Republic of Iraq
Ministry of Higher Education and Scientific Research
University of Baghdad
College of Dentistry

A literature Review: Techniques of Placement of Composite in Class II 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

By

Abdulrahman Zeyad Mohammed

Supervised by:
Prof. Abdullah Al-Shammaa'
B.D.S.,

2022 A.D. **1443 A.H.**

Certification of the Supervisor

I certify that this project entitled "A literature Review: Techniques of Placement of Composite in Class II Restorations" was prepared by **Abdulrahman Zeyad Mohammed** under my Supervision at the College of Dentistry/University of Baghdad in partial fulfilment of the graduation requirements for the Bachelor Degree in Dentistry.

Supervisor's name:

Date:

Dedication

For my mother, I wouldn’t be here without your endless support. Thanks for always being there for me. I’m so proud to be your son!

For my Supportive family,

For my supportive friend who was beside me when I was the most unbearable person in the world,

For all my friends who passed during 2019 Protesting,

For my Physics Teacher who said ‘you will never be a dentist’..

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Introduction

Advancement and development of Dental Sciences and Materials have led to increase the demand of having tooth-colored restorations. Nonetheless, many struggles have been facing these studies and development steps in the context of microleakage, Bonding efficiency and required physical properties.

Composite resin has come a long way over the last decades with continuous improvements to become the material of choice for most anterior and posterior restorations. The aim is to esthetically and functionally replace the missing tooth tissue and ensure long-term stability of the tooth-restoration complex in the oral environment.

In this literature review, resin composite restorations will be defined and discussed briefly in addition to their placement in class II restorations being discussed in detail mentioning the placement techniques and the efficiency of each technique compared to others.

1.Resin composite restorations:

1.1. Definition:

Composites are a combination of two or more classes of materials. In dentistry, the most common composite is a combination of a polymer and ceramic, where the polymer is used to bind ceramic particles. The polymer functions as the matrix in dental composites and the particles are reinforcing materials. (Ronald Sakaguchi et al., 2019)

1.2. History:

During the first half of the 20th century, silicates were the only tooth colored esthetic material available for cavity restoration. Proceeding to late 1940s and the early 1950s acrylic resin similar to those used for custom impression trays and dentures replaced silicates because of their tooth like appearance, insolubility in oral fluids, ease of manipulation and low cost. (Adela Hervás García et al., 2005)

In 1956, Bowen investigated dimethacrylates (Bis-GMA) and silanized inorganic filler, dimethacrylates was generally known as Bis-GMA or Bowen's resin, was made up from the combination of bisphenol-A and glycidyl methacrylate. (Richard Trushkowsky et al., 2015)

In the 1970s, microfilled composite were introduced and were marketed at the end of 70s. it was composed of microfine filler particles of pyrolytic silica (SiO_2), in the range of 0.007 – 0.14 µm with a mean of 0.04 µm. (Dijken, H.W., 1987)

Proceeding to the end of 20th century, condensable/packable composites were introduced in 1990s. However, Due to a high failure rate in clinical use, this type of composite has been phased out.

During the Beginning of 21st century, nanofill composites were introduced (Cangul et al., 2017)

1.3. Properties of Composite Restorative Materials

1.3.1 Coefficient of Thermal Expansion

Coefficient of thermal expansion of composites is approximately three times higher than normal tooth structure. This results in more contraction and expansion than enamel and dentin when there are temperature changes, it can result in loosening of the restoration. This can be reduced by adding more filler content.

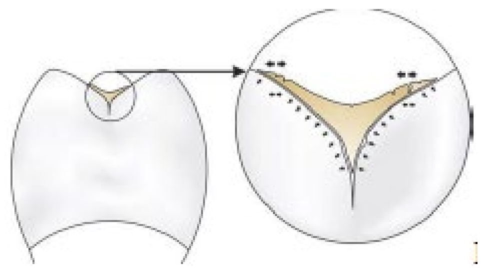

Fig1: Coefficient of thermal expansion can result in dimensional change in restoration which can cause gap between tooth and the restoration

1.3.2. Water Absorption

Composites have a tendency to absorb water which can lead to the swelling of resin matrix, filler debonding and thus restoration failure. Composites with higher filler content exhibit lower water absorption and therefore better properties, than composites with lower filler content.

Factors Affecting Water Absorption of Composites

- More is the filler content less is the water sorption
- Lesser degree of polymerization causes more sorption

Type and amount of monomer and dilutent also affect water sorption. For example, UDMA based composites show less sorption and solubility.

1.3.3. Wear Resistance

Composites are prone to wear under masticatory forces or use of tooth brushing and abrasive food (Fig 2) . Wear resistance is a property of filler particles depending on their size and quantity. The site of restorations in dental arch and occlusal contact relationship, size, shape and content of filler particles affect the wear resistance of the composites.

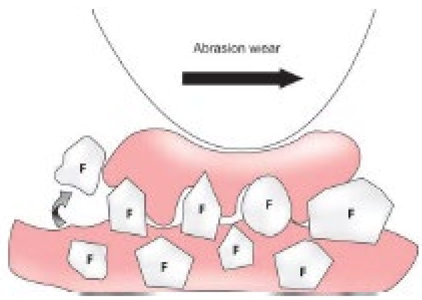

Fig2: Abrasive wear in composite restoration causes exposure of filler-particles which get removed from the surface of composite restoration

Factors Affecting Degradation/Wear of Composites

• Lesser is the polymerization, more is the degradation
• Microfilled composites show less of degradation
• Hydrolytic degradation of strontium or barium glass fillers can result in pressure built up at resin filler junctions. This may cause cracks and fracture of composite restoration. Sudden temperature change can result in disruption in silane coating and thus bond failure between matrix and filler.

1.3.4. Surface Texture

The size and composition of filler particles determine the smoothness of the surface of a restoration. Microfill composites offer the smoothest restorative surface. This property is more significant if the restoration is in close approximation to gingival tissues.

1.3.5. Radiopacity

Resins are inherently radiolucent. Presence of radiopaque fillers like barium glass, strontium and zirconium makes the composite restoration radiopaque.

1.3.6. Modulus of Elasticity

Modulus of elasticity of a material determines its rigidity or stiffness. Microfill composites have greater flexibility than hybrid composite since they have lower modulus of elasticity.

1.3.7. Solubility

Composite materials do not show any clinically significant solubility in oral fluids. Water solubility of composites ranges between 0.5-1.1 mg/cm2.

1.3.8. Creep

Creep is progressive permanent deformation of material under occlusal loading. More is the content of resin matrix, more is the creep. For example, microfilled composites show more creep since they contain more of resin matrix.

1.3.9. Polymerization Shrinkage

Composite materials shrink while curing which can result in formation of a gap between resin based composite and the preparation wall. It accounts for 1.67–5.68 percent of the total volume. In light cured composites, about 60% polymerization ;occurs within 60 seconds, further 10% in next 48 hours; remaining resin does not polymerize. Since the material nearest to the light sets first. Shrinkage in light cured composites occurs in the direction of light (Fig 3 A&B). For chemical cured composites shrinkage occurs slowly and uniformly towards the center of restoration.

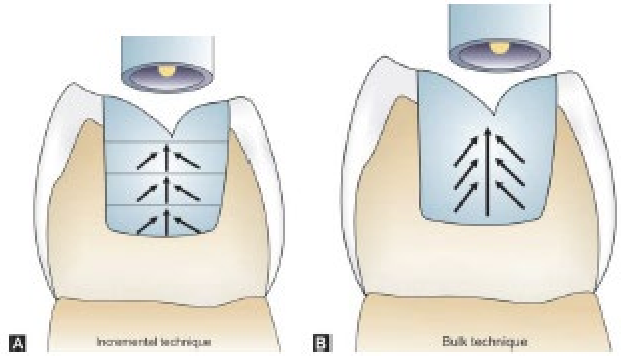

Fig3: A and B: In light cured composites, shrinkage occurs towards source of light

Polymerization shrinkage can be reduced by Decreasing monomer level, Increasing monomer molecular weight, improving composite placement technique.

1.3.10. Configuration or “C-factor”

(C-factor) is the ratio of bonded surface of the restoration to the unbounded surfaces. The higher the value of ’’C‟-factor, the greater is the polymerization shrinkage. (Table 1)

S. No	Type of preparation	Value
1.	Class I and V (five-walled preparation)	5
2.	Class II (four-walled preparation)	2
3.	Class III (three-walled preparation)	1
4.	Class IV (two-walled preparation)	0.5
5.	Smooth surface restoration (one walled preparation)	0.2

Table1: ‘C’ Factor Values for different tooth preparations

1.3.11. Aesthetics of Composites

Composites have shown good aesthetics because of their property of translucency. Composites are available in different opacities and shades so they can be used in different places according to aesthetic requirements.

1.3.12. Microleakage and Nanoleakage

Microleakage is passage of fluid and bacteria in microgaps (10–6 m) between restoration and tooth. It can result in damage to the pulp. Microleakage can occur due to:
– Polymerization shrinkage of composites
– Poor adhesion and wetting
– Thermal stresses
– Mechanical loading
Microleakage can result in bacterial leakage

Nanoleakage: It is passage of fluid/dissolved species in nanosized (10–9 m) gaps. These nanosized porosities occur within the hybrid layer. These can occur because of:
– Inadequate polymerization of primer before application of bonding agent.
– Incomplete resin infiltration.
– Polymerization shrinkage of maturing primer resin.
Nanoleakage can result in **sensitivity** during occlusal and thermal stresses.

2. Class II Cavities Composite Restoration

2.1. The evolution of composite restorations in posterior teeth

Silver amalgam has been used in dentistry to restore posterior teeth for well over a century. Preparing posterior teeth to receive amalgam fillings has universally been one of the first surgical procedures students perform in dental schools and the material have been the mainstay of services provided to patients well into the 1990s. The reasons for its popularity are many but primarily include: simplicity, predictability, longevity and low cost.

Although amalgam has served dentistry well for a very long time, it is not a restorative material without drawbacks. Amalgam undergoes constant corrosion in the mouth, does not strengthen teeth, requires additional tooth structure removal for retention, and is not aesthetic.

In 2013 a global treaty was signed by 128 countries calling for the promotion of cost and clinically effective mercury-free fillings and, among other provisions, encourages professional organisations and dental schools to educate and train on the use of mercury-free alternatives. Currently, the obvious alternative material to use as a direct restorative in posterior teeth is composite resin. This adhesively bonded material seals teeth, reinforces teeth, is more conservative since it does not require mechanical retention or specific preparation geometry, and satisfies patient desires for a natural looking restoration. (Ben-Amar et al., 1987)

2.2. Problems faced with Composite resin in Class II Cavities:

2.2.1. Microleakage

Microleakage can lead to the penetration of acids, enzymes, ions, and bacterial products through the gap resulting in marginal discoloration, post-treatment sensitivity, secondary caries, and pulp defects. (Deviyanti et al., 2018)

2.2.2. Fracture (Fig 4)

The remaining enamel in the cervical area has a great effect on the fracture strength of the composite since the fracture strength of the marginal ridge in composite class II restorations that extend below the CEJ (without available cervical enamel) is significantly lower than when the restoration's margin is located coronally to the CEJ (with available cervical enamel). The area of available cervical enamel in the preparation has a positive influence on the fracture strength. (Laegreid et al., 2011)

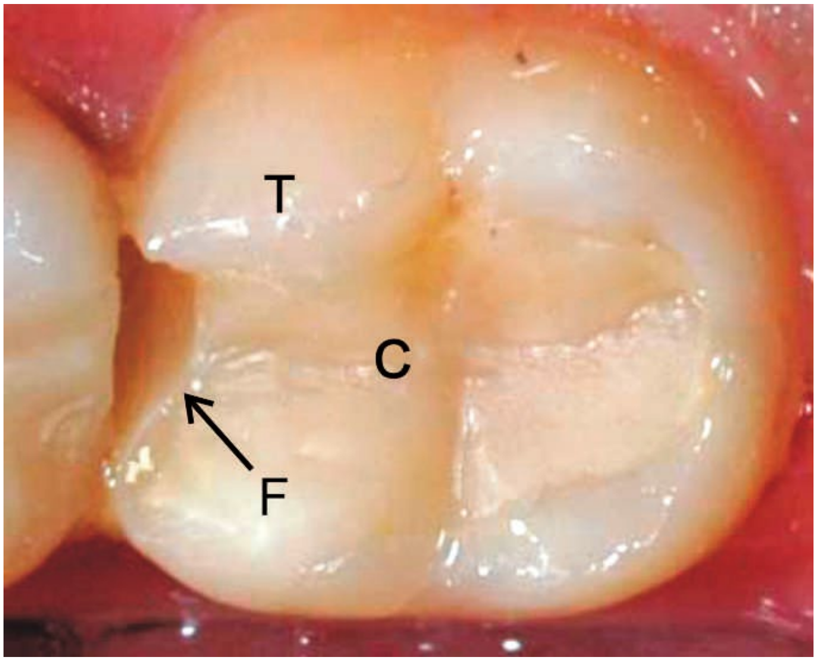

Fig4: Fracture of the marginal ridge of a composite class II restoration in a posterior molar in a clinical setting (C:composite, T: tooth substance, F: fracture).

2.2.3. Difficulty in re-establishing the proximal contact

Composite resin is a passive material. During shaping and prior to curing, it cannot maintain complete rigidity. This is especially true when attempting to create a tight interproximal contact with an adjacent tooth or teeth. In addition to inherent material shrinkage during curing, failure has been linked to the use of amalgam matrix systems for direct composite and has led to poor gingivo-axial margin adaptation and open contacts. This may explain why in the past, direct composite, especially when used to restore Class II cavity preparations, might have exhibited a shorter lifespan and been seen as inferior to amalgam. (Ian Shuman., 2016)

2.3. Cavity Design

Preparation design for posterior composite restorations should differ from that for amalgam restorations from different points. Occlusal form should be narrower and the depth shallower. The proximal extensions (facial and lingual) should be placed in areas that can be seen, probed, and polished. Internal line angles should be rounded and retentive grooves placed in proximal line angles (axiofacial and axiolingual) and the gingival wall. Beveling is recommended for proximal margins but not for occlusal margins. (Ben-Amar et al., 1987)

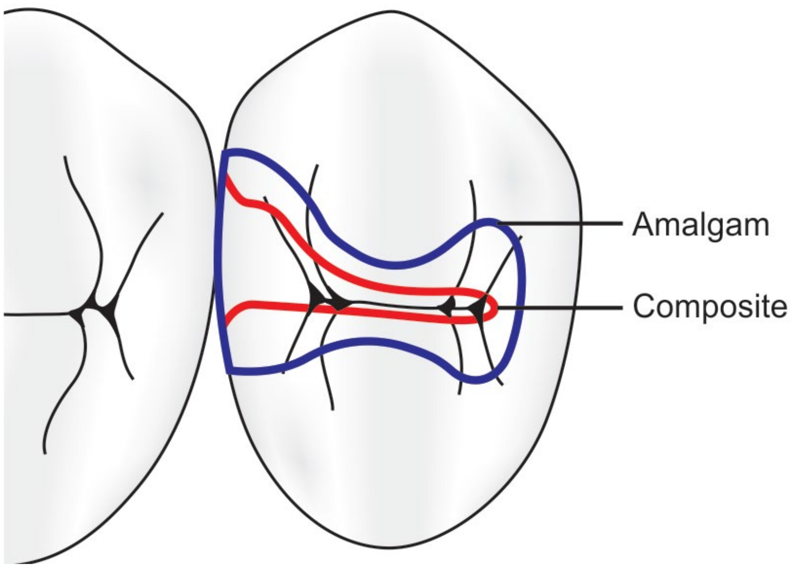

Fig 5: Conservative outline of composite resin in comparison to traditional amalgam restoration

2.4. Placement Techniques

2.4.1. Incremental Techniques:

Incremental techniques as (Aschheim et al., 2015) discussed are as follows:

2.4.1.1. Incremental Layering Technique (Fig 6)

This technique is advocated for use in medium to large posterior composite restorations to avoid the limitation of depth of cure.

Incremental layering technique has many characteristics:

- This technique is based on polymerization of resin based composite layers of less than 2 mm thickness.
- Helps to attain good marginal quality.
- It prevents deformation of the preparation wall.
- It ensures complete polymerization of the resin-based composite.
- Incremental layering of dentin and enamel composite creates layers with high diffusion which allow optimal light transmission within the restoration, thus increasing aesthetics.

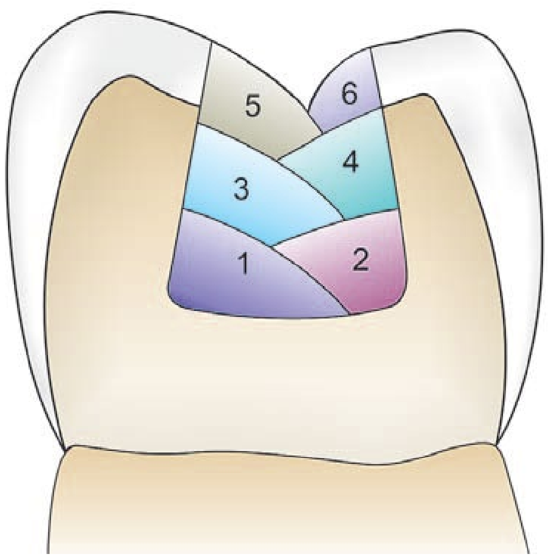

Fig 6: Incremental layering technique

2.4.1.2. Horizontal Technique (Fig 7)

Occluso-gingival layering is done with this technique. Also, it is indicated for small restorations only as it increases the C-Factor.

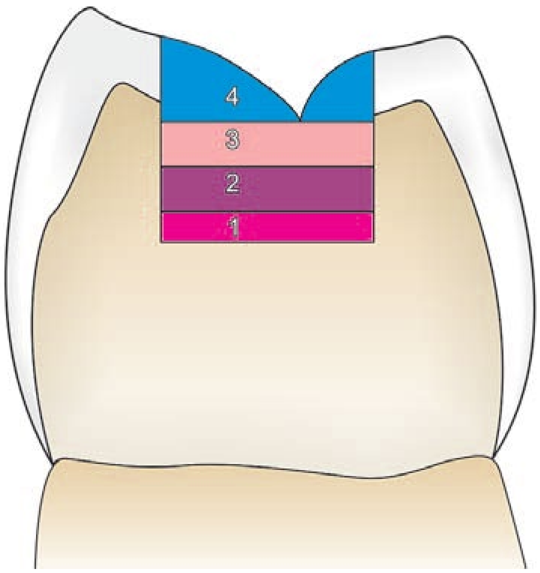

Fig 7: Horizontal Technique

2.4.1.3. U-shaped Layering Technique (Fig 8)

This Technique is being applied as follows:

- First increment in the form of U-Shape is placed at the base, both gingival and occlusal.
- Over that place horizontal and oblique increments to pack the preparation.
- Then, curing is carried out from all the sides.

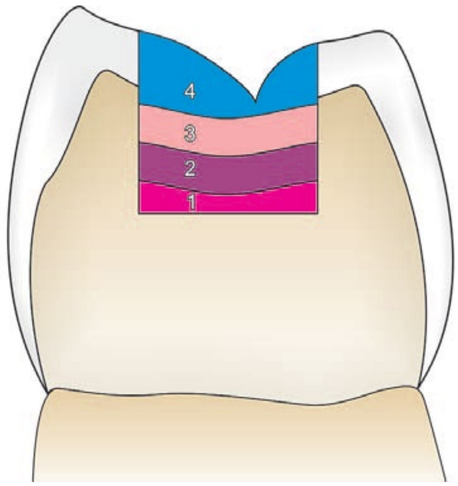

Fig 8: U-shaped Layering Technique

2.4.1.4. Vertical Layering Technique (Fig 9)

This Technique is being applied as follows:

• Place small increments in a vertical pattern starting from one wall, i.e. buccal or lingual and carried to another wall.

• Start polymerization from behind the wall, i.e. if buccal increment is placed on the lingual wall, it is cured from outside the lingual wall.

• Reduces gap at gingival wall which is formed due to polymerization shrinkage, hence postoperative sensitivity and secondary caries.

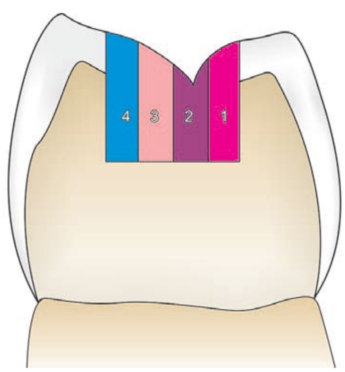

Fig 9: Vertical Layering Technique

2.4.1.5. Oblique Technique (Fig 10)

In this technique, wedge-shaped composite increments are placed to prevent deformation of preparation walls.

• It reduces the C-factor.

• In this technique, polymerization is started first through the preparation walls and then from the occlusal surface.

• This technique directs the vectors of polymerization toward the adhesive surface, this is indirect polymerization technique.

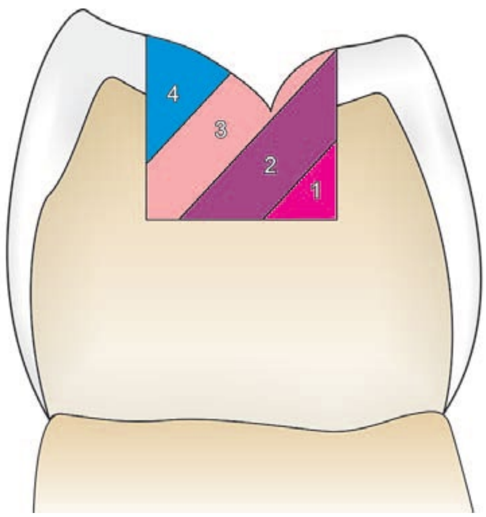

Fig 10: Oblique Technique

2.4.1.6. Three-site technique (Fig 11)

In this technique, polymerization vectors are directed towards the gingival margin.

• This technique uses clear matrix and reflective wedges.

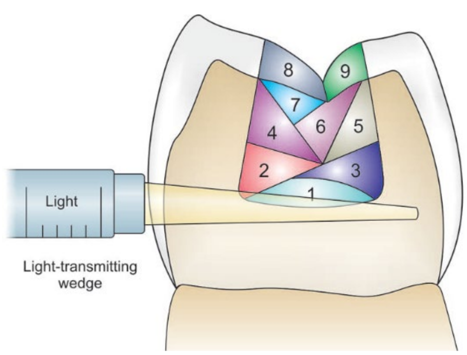

Fig11: Use of light transmitting wedges for better curing at gingival margins

2.4.1.7. Split Horizontal Technique (Fig 12)

For this technique, each horizontal increment was split, before curing, into four triangle-shaped portions, with each portion placed against only one cavity wall and part of the floor one diagonal cut was filled completely with dentin shade composite and photocured. (Rudrapati et al., 2017)

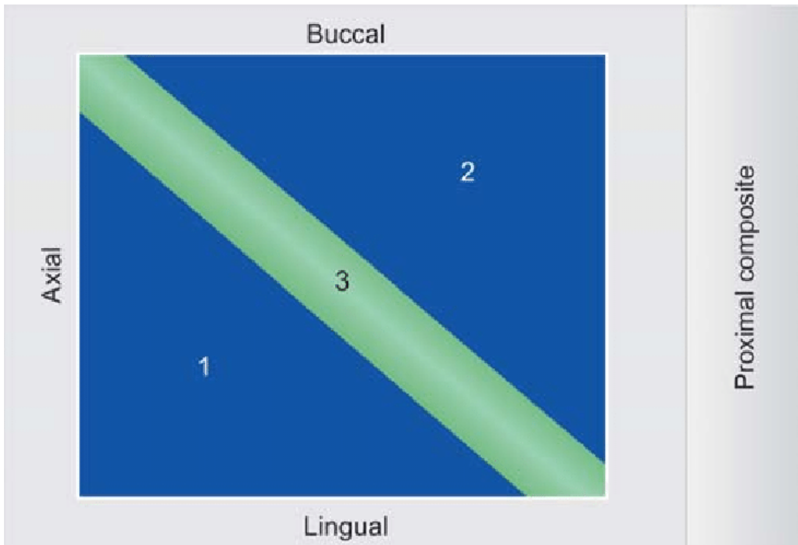

Fig12: Split Horizontal Technique

2.4.1.8. Successive Cusp Build-up Technique

- The first composite increment is applied to a single dentin surface without contacting the opposing preparation walls.
- After this restoration, build up is done by placing wedge-shaped composite increments.
- This technique minimizes the C-factor in three-dimensional tooth preparations.

2.4.2. Bulk Technique (Fig 13)

Bulk-fill resin composites have been introduced into the market for restorations in posterior teeth. The main characteristic of these materials is their insertion in single-increment applications of 4 to 5 mm.

Low-viscosity bulk-fill resin composites were the first materials developed. These flowable materials are indicated as a restorative base and require a 2-mm thick covering layer with a regular/conventional resin composite. Subsequently, paste-like "full-body" bulk-fill restorative resin composites were introduced. These materials contain a higher percentage of inorganic filler, which allows their use in high-masticatory load-bearing areas without the need of coverage. (Durão et al., 2020)

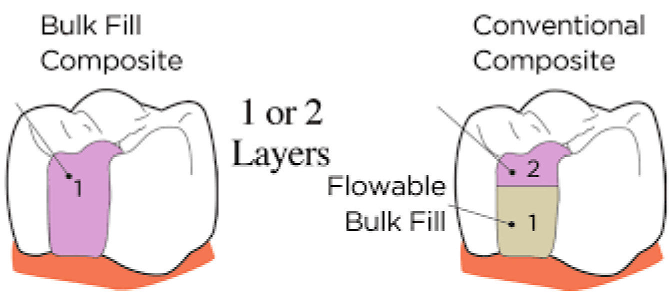

Fig 13: Bulk Technique

2.4.3. Snow Plow Technique

The snowplow technique involves the placement of a layer of flowable composite on the pulpal floor and the gingival margin of the proximal box of a posterior composite resin restoration. However, the layer of flowable composite is not cured prior to placement of a denser-filled composite resin restorative material. In this way, the flowable is pushed into a very thin layer, and the excess is pushed out of the preparation. Reportedly, this will leave a very thin film of the high shrinking flowable composite in a location that may contain porosities if a denser-filled composite was used by itself. The flowable and the initial heavier-filled composite layer are light cured as one increment. (Presicci et al., 2012)

2.4.4. Preheated Composite

Preheating a high-viscosity and packable composite resin up to 68°C before placing it in the cavity and light-curing it has been demonstrated that it will decrease its viscosity and thickness, increasing its flow and adaptation with the cavity walls. In addition, preheating increases the polymerization rate and microhardness of composite resin, improving its physico mechanical properties. The effect of heat, due to a preheated composite resin, on the increase in pulpal temperature is minimal (approximately 2°C), which can be tolerated by the pulp. (Darabi et al., 2020)

2.4.5. Injection Molding Technique (Fig 14)

This technique involves the use of a redesigned cavity preparation, a translucent matrix system, and the proper combination of paste and flowable composites to create strong and esthetic restorations which reduces the potential for voids and fault lines while maintaining the structural integrity of the tooth. (Clark., 2010)

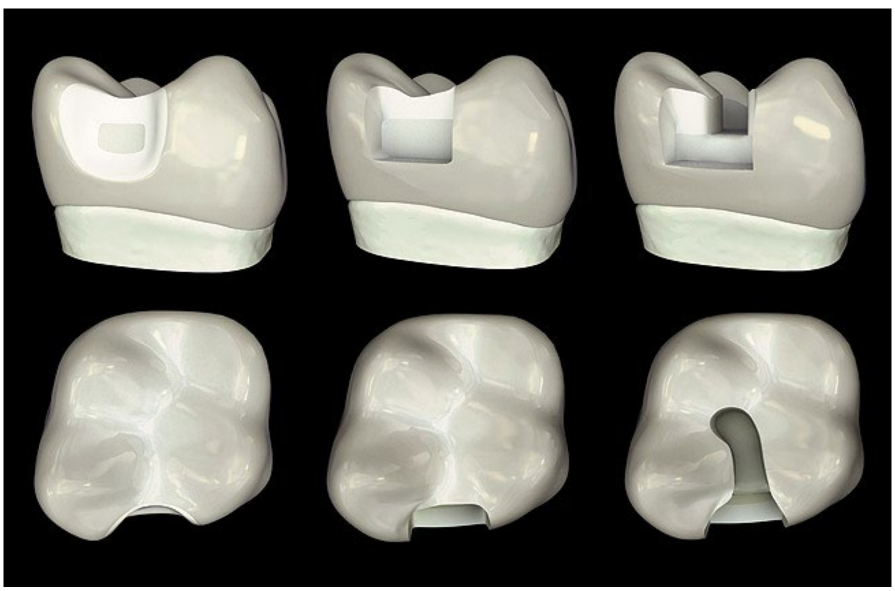

Fig 14: Comparison of Clark Class II preparation (injection Molding Technique) (left) vs the slot preparation (center) vs the G.V. Black preparation (right).

2.4.6. SonicFill Composite Technique

Very recently, Kerr and KaVo, launched the SonicFill™ system for posterior restorations. The system consists of a hand piece activated sonically and a special composite formulation, which contains about 83.5% of fillers by weight. Upon activation, the sonic energy lowers the viscosity of the composite and extrudes the composite that has initially a thick consistency. The viscosity change of the composite will ensure a perfect adaptation to the cavity walls and avoids the stickiness of the composite to the instrument. It is not necessary to condense the composite because the high frequency vibration yields intimate adaptation to the cavity walls without voids inclusion. (Fahad et al., 2014)

2.4.7. Centripetal Technique

This technique restores the lost tooth structure from the periphery to the center of the cavity thereby achieving better marginal adaptation to the gingival floor.
The centripetal technique has the advantage of transforming the Class II into a Class I, and facilitating visualization and access because the matrix band is removed immediately after the proximal box is restored. (Bichacho., 1994)

3. Effects of different placement techniques

3.1. Marginal Adaptation:

- (de Wet FA et al., 1991) compared three placement techniques (Bulk pack, Horizontal layering and Vertical layering) and the results showed polymerization shrinkage with all three techniques, with the poorest the bulk pack technique where large marginal discrepancies were visible. No significant differences were detected between the horizontal and vertical placement techniques.

- (Aulfat Ahmed Albahari1et al., 2020) concluded that the marginal adaptation were not affected by the various tested application techniques in a comparison study between incremental techniques and bulkfill techniques.

- (Cem Peskersoy et al., 2022) Bulk-fill composite resins placed either with sonic-activated or sonic-vibrated instrument demonstrated better adaptability, less gap formation and higher bond strength than both the bulk-fill flowable composite and conventional incremental techniques.

- (Dr. Ramciya KV et al., 2020) in a study comparing marginal adaptability of fiber-reinforced and nanohybrid composite resin placed using layering and bulk placement technique demonstrated that marginal adaptation of fiber reinforced composite in layering technique found to be maximum whereas marginal adaptation of nanohybrid composite in bulk filling technique found to be minimum among the groups.

3.2. Marginal leakage:

- (Mohammed K Fahmi et al., 2019) in a comparison study using a high-viscosity bulk-fill composite with incremental and bulk-fill technique separately showed that bulk-fill composites used with an incremental layering technique sealed significantly better than the other groups followed by bulk-fill composite in the bulk technique.

- (Anupriya Bugalia et al., 2011) in a study comparing four different placement techniques (Split horizontal, centripetal, oblique, and bulk techniques) demonstrated that microleakage was significantly decreased in groups where composite resin was placed in increments when compared with bulk placement technique while among the incremental techniques, split horizontal incremental technique showed least microleakage followed by centripetal incremental technique and oblique placement technique at the occlusal margin of restorations.

- (Marjaneh Ghavamnasiri et al., 2007) in a study aimed to evaluate the microleakage at gingival margins below the cementoenamel junction (CEJ) of Class II composite restorations using centripetal and incremental techniques demonstrated that there was no significant difference in microleakage between experimental groups.

- (Presicci, 2012) assessed microleakage and voids formation using micro-computed tomography. The tested 4 groups include cured flowable +incremental technique, cured flowable +bulkfill ,uncured flowable +incremental technique , uncured flowable +bulkfill technique. The results revealed that the use of the snowplow technique significantly reduced microleakage when the composite was placed incrementally and the greatest amount of microleakage occurred when the flowable composite was cured and the restorative composite was cured incrementally.

3.3. Fracture Resistance:

- (E D Bonilla et al., 2020) in their study compared the effect of centripetal and bulk techniques on fracture resistance of MOD restorations with various resin composites and demonstrated that there was no significant effect of the two placement techniques on the fracture resistance of Class II resin composite restorations.

- (Horieh Moosavi et al., 2012) in their study compared the effect of centripetal and bulk techniques on fracture resistance in composite restorations demonstrated that placement techniques did not have a significant effect on the fracture resistance (P=0.58).

3.4. Cuspal Deflection:

- (S. Jafarpour et al., 2012) compared the bulk and horizontal layering techniques from the aspect of cuspal deflection and demonstrated that all insertion techniques using conventional composite caused cuspal deformation with the deviation of combined buccal and lingual cuspal deflection being higher with the bulk technique when the cavity depth is at 4mm in depth while it's higher in horizontal technique when the depth is at 6mm in depth.

- (G Abbas et al., 2003) in their study, demonstrated that total mean cuspal deflection measurements obtained with incremental technique were significantly increased compared with bulk technique.

- (ME Kim et al., 2011) compared the cuspal deflection in premolars with bulk and incremental techniques and reported lower cuspal deflection in the bulk cure compared with the incremental cure and linked the results to the incomplete cure of the composites.

3.5. Post Operative Sensitivity:

- (Patrícia Valéria Manozzo Kunz et al., 2022) in their systematic review and meta-analysis evaluated the clinical performance of class I and II with composite restorations using bulk and incremental techniques from the post-operative sensitivity aspect and demonstrated that the clinical performance of class I and II restorations in posterior teeth is similar when placed with the incremental and bulk-filling techniques.

- (Chane TARDEM et al., 2019) in their randomized clinical trial about the clinical time and postoperative sensitivity after use of bulk-fill and incremental filling composites demonstrated that neither the bulk nor the incremental techniques have affected the risk of postoperative sensitivity.

Conclusion

Composite resin is one of the most crucial topics that gathers the attention of dentists and scientists worldwide who are working toward developing composite resin in the context of composition, bonding technique, curing technique, and placement technique.
Meanwhile, composite placement techniques have a dramatic significance in class II restorations. While taking the studies discussed above into consideration, we can demonstrate that:

Bulk-fill composite resins placed either with sonic-activated or sonic-vibrated instruments showed a superiority above bulk and incremental techniques when comparing the marginal adaptation with the incremental techniques showing better marginal adaptation when being compared with bulk-fill technique. However, some studies had demonstrated that there is no siginficant difference of placement technique when evaluating the marginal adaptation.
Snow-plow technique has shown the least microleakage when being evaluated with the incremental technique, meanwhile the incremental technique demonstrated the same result when being compared with centripetal technique with the bulk technique being the most technique posing microleakage.
The studies had demonstrated that different placement techniques have no significant effect on the fracture resistance.
Cuspal deflection has been shown to be less in bulkfill technique in comparison to incremental technique. However, some studies demonstrated that the cavity depth could affect the cuspal deflection.
In terms of Post operative sensitivity, there was no signifcant difference between placement techniques.

However, with the evolution of new techniques and new materials requires more studies with the existing methods and materials.

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