) .**

7.4. Incremental technique

Composite should be placed in successive, laminated increments to ensure proper curing and prevent excessive polymerization shrinkage stress **(Ferracane, 1992).**

Incremental curing decreases the effects of polymerization shrinkage, enhances marginal adaptation, decreases gap formation, reduces marginal leakage, decreases cuspal deformation, makes the cusps more resistant to subsequent fracture, improves bond strength to cavity walls, and decreases postoperative sensitivity **(Eick *et al*., 1986).**

One of the greatest benefits to the incremental fill technique may be its effect on cavity configuration, or C-factor **(Lutz *et al*., 1991).**

The end result is that the incrementally placed and cured restoration is bonded better to the cavity walls than if the preparation had been filled and the resin composite material cured in bulk **(Kim *et al*., 2011).**

7.4.1. First increment

First, an increment no thicker than 1 mm is placed against the gingival wall. A thin first layer will ensure proper light irradiation throughout the increment **(Bryant, 1992).**

If a clear matrix and light-reflecting wedge are being used, the initial curing should be directed through the flat end of the wedge.

If a metal matrix that surrounds the tooth has been chosen, all increments must be cured from the occlusal aspect. The tip of the light should be positioned as close as possible to the resin being cured **(Ferracane, 1995).**

After the metal matrix is removed, all proximal areas of the restoration should receive additional curing with the light to maximize restoration cure **(Opdam *et al*., 2007).**

Resin composites that are marketed for posterior use vary widely in their viscosity **(Opdam *et al*., 1996).**

This can have an impact on adaptation of resin composite to the walls of a cavity preparation **(Opdam *et al*., 1996).**

Adaptation of resin composite to cavity walls can have a dramatic effect on the bond strength; as adaptation worsens and voids increase, the bond decreases significantly **(Purk *et al*., 2007).**

Thicker consistency resin composites have significantly increased cavity-wall voids compared with medium- or thinner-viscosity materials. Resin composites that are supplied in preloaded resin composite tips or ampules tend to have a higher viscosity than do composites that are supplied in syringes **(Opdam *et al*., 1996).**

Placement technique can also determine how well the resin composite adapts to the cavity-preparation walls. Use of Centrix placement tips for resin composite decreases the viscosity of the material and significantly decreases voids adjacent to the preparation walls compared with either smearing the material into place with a plastic instrument or "condensing" it **(Opdam *et al*., 1996).**

7.4.1.1. Flowable resin composites

Another method that has been suggested is the use of low viscosity, or flowable, resin composites for the first increment of a proximal box or pulpal floor **(Behle, 1998).**

The rationale is that these materials flow more readily than standard hybrid formulations and will therefore easily and thoroughly adapt to all areas of the cavity preparation. Also, because of their lower filler content and reduced elastic modulus, it is theorized that these materials could act as "stress relievers" to absorb forces of polymerization shrinkage or cyclic loading **(Bayne *et al*., 1998).**

There are a number of problems associated with these materials. Because of their higher resin content **(Labella *et al*., 1999).**

Flowable resin composites demonstrate up to three times greater polymerization shrinkage than do standard hybrid resin composite formulations **(Tollidis *et al*., 1999).**

7.4.2. Additional increments

Subsequent increments should be placed in thicknesses no greater than 2 mm. An oblique layering technique should be used whenever access allows **(Fig 1-32)**. An oblique layering technique is preferred because it leads to higher bond strength compared with either the use of horizontal increments or bulk placement **(Niu *et al*., 2009).**

In addition, incremental techniques in which the facial and lingual walls are linked by the composite increment during curing tend to show greater cuspal deformation, particularly when the final, occlusal composite increment engages both the facial and lingual cavity walls **(Donly *et al*., 1989).**

The restoration should be cured from the facial and lingual aspects after removal of the matrix **(Fig 1-33)**. If a clear matrix is employed, the oblique technique **(Fig 1-32a)** should be used, and additional curing from the facial and lingual aspects can be accomplished through the matrix to ensure a thorough cure.

An alternative to the layering techniques is the use of a conical light-curing tip **(Fig 1-34)**. The proximal box is filled with composite to just gingival to the contact area, and the conical tip is wedged into the resin composite. The cone is used to apply pressure to the matrix band and push it against the adjacent tooth during curing. Subsequent increments restore the cone-shaped gap formed by the tip. This technique is designed To ensure adequate interproximal contact and to minimize the thickness of resin composite that the light must penetrate **(González-Lopéz *et al*., 2004).**

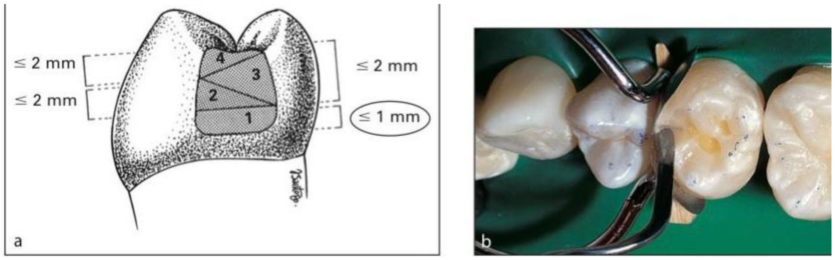

Figure (1-32): ((a) If a metal matrix is used with a light-curing resin composite, a minimal (1 mm) gingival increment is placed and cured.(b) After the initial increment is cured, the next increment is syringed into place and "ramped" obliquely with a plastic instrument.

Figure (1-33): (If a surrounding metal matrix was used, the restoration should-be cured from the facial and lingual aspects after matrix removal).

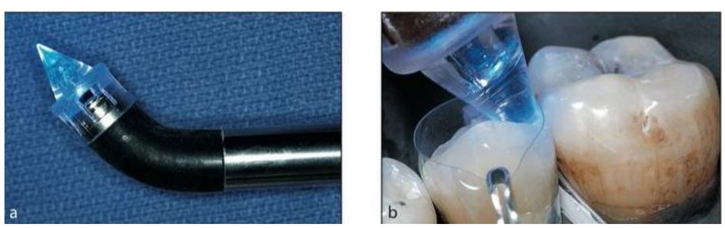

Figure (1-34): (conical light tip (a) can be placed into uncured resin composite increment (b) to provide curing while also pushing the matrix against the adjacent tooth to enhance proximal contact).

7.4.3. Final increment

Careful control of the final increment will minimize the amount of finishing. A number of techniques are helpful in accomplishing this goal. A rounded, cone-shaped instrument (e.g. PKT3), slightly moistened with resin adhesive or a low-viscosity resin specifically designed to prevent sticking of resin composite to the instrument, may be used to shape and form the occlusal surface before curing **(Fig 1-35)**. It is important that only a thin layer of low-viscosity resin be applied to the instrument to act as a lubricant. The best way to ensure this is to place a drop of resin in a gauze sponge and then wipe the end of the instrument with the gauze. A fine-bristled brush (eg, sable) can be very helpful in smoothing the composite surface and achieving intimate adaptation of the resin composite to the cavosurface margins **(Liebenberg, 1996).**

The matrix is allowed to remain in place to provide protection of the adjacent tooth during proximal-surface finishing **(Fig 1-36b)** and re-etching prior to sealing **(Fig 1-36c)(Bertolotti, 1991).**

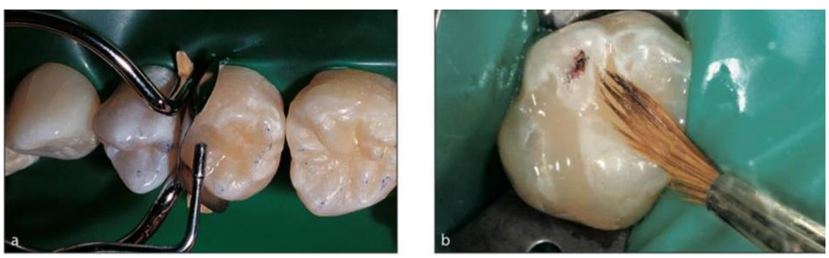

Figure (1-35): ((a) A small condenser or burnisher, lightly moistened with adhesive, is used to establish preliminary occlusal contours (b) A sable brush is used to smooth the composite surface and ensure intimate adaptation of the restorative composite to the cavosurface margins.).

Figure (1-36): (((b) The matrix is allowed to remain in place during finishing to protect the adjacent tooth (c) The matrix should also remain in place during re-etching and sealing).

8. Clinical Evaluation of Sectional Matrix Versus Circumferential Matrix for Reproduction of Proximal Contact by Undergraduate Students and Postgraduate Dentists: A Randomized Controlled Trial:

Aim: This study aimed at assessing the influence of different matricing techniques; either sectional matrix or circumferential matrix and operator experience; either undergraduate students or postgraduate dentists on reproduction of optimum proximal contacts for posterior proximal resin composite restorations.

Materials and Methods: A total of 60 patients were enrolled; after class II cavity preparation, matrix systems were applied by undergraduate students or postgraduate dentists, by using either sectional matrix or circumferential matrix systems. Cavity preparations were restored by using resin composite restorations according to manufacturers' instructions. Tightness of proximal contacts was evaluated by using dental floss according to FDI recommendations to be either optimum, tight, or open contact. Chi-square test was used to compare between groups; P value ≤ 0.05 was considered statistically significant. Relative risk (RR) was used to determine the clinical significance.

Results: There was a statistically significant difference between the sectional matricing technique and the circumferential matricing technique ($P < 0.0001$). There was less risk of poor proximal contact (tight or open) with the sectional matrix system, and the risk was 70% less than the circumferential matrix.

Clinical implications: Failure to reproduce contact area will cause subsequent periodontal diseases and tooth movements. Conventional circumferential matrix systems produced poor proximal contact points with proximal overhangs or open contacts, and they failed to produce optimum contact points; thus, their usage should be prohibited. Sectional matrix systems with separation rings should be implemented as the first choice in clinical decision making for proximal posterior restorations.

Conclusions: Optimum contact points were highly associated with the sectional matrix system. Open and tight contacts were highly associated with the circumferential matrix system regardless of operator experience **(Shaalan and Ibrahim, 2021).**

9. Influence of open contacts

Proximal tooth open contacts have been suggested as an etiologic factor in food impaction and retention and as a modifying factor in periodontal disease. However, published information has been chiefly anecdotal. Moreover, studies with data linking open contacts with periodontal disease are few and contradictory.

Thus, the role of the open contact in the etiology of periodontal disease has not yet been adequately defined. Several investigators have found open contacts to be a modifying factor in periodontal disease. Sanjana et al. reported that the percentage of diseased papillae increase with weak proximal contact was consistently higher than that found in areas of good contact. Gould and Picton" studied spacing between adjacent teeth and periodontal disease as evaluated by gingival form, inflammation, tooth mobility and crevicular depth. They found that teeth associated with open contacts had significantly greater periodontal disease**(Jernberg et al., 1983).**

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