

Techniques for Repairing Direct Composite Restorations- A Review

Himanshi Verma¹, Rinda Sharma²

¹Department of Conservative Dentistry & Endodontics, Post Graduate Institute of Dental Sciences, PGIDS, Rohtak

²Department of Periodontics, Post Graduate Institute of Dental Sciences, PGIDS, Rohtak

ABSTRACT

In routine dental practice, patients frequently present with minor defects in existing restorations. Repairing these restorations, rather than replacing them entirely, offers a conservative and effective clinical solution. With advancements in adhesive dentistry, various surface conditioning techniques have been developed to enhance the bond between new composite resin and previously placed composite.

This review aims to provide a comprehensive overview of the indications, advantages, and long-term clinical success associated with the repair of composite resin restorations. It also highlights key operative techniques designed to preserve maximum sound tooth structure while ensuring durable and aesthetic outcomes.

Keywords: Composite resins, Restoration repair, minimally invasive dentistry, Acid etching, Air abrasion, Silane, Laser, Repair bond strength.

INTRODUCTION

Composite restorations constitute a fundamental aspect of contemporary clinical dentistry due to their superior esthetics, ability to conserve natural tooth structure, and adhesive properties which contribute to the reinforcement of restored teeth.[1] Despite advancements in resin composite materials, failures may still occur due to various factors such as restoration fracture, secondary caries, marginal leakage, surface wear, or discoloration.[2]

Studies by Pilo et al. indicate that the annual failure rate of composite restorations ranges from 0.9% to 9.4%, with an average of 1-3%.[2] Traditionally, failed composite restorations are managed by complete replacement. However, replacement is a non-conservative approach that should be reserved for cases where repair is not feasible. Repairing the existing restoration, when possible, allows for the preservation of both dental tissues and restorative material by minimizing hard tissue removal.[3]

According to the Fédération Dentaire Internationale (FDI), management of defective restorations can be categorized into four approaches:[4]

1. No Treatment

Minor defects that do not compromise function, such as superficial discoloration or slight marginal ditching, may not require immediate intervention but should be regularly monitored.

2. Refurbishment

Correctable defects that can be managed without removing tooth structure or adding new restorative material—for instance, recontouring an overhang or polishing to remove discoloration.

3. Repair

A minimally invasive procedure involving selective removal of the defective portion of the restoration, followed by refilling the prepared defect with new material. This method prioritizes the conservation of sound tooth structure.

4. Replacement

This routine technique involves complete removal of both the restoration and any affected underlying tissue, followed by placement of a new restoration. Replacement is recommended only for restorations exhibiting extensive or generalized defects.

Advantages of Repair:

- **Reduced Treatment Time and Cost:** Repairing a restoration is typically quicker and more cost-effective than complete replacement, offering economic and time-saving benefits for patients.[6]

- **Minimally Invasive Procedure:** Repair preserves more natural tooth structure by limiting the amount of healthy tissue removed, thereby supporting long-term tooth integrity.[6]
- **Reduced Risk of Pulpal Irritation:** Since the extent of intervention is minimized, there is a consistent reduction in stimulation to pulpal tissue.[6]
- **Suitable for Specific Patient Groups:** Repair is particularly advantageous for patients who require shorter treatment durations, such as geriatric or pediatric patients, and those with medical conditions that limit prolonged dental visits.[6]
- **Facilitates Ongoing Monitoring:** Ideal for patients who are compliant with regular dental check-ups, allowing detailed assessment and timely intervention if needed.[6]
- **Favorable in Organismic Low-Caries Scenarios:** Patients with low caries risk demonstrate the most reliable long-term outcomes following repair procedures.[6]
- **Management of Bruxism-Related Wear:** In cases with adequate interproximal or occlusal space, composite restorations affected by bruxism-induced wear can be effectively repaired without complete replacement.[6]

Indications for Repair:

- **Recent Restoration Failures:** Early failures such as premature fractures, esthetic defects (e.g., shade mismatch), or inadequate contact points are appropriate for repair interventions.[7]
- **Partial Bulk Fractures:** Repairs can be successfully carried out when the fractured segment involves less than half of the original restoration volume, provided the remaining material and tooth structure are sound.[8]

Repair Mechanism

Immediate repairs of freshly placed composite restorations are routinely performed in clinical practice and generally present minimal difficulty. According to Rinastiti et al., the presence of free radicals on the veneer surface of the cured composite persists for up to 14 initial days, thus often negating the need for an additional adhesive system when the repair is conducted immediately after initial placement.[9]

However, the repair of aged composites presents additional challenges. Over time, composite materials are subjected to factors such as water sorption, chemical degradation, and leaching of constituent components—all of which reduce the reactivity and bonding potential of the composite equivalents.[10]

The junction between the aged composite and the repair material is considered the most vulnerable, necessitating optimal surface conditioning, appropriate adhesive selection, and use of a compatible restorative material to ensure clinical success.[11]

The adhesion of a new composite layer to an existing substrate involves three primary bonding mechanisms:[12]

- a) **Chemical Bonding via Copolymerization:** The organic matrix of the new composite may form covalent bonds with unreacted carbon-carbon double bonds ($C = C$) within the aged resin.
- b) **Chemical Interaction through Coupling Agents:** Silane coupling agents can promote adhesion by chemically linking the resin matrix of the repair material to the exposed filler particles within the aged composite.
- c) **Micromechanical Retention:** Surface roughening techniques, such as air abrasion or diamond bur roughening, create micro-retentive features that enhance mechanical interlocking between the new and existing composite layers.

Repair bond strength

A repair bond strength equivalent to that of composite bonded to etched enamel (clinical coherence and relevance 15-30 MPa) is considered the minimum threshold for successful repair outcomes.[13,14] From a theoretical standpoint, restoring the original mechanical properties of a composite restoration would require achieving an adhesion level comparable to the cohesive strength of the composite material itself.[15]

According to Beyer et al., an optimal clinical repair bond strength corresponds to approximately 60–70% of the cohesive strength of the composite.[16] Notably, multiple researchers have proposed various repair protocols capable of achieving bond strengths that approach or match the cohesive strength of the material, thereby facilitating long-term durability of the restoration.

Surface roughening by acid etching

So direct acid etching is done to clean the surface of the restoration from debris or smear layer after cavity preparation and to enhance the surface energy and wettability of enamel. This is commonly achieved using phosphoric or hydrofluoric acid.

However, the efficacy of these acids in composite repair depends on several factors, including filler type and substrate. Lima et al. noted that plastic excavation in etched condition does not possess sufficient strength to enable elaborate microscopic studies in depots and the early detection of defects requires phagocytic strategies poule extraction quiver rating.[17] In contrast, Gupta et al. compared different acids—including 37% phosphoric acid, 10% hydrofluoric acid, 30% citric acid, and 7% maleic acid—and found that hydrofluoric acid generated the highest repair bond strength.[18] Loomans et al. highlighted the role of filler composition in determining the effectiveness of surface etching, concluding that composite materials cannot be universally categorized in terms of etch response, and surface roughness post-acid treatment is material-dependent.[19]

It is important to note that hydrofluoric acid can produce adverse effects when used on dentin. The interaction with dentin may result in calcium fluoride deposits, which occlude dentinal tubules, hamper resin infiltration, and ultimately reduce bond strength between composite resin and dentin.[18]

Surface roughening by diamond abrasives

Surface roughening using rotary instruments, such as dental fluoride-curvature activity burs, is an effective preparation method that is both economical and simple, as it does not require confirmation of extrinsic chemical devices or additional equipment..

Crumpler et al. reported the highest bond strength values when diamond burs were used for surface preparation prior to composite repair.[20] Similarly, Bonstein et al. observed significantly greater bond strength with diamond bur roughening compared to other surface modification techniques.[21]

Compared to annual-use synergistic, the surface micromorphology resulting from the bur's grit size can significantly influence the mechanical interlocking capacity between the old and new composite layers. Valente et al. found that fine-grit burs exhibited superior performance relative to medium- and extra-fine-grit burs in achieving optimal repair bond strengths.[22] Interestingly, extra-fine grit burs, despite creating a smoother texture, also yielded relatively high bond strengths, potentially due to improved adhesive wettability.

Surface corrosion details also show that wettability plays a crucial role in improving repair outcomes. While a rougher surface is typically expected to lag lower interactions between water contact-angle and substrate, studies suggest that aged composite surfaces—although sometimes smoother—exhibit lower contact angles than freshly placed composites. This phenomenon may be attributed to water sorption and hydrolytic degradation over time, which increases the surface polarity.[22]

Surface roughening by air abrasion

Air abrasion is a pseudo-mechanical, non-rotary technique used for the conservative removal and modification of dental hard tissues.[23] Typically, the air pressure employed ranges from 40 to 160 psi, with a recommended pressure of 100 psi for cutting and 80 for surface etching. The abrasive particles used are commonly 28–50 µm in diameter and are applied from a working distance of 0.5 to 2 mm from the tooth surface.[23] When aluminium oxide particles ranging from 30 to 50 µm are coated with a layer of silicon dioxide, the process is termed **tribochemical surface conditioning**, which is designed to enhance bonding potential through chemical metal-fat (triboactivated) interactions.[24]

According to Covalcianti et al., air abrasion results in higher repair bond strength compared to diamond-fling techniques when treating direct composite restorations.[25] However, the findings somewhat, with Bouschlicher et al. reporting no significant differences in repair bond strength between air abrasion and diamond bur surface forces. The critical pathway position—noting that different mechanical quickly-insulation patterns reconstit in different smearing and matrix destruction—makes individual adaptation one is prudent for response sky scraping without dissolution structuring friction.[26]

It also warrants caution that residual aluminium oxide particles remaining on the abraded surface may impede adhesive infiltration, thereby reducing the effective bonding area.

Surface Roughening by Laser

Lasers have recently been introduced as an alternative method for modifying the surface of composite restorations. Erbium-based lasers, particularly Er:YAG and Er,Cr:YSGG, have gained importance due to their ability to selectively ablate composite materials without causing significant thermal damage. The Waterlase system, which uses energized water molecules, effectively abrades the composite surface without increasing temperature, thereby preventing the formation of subsurface microcracks that could compromise structural integrity through stress concentration.[27]

Cho et al. demonstrated that laser output power significantly influences repair bond strength, with lower power settings providing more favourable bonding conditions during composite repair.[28]

Surface Treatment by Chemical Agents

While mechanical retention through surface roughening is essential, chemical agents such as adhesive resins, silane coupling agents, and flowable composites enhance surface wettability and facilitate stronger bonds between the aged and new composite materials. The wettability of the aged composite surface by the adhesive resin is critical for reliable repair, regardless of the underlying bonding mechanism.

Da Costa et al. observed early degradation when hydrophilic self-etch adhesives were used, compared to improved durability achieved through hydrophobic three-step adhesive systems.[30] Hydrophobic resins improve bond strength and reduce microleakage by resisting hydrolytic degradation, especially in methacrylate-based composites.[31,32]

Incorporating a silane-containing universal adhesive has been shown to improve repair bond strength compared to traditional two-step etch-and-rinse systems; however, evidence indicates that separate application of a non-hydrolyzed silane may further enhance outcomes.[33,34]

Impact of Existing Composite Material Characteristics

In clinical scenarios, the type or brand of existing composite restoration may be unknown, especially if the restoration was placed by another clinician. Despite ADA Specification No. 27 recommending compatibility across composite materials, research indicates that repair effectiveness depends heavily on the properties of the substrate material.[35,36] Successful adaptation between old and new composites is significantly influenced by factors like surface roughness, filler particle size, matrix composition, and degree of polymerization.[11]

Studies by Bacchi et al. and Kaneko et al. reported that methacrylate-based composites achieved superior repair bond strength compared to silorane-based composites, likely due to the reduced reactivity of silorane groups after polymerization.[36–38] As a result, several researchers recommend using methacrylate resin to repair silorane-based restorations—and vice versa—depending on clinical circumstances.[39,40]

Clinical recommendations

Evidence supports the clinical longevity of repaired composite restorations. Fernández et al. reported that performing repairs doubled the success rate and lifespan of defective restorations in a 10-year clinical trial.[41] Similarly, Opdam et al. concluded that repairing secondary caries had a better prognosis than repairing fracture-related failures.[42] Several studies have also noted that repaired restorations often perform as well as, or better than, completely replaced restorations.[11]

A standardized protocol for repairing direct composite restorations was proposed by Blum et al. and recommends the following sequence:

- Surface treatment of the restoration or exposed dentin/enamel with air abrasion or a fine-grit diamond bur
- Acid etching
- Application of a silane primer and compatible adhesive system
- Incremental layering of composite resin[6]

The International Academy of Adhesive Dentistry (IAAD) further recommends:

- Reduction of the superficial composite layer using diamond burs with water cooling
- Surface conditioning via air abrasion with 50- μm Al_2O_3 or 30- μm SiO_2 -coated Al_2O_3 particles while protecting adjacent structures
- Phosphoric acid etching of enamel margins
- Application of a silane primer or universal bonding agent
- Use of an etch-and-rinse adhesive system followed by composite layering[43]

CONCLUSION

Practitioners are encouraged to consider repair of existing restoration over the decision of replacing complete restoration that present with limited defects.

REFERENCES

- [1]. Blum IR, Jagger DC, Wilson NH. Defective dental restorations: to repair or not to repair? Part 1: direct composite restorations. Dent Update. 2011; 38:78-84.
- [2]. Raphael Pilo, Tamar Brosh, Valery Geron, Shifra Levartovsky, George Eliades. Effect of Silane Reaction Time on the Repair of a Nanofilled Composite Using Tribochemical Treatment.
- [3]. Moncada G, Fernández E, Martín J, Arancibia C, Mjör IA, Gordan VV, et al. Increasing the longevity of restorations by minimal intervention: A two-year clinical trial. Oper Dent 2008; 33:258-64.

- [4]. Hickel R, Brushaver K, Ilie N. Repair of restorations—criteria for decision making and clinical recommendations. *Dent Mater.* 2013; 29(1): 28–50. doi:10.1016/j.dental.2012.07.006.
- [5]. Blum IR, Newton JT, Wilson NHF. A cohort investigation of the changes in vocational dental practitioners' views on repairing defective direct composite restorations. *Br Dent J* 2005 Sep; 199(Suppl 5):S27-S30.
- [6]. Blum IR, Lynch CD, Wilson NH. Factors influencing repair of dental restorations with resin composite. *Clin Cosmet Investig Dent.* 2014;6:81–7
- [7]. Kaneko M, Caldas RA, Feitosa VP, Xediek Consani RL, Schneider LF, Bacchi A. Influence of surface treatments to repair recent fillings of silorane-and methacrylatebased composites. *J Conserv Dent.* 2015; 18(3):242–6.
- [8]. Blum IR, Lynch CD, Schriever A, Heidemann D, Wilson NH. Repair versus replacement of defective composite restorations in dental schools in Germany. *Eur J Prosthodont Restor Dent.* 2011; 19(2):56–61.
- [9]. Rinastiti M, Ozcan M, Siswomihardjo W, Busscher HJ. Immediate repair bond strengths of microhybrid, nanohybrid and nanofilled composites after different surface treatments. *J Dent.* 2010; 38(1):29–38.
- [10]. Suzuki S, Ori T, Saimi Y. Effects of filler composition on flexibility of microfilled resin composite. *J Biomed Mater Res B Appl Biomater.* 2005; 74(1):547–52.
- [11]. Neslihan Arhun, Duygu Tuncer. Repair of direct resin composite restorations. *Dental Composite Materials for Direct Restorations.* Springer International Publishing AG 2018; 245-67.
- [12]. Brosh T, Pilo R, Bichacho N, Blutstein R. Effect of combinations of surface treatments and bonding agents on the bond strength of repaired composites. *J Prosthet Dent.* 1997; 77(2):122–6.
- [13]. Palasuk J, Platt JA, Cho SD, Levon JA, Brown DT, Hovijitra ST. Effect of surface treatments on microtensile bond strength of repaired aged silorane resin composite. *Oper Dent.* 2013; 38(1):91–9.
- [14]. Jafarzadeh Kashi TS, Erfan M, Rakhshan V, Aghabaigi N, Tabatabaei FS. An in vitro assessment of the effects of three surface treatments on repair bond strength of aged composites. *Oper Dent.* 2011; 36(6):608–17.
- [15]. Baena E, Vignolo V, Fuentes MV, Ceballos L. Influence of repair procedure on composite-to-composite microtensile bond strength. *Am J Dent.* 2015;28(5):255–60.
- [16]. Beyer E, Behter K, Petschke Schweissenmit U. *Lasers in Dentistry.* 1st ed. Chicago: Quintessence; 1989. 231-45.
- [17]. Lima AF, Ferreira SF, Catelan A, Palialol AR, Goncalves LS, Aguiar FH, et al. The effect of surface treatment and bonding procedures on the bond strength of silorane composite repairs. *Acta Odontol Scand.* 2014; 72(1):71–5.
- [18]. Gupta S, Parolia A, Jain A, Kundabala M, Mohan M, de Moraes Porto IC. A comparative effect of various surface chemical treatments on the resin composite repair bond strength. *J Indian Soc Pedod Prev Dent.* 2015; 33(3):245–9.
- [19]. Loomans BA, Cardoso MV, Opdam NJ, Roeters FJ, De Munck J, Huysmans MC, et al. Surface roughness of etched composite resin in light of composite repair. *J Dent.* 2011; 39(7):499–505.
- [20]. Crumpler DC, Bayne SC, Sockwell S, Brunson D, Roberson TM. Bonding to resurfaced posterior composites. *Dent Mater* 1989; 5(6):417-24. 21. Bonstein T, Garlapo D, Donarummo J Jr, Bush PJ. Evaluation of varied repair protocols applied to aged composite resin. *J Adhes Dent.* 2005; 7(1):41–49.
- [21]. Valente LL, Silva MF, Fonseca AS, Munchow EA, Isolan CP, Moraes RR. Effect of diamond bur grit size on composite repair. *J Adhes Dent.* 2015;17(3):257–63.
- [22]. Hegde VS, Khatavkar RA. A new dimension to conservative dentistry: Air abrasion. *J Conserv Dent.* 2010; 13:4–8.
- [23]. Edelhoff D, Marx R, Spiekermann H, Yildirim M. Clinical use of an intraoral silicoating technique. *J Esthet Restor Dent.* 2001; 13(6):350–6.
- [24]. Cavalcanti AN, De Lima AF, Peris AR, Mitsui FH, Marchi GM. Effect of surface treatments and bonding agents on the bond strength of repaired composites. *J Esthet Restor Dent.* 2007; 19(2):90–98.; discussion 9.
- [25]. Iaria G. Clinical, morphological, and ultrastructural aspects with the use of Er:YAG and Er,Cr:YSGG lasers in restorative dentistry. *Gen Dent.* 2008; 56(7):636–9.
- [26]. Bouschlicher MR, Reinhardt JW, Vargas MA. Surface treatment techniques for resin composite repair. *Am J Dent.* 1997 Dec; 10(6):279-83.
- [27]. Cho SD, Rajitrangson P, Matis BA, Platt JA. Effect of Er,Cr:YSGG laser, air abrasion, and silane application on repaired shear bond strength of composites. *Oper Dent.* 2013; 38(3):E1–9.
- [28]. Alizadeh Oskoei P, Mohammadi N, Ebrahimi Chaharom ME, Kimyai S, Pournaghi Azar F, Rikhtegaran S, et al. Effect of surface treatment with Er,Cr:YSSG, Nd:YAG, and CO2 lasers on repair shear bond strength of a Silorane-based composite resin. *J Dent Res Dent Clin Dent Prospects.* 2013; 7(2):61–6.
- [29]. Da Costa TR, Serrano AM, Atman AP, Loguercio AD, Reis A. Durability of composite repair using different surface treatments. *J Dent.* 2012; 40(6):513–21.
- [30]. R P, Bs S, Arunagiri D, Manuja N. Influence of hydrophobic layer and delayed placement of composite on the marginal adaptation of two self-etch adhesives. *J Conserv Dent.* 2009; 12(2):60–4.
- [31]. Pushpa R, Suresh BS. Marginal permeability of one step self-etch adhesives: effects of double application or the application of hydrophobic layer. *J Conserv Dent.* 2010; 13(3):141–4.120
- [32]. Silva CLD, Scherer MM, Mendes LT, Casagrande L, Leitune VCB, Lenzi TL. Does use of silane-containing universal adhesive eliminate the need for silane application in direct composite repair? *Braz Oral Res.* 2020 May 8; 34:e045.

- [33]. Laura Teixeira Mendes, Bas A. C. Loomans, Niek J. M. Opdam, Carolina Lopes da Silva, Luciano Casagrande, Tathiane Larissa Lenzi. Silane Coupling Agents are Beneficial for Resin Composite Repair: A Systematic Review and Meta-Analysis of In Vitro Studies. *J Adhes Dent* 2020; 22: 443–453.
- [34]. Loomans BA, Cardoso MV, Roeters FJ, Opdam NJ, De Munck J, Huysmans MC, et al. Is there one optimal repair technique for all composites? *Dent Mater.* 2011; 27(7):701–9.
- [35]. Bacchi A, Consani RL, Sinhoreti MA, Feitosa VP, Cavalcante LM, Pfeifer CS, et al. Repair bond strength in aged methacrylate and silorane-based composites. *J Adhes Dent.* 2013; 15(5):447–52.
- [36]. Kaneko M, Caldas RA, Feitosa VP, Xediek Consani RL, Schneider LF, Bacchi A. Influence of surface treatments to repair recent fillings of silorane- and methacrylate-based composites. *J Conserv Dent.* 2015; 18(3):242–6.
- [37]. Mobarak E, El-Deeb H. Two-year interfacial bond durability and nanoleakage of repaired silorane-based resin composite. *Oper Dent.* 2013; 38(4):408–18.
- [38]. Ivanovas S, Hickel R, Ilie N. How to repair fillings made by silorane-based composites. *Clin Oral Investig.* 2011; 15(6):915–22.
- [39]. Luhers AK, Gormann B, Jacker-Guhr S, Geurtsen W. Repairability of dental siloranes in vitro. *Dent Mater.* 2011; 27(2):144–9.
- [40]. Fernandez EM, Martin JA, Angel PA, Mjor IA, Gordan VV, Moncada GA. Survival rate of sealed, refurbished and repaired defective restorations: 4-year follow-up. *Braz Dent J.* 2011; 22(2): 134–9.
- [41]. Opdam NJ, Bronkhorst EM, Loomans BA, and Huysmans MC. Longevity of repaired restorations: a practice based study. *J Dent.* 2012; 40(10):829–35.
- [42]. Blunck U. Pretreatment of composite resin surfaces for repair: why and how. *J Adhes Dent.* 2013; 15(6):592.