International Journal of Dental Sciences
www.dentaljournal.in
E-ISSN: 2663-4708
Received: 29-06-2026; Accepted: 30-07-2026; Published: 14-08-2026
Volume 8, Issue 3, 2026, Page No. 93-100

Influence of different time intervals following 980-nm diode laser desensitization on the shear bond strength of self-adhesive resin cement to dentin: An *in vitro* study

Ansar[1], Aftab Damda[2]
[1] Department of Conservative Dentistry and Endodontics, A.J. Institute of Dental Sciences, Mangalore, Karnataka, India
[2] Professor and Head, Department of Conservative Dentistry and Endodontics, A.J. Institute of Dental Sciences, Mangalore, Karnataka, India
DOI: https://doi.org/10.66856/ijds.2026.8.3.8095

Abstract
Background: Dentin hypersensitivity is a common clinical condition that frequently develops following tooth preparation, gingival recession, and cervical dentin exposure. High-power diode lasers have emerged as an effective modality for dentin desensitization by promoting dentinal tubule occlusion while minimizing pulpal injury. However, laser-induced morphological alterations may influence subsequent adhesive procedures, particularly the bonding of resin cements to dentin. Although previous investigations have evaluated the effect of diode laser desensitization on bond strength, limited evidence exists regarding the ideal waiting period between laser treatment and definitive adhesive cementation.
Objective: To evaluate the effect of different time intervals following 980-nm diode laser desensitization on the shear bond strength of a self-adhesive resin cement to dentin.
Materials and Methods: Sixty freshly extracted human premolars were prepared to expose flat coronal dentin surfaces. All specimens received diode laser desensitization using a 980-nm diode laser at 1.0 W in continuous mode for 20 seconds. Specimens were randomly allocated into three groups (n = 20) according to the interval between laser treatment and bonding:

- Immediate bonding (within 30 minutes)
- Bonding after one week
- Bonding after two weeks

RelyX U200 self-adhesive resin cement was bonded to dentin using standardized cylindrical molds. Shear bond strength testing was performed using a universal testing machine at a crosshead speed of 1 mm/min. Data were analyzed using SPSS Version 23. Normality was assessed using the Shapiro-Wilk test. Intergroup comparisons were performed using non-parametric statistics with statistical significance set at $p < 0.05$.
Results: The one-week group demonstrated the highest mean shear bond strength (12.67 ± 3.62 MPa), followed by the two-week group (10.60 ± 5.25 MPa) and the immediate bonding group (9.93 ± 3.38 MPa). Pairwise comparisons revealed significantly greater bond strength in the one-week group compared with immediate bonding, whereas no significant difference was observed between the immediate and two-week groups. These findings indicate that delaying bonding for one week after diode laser desensitization provides a more favourable substrate for resin cement adhesion than immediate or two-week delayed bonding.
Conclusions: Within the limitations of this *in vitro* study, delaying adhesive cementation for one week following 980-nm diode laser desensitization significantly improved the shear bond strength of self-adhesive resin cement to dentin. Immediate bonding and a two-week delay did not demonstrate comparable improvements. A one-week interval may therefore represent the optimal clinical waiting period before definitive adhesive cementation after diode laser desensitization.

Keywords: Diode laser 980 nm laser Dentin hypersensitivity Resin cement Shear bond strength Laser desensitization Self-adhesive resin cement Adhesive dentistry

Introduction

Dentin hypersensitivity (DH) is one of the most common painful conditions encountered in restorative and prosthodontic practice. It is characterized by a short, sharp pain arising from exposed dentin in response to thermal, tactile, evaporative, osmotic, or chemical stimuli that cannot be attributed to any other dental pathology [1]. According to the hydrodynamic theory proposed by Brännström, external stimuli induce rapid movement of fluid within exposed dentinal tubules, resulting in activation of mechanoreceptors associated with Aδ nerve fibers and the perception of pain [2]. Consequently, dentin hypersensitivity can adversely affect Patients oral hygiene practices, dietary habits, quality of life, and acceptance of restorative treatment.

The prevalence of dentin hypersensitivity is particularly high among patients presenting with gingival recession, non-carious cervical lesions, erosive tooth wear, periodontal therapy, and extensive tooth preparation for indirect restorations [4]. During fixed prosthodontic procedures, cervical dentin is frequently exposed after tooth preparation, making postoperative hypersensitivity a significant clinical concern. Persistent sensitivity may compromise patient comfort, interfere with provisionalization, and reduce patient satisfaction with definitive restorative treatment. Consequently, effective dentin desensitization has become an integral component of contemporary adhesive dentistry [6].

A wide range of desensitization strategies has been introduced to reduce dentinal permeability and alleviate hypersensitivity. These include potassium nitrate-containing formulations that reduce pulpal nerve excitability, fluoride varnishes that promote mineral precipitation, oxalate compounds that occlude dentinal tubules, bioactive materials such as hydroxyapatite and bioactive glass, dentin bonding agents that create hybridized barriers, and various laser systems [6]. Each modality acts through one or more mechanisms, including tubular occlusion, reduction in dentinal fluid movement, remineralization, or neural desensitization [7]. Nevertheless, no single technique has consistently demonstrated superior long-term clinical performance under all clinical conditions.

Among physical treatment modalities, laser therapy has gained considerable popularity because of its minimally invasive nature, rapid onset of action, and ability to achieve durable dentinal tubule occlusion without direct chemical application. High-power lasers such as Nd: YAG, Er: YAG, CO_2, and diode lasers have been extensively investigated for dentin hypersensitivity management. Of these, the 980-nm diode laser is widely used owing to its compact design, cost-effectiveness, ease of clinical application, and favorable safety profile [7]. Laser irradiation induces localized thermal effects that partially melt peritubular dentin, resulting in narrowing or complete occlusion of dentinal tubules, thereby reducing dentinal fluid movement responsible for hypersensitivity.

Despite these clinical advantages, laser-induced morphological and chemical modifications of dentin may influence subsequent adhesive procedures. Successful resin bonding depends on adequate substrate wetting, preservation of collagen architecture, optimal dentin permeability, and formation of a stable hybrid layer. Thermal effects generated during diode laser irradiation may produce collagen shrinkage, alteration of the smear layer, recrystallization of dentin minerals, reduction in dentinal permeability, and changes in surface energy. Although these modifications are beneficial for reducing hypersensitivity, they may either enhance or compromise resin infiltration depending on laser parameters, adhesive systems, and the interval between laser application and bonding.

Previous investigations have reported conflicting findings regarding the influence of diode laser desensitization on dentin bond strength. Alfredo *et al*. demonstrated enhanced bond strength of self-adhesive resin cement to root dentin following 980-nm diode laser irradiation, whereas Prabhakar *et al*. observed reduced shear bond strength after diode laser desensitization compared with bioactive glass and hydroxyapatite. More recent systematic reviews have concluded that the influence of desensitizing agents on adhesive performance remains material-dependent and protocol-sensitive. Such inconsistencies suggest that the biological changes occurring after laser irradiation are dynamic and may evolve with time rather than remaining constant immediately after treatment [6].

An important but insufficiently investigated variable is the time interval between diode laser desensitization and definitive adhesive cementation. Most available studies have either evaluated immediate bonding or assessed long-term aging periods extending over several months. However, these experimental designs do not accurately reflect routine clinical practice, where definitive restorations are commonly cemented within a few days to two weeks following tooth preparation and desensitization. During this period, laser-modified dentin may undergo rehydration, collagen re-expansion, mineral reorganization, and stabilization of the superficial dentin layer, potentially altering the substrate available for adhesive interaction [7].

To date, evidence identifying the optimal waiting period before adhesive cementation after diode laser desensitization remains scarce. Determining whether immediate restoration or delayed bonding provides superior adhesion is clinically important because improved bond strength may contribute to enhanced retention, reduced marginal leakage, and increased longevity of indirect restorations.

Therefore, the present *in vitro* study was undertaken to evaluate the effect of three clinically relevant time intervals - immediate bonding, one-week delayed bonding, and two-week delayed bonding following 980-nm diode laser desensitization on the shear bond strength of a self-adhesive resin cement to dentin. It was hypothesized that the interval between laser desensitization and adhesive cementation would significantly influence resin–dentin bond strength.

Materials and Methods

Study Design

The present investigation was designed as an *in vitro* experimental study to evaluate the influence of different waiting periods following diode laser desensitization on the shear bond strength (SBS) of a self-adhesive resin cement to dentin.

The study was conducted in the Department of Conservative Dentistry and Endodontics, A.J. Institute of Dental Sciences, Mangalore, India, after obtaining approval from the Institutional Ethics Committee.

Sample Size Calculation

The sample size was calculated using G*Power software (Version 3.1.9.7, Heinrich Heine University, Düsseldorf, Germany) based on the study conducted by Prabhakar *et al*. An effect size (f) of 0.45, significance level (α) of 0.05, and statistical power ($1-\beta$) of 80% were considered. A one-way fixed-effects ANOVA model yielded a minimum sample size of 51 specimens (17 per group). To compensate for possible specimen loss during preparation or testing, the sample size was increased to 60 teeth, with 20 specimens allocated to each experimental group.

Specimen Collection

Sixty freshly extracted human permanent premolars extracted for orthodontic or periodontal reasons were collected from the Department of Oral and Maxillofacial Surgery and private dental clinics in and around Mangalore. Teeth exhibiting intact coronal morphology were selected.

Inclusion Criteria

- Freshly extracted human maxillary and mandibular premolars
- Teeth extracted for orthodontic or periodontal reasons
- Intact crown morphology
- No previous restorative procedures

Exclusion Criteria

- Dental caries
- Cracks or fractures
- Developmental anomalies
- Hypoplastic teeth
- Hypomineralized teeth
- Teeth with discoloration
- Teeth exhibiting structural defects

Materials Used

The following materials and equipment were used in the present investigation:

Material	Manufacturer
Chloramine-T hydrate	Sigma-Aldrich
Self-cure acrylic resin	DPI, India
Polyvinyl chloride cylinders	Local supplier
Rubber cup	Addler
Pumice	2GM
Diode laser (980 nm)	Cheese II-108, Lotus NL B.V.
Self-adhesive resin cement (RelyX U200)	3M ESPE
LED curing unit	3M ESPE Elipar
Universal Testing Machine	Instron 8500 Plus Canon

Specimen Preparation

Immediately after extraction, adherent soft tissue remnants and calculus were removed using hand instruments. Teeth were polished with pumice slurry using a rubber prophylaxis cup.

The specimens were disinfected by immersion in chloramine-T hydrate solution for five days, following which they were stored in distilled water at room temperature until use. Storage medium was changed periodically to minimize contamination and dehydration.

Each tooth was vertically embedded in self-cure acrylic resin contained within polyvinyl chloride cylinders (10-mm diameter), leaving the crown exposed above the cemento-enamel junction.

The occlusal enamel was sectioned perpendicular to the long axis of the tooth using a water-cooled diamond disc until a flat mid-coronal dentin surface was exposed. The dentin surface was subsequently standardized using 400 and 600 grit silicon carbide abrasive papers under continuous water irrigation to create a uniform smear layer and ensure consistency among specimens.

Diode Laser Desensitization Protocol

All specimens received diode laser irradiation before bonding.

Laser application was performed using a 980-nm diode laser operating in continuous-wave mode with an output power of 1.0 W.

The optical fiber tip (200–300 µm diameter) was maintained approximately 1 mm from the dentin surface and moved continuously in a circular sweeping motion to avoid localized heat accumulation.

Each specimen received laser irradiation for 20 seconds.

Following irradiation, specimens were allowed to cool for 5 minutes before further processing.

The selected parameters were based on previously published investigations demonstrating effective dentinal tubule occlusion without producing irreversible thermal damage to pulpal tissues.

Laser parameters are summarized below.

Parameter	Specification
Laser type	Diode laser
Wavelength	980 nm
Output power	1.0 W
Mode	Continuous
Fiber diameter	200–300 µm
Working distance	1 mm
Exposure time	20 s
Motion	Continuous circular sweeping

Group Allocation

Following laser desensitization, specimens were randomly allocated into three experimental groups according to the interval between laser treatment and adhesive cementation.

Group 1 (Immediate)

Bonding performed within 30 minutes following laser irradiation.

Group 2 (One Week)

Specimens stored in distilled water at 37°C for 7 days, followed by bonding.

Group 3 (Two Weeks)

Specimens stored in distilled water at 37°C for 14 days, followed by bonding.

Twenty specimens were included in each group.

Bonding Procedure

A cylindrical polyethylene catheter tube having an internal diameter of 3 mm and height of 3 mm was positioned perpendicular to the prepared dentin surface.

Self-adhesive resin cement (RelyX™ U200, 3M ESPE) was manipulated according to the manufacturer's recommendations and inserted into the mold.

The cement was polymerized using a LED light-curing unit delivering an intensity of 1000 mW/cm² for 40 seconds.

After polymerization, the catheter tube was carefully removed using a scalpel blade, producing standardized cylindrical resin specimens bonded to dentin.

All bonding procedures were performed by a single calibrated operator to minimize operator-related variability.

Shear Bond Strength Testing

The bonded specimens were subjected to shear bond strength testing using a Universal Testing Machine (Instron 8500 Plus Canon).

Each acrylic block was securely mounted in the testing jig such that the loading blade contacted the resin cylinder as close as possible to the adhesive interface.

A shear load was applied parallel to the bonded interface at a crosshead speed of 1 mm/min until bond failure occurred.

The maximum debonding force was recorded in Newtons (N).

Shear bond strength was calculated using the following equation:

$$\text{SBS (MPa)} = \frac{\text{Load at failure (N)}}{\text{Bonded surface area (mm}^2\text{)}}$$

The calculated bond strength values were expressed in megapascals (MPa).

Outcome Measure

The primary outcome variable was the shear bond strength (MPa) of self-adhesive resin cement bonded to diode laser-treated dentin at three different post-desensitization intervals.

Statistical Analysis

Data were entered into Microsoft Excel and analyzed using IBM SPSS Statistics Version 23.0 (IBM Corp., Armonk, NY, USA).

Data distribution was evaluated using the Shapiro–Wilk test. Descriptive statistics including mean, standard deviation, median, minimum, maximum, and interquartile range were calculated for each group.

Because the data did not demonstrate normal distribution, comparisons among groups were performed using the Kruskal–Wallis test.

When statistically significant differences were observed, pairwise comparisons were carried out using the Mann–Whitney U test with Bonferroni correction to control for multiple testing.

The level of statistical significance was established at $p < 0.05$.

Results

A total of 60 dentin specimens were included in the study, with 20 specimens allocated to each experimental group. All specimens completed the experimental protocol, and no sample was excluded from the statistical analysis. The shear bond strength (SBS) values obtained from the three groups were subjected to descriptive and inferential statistical analysis to determine the influence of different time intervals following diode laser desensitization on the bond strength of self-adhesive resin cement to dentin.

Normality Assessment

The distribution of SBS values was assessed using the Shapiro–Wilk test, as each experimental group contained fewer than 50 specimens.

The Immediate group demonstrated a Shapiro–Wilk p-value of 0.023, while both the 1-week and 2-week groups showed p-values < 0.001, indicating significant deviation from a normal distribution. Therefore, the assumption of normality was violated, and non-parametric statistical tests were used for subsequent analyses.

Table 1: Shapiro–Wilk Test for Normality

Group	p-value	Interpretation
Immediate	0.023	Not normally distributed
1 Week	<0.001	Not normally distributed
2 Weeks	<0.001	Not normally distributed

Descriptive Statistics

Descriptive statistics of shear bond strength are presented in Table 2.

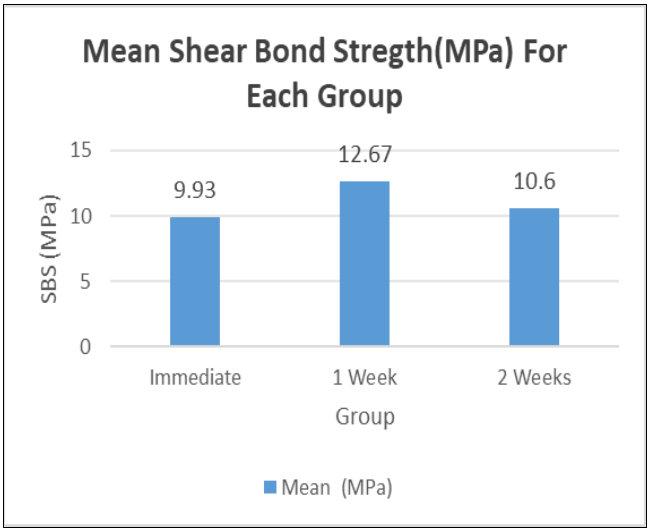
The 1-week group exhibited the highest mean SBS (12.67 ± 3.62 MPa), followed by the 2-week group (10.60 ± 5.25 MPa) and the Immediate group (9.93 ± 3.38 MPa).

The median SBS values were 10.55 MPa, 11.72 MPa, and 8.75 MPa for the Immediate, 1-week, and 2-week groups, respectively.

Among all groups, the 2-week group demonstrated the greatest variability, with the widest range (14.89 MPa), highest standard deviation (5.25 MPa), and positive skewness (1.222), indicating greater dispersion of SBS values. Conversely, the 1-week group exhibited the highest bond strength with comparatively lower variability, suggesting a more consistent adhesive performance following a one-week delay after diode laser desensitization.

Table 2: Descriptive Statistics of Shear Bond Strength (MPa)

Parameter	Immediate	1 Week	2 Weeks
Mean ± SD (MPa)	**9.93 ± 3.38**	**12.67 ± 3.62**	**10.60 ± 5.25**
Median (MPa)	10.55	11.72	8.75
Minimum (MPa)	5.38	8.73	5.42
Maximum (MPa)	15.00	19.29	20.31
Range (MPa)	9.62	10.56	14.89
Interquartile Range	3.68	1.04	2.28



Overall Comparison of Shear Bond Strength

The Kruskal–Wallis test was employed to compare SBS among the three experimental groups because the data were not normally distributed.

A statistically significant difference in SBS was observed among the three groups ($H = 9.103$, $df = 2$, $p = 0.011$), indicating that the interval between diode laser desensitization and adhesive cementation significantly influenced the bond strength of self-adhesive resin cement to dentin.

The 1-week group demonstrated the highest mean rank (40.10), whereas both the Immediate and 2-week groups had identical mean ranks of 25.70, suggesting superior bonding performance after a one-week waiting period.

Table 3: Kruskal–Wallis Test Comparing Shear Bond Strength Among Groups

Variable	Chi-square (H)	Degrees of Freedom	p-value
Shear Bond Strength (MPa)	9.103	2	0.011

Interpretation: There was a statistically significant difference in shear bond strength among the three experimental groups ($p < 0.05$).

Pairwise Comparisons

Following the significant Kruskal–Wallis test, pairwise comparisons were performed using the Mann–Whitney U test with a Bonferroni-adjusted significance level of 0.0167.

Immediate vs One Week

The comparison between the Immediate and 1-week groups revealed a statistically significant increase in SBS in the 1-week group ($U = 96.0$, $Z = –2.826$, $p = 0.005$), indicating that delaying adhesive cementation for one week significantly improved resin–dentin bond strength.

Immediate vs Two Weeks

No statistically significant difference was observed between the Immediate and 2-week groups (U = 192.0, Z = –0.217, p = 0.828), suggesting that extending the waiting period to two weeks did not improve bonding compared with immediate cementation.

One Week vs Two Weeks

The comparison between the 1-week and 2-week groups yielded U = 112.0, Z = –2.392, p = 0.017. Although the 1-week group demonstrated higher SBS values, the result did not remain statistically significant after Bonferroni correction (adjusted α = 0.0167). Therefore, the observed difference should be interpreted as a trend rather than definitive statistical evidence

Table 4: Pairwise Mann–Whitney U Test

Comparison	U Value	Z Value	p-value	Interpretation
Immediate vs 1 Week	96.0	–2.826	0.005	Significant
Immediate vs 2 Weeks	192.0	–0.217	0.828	Not significant
1 Week vs 2 Weeks	112.0	–2.392	0.017	Not significant after Bonferroni correction

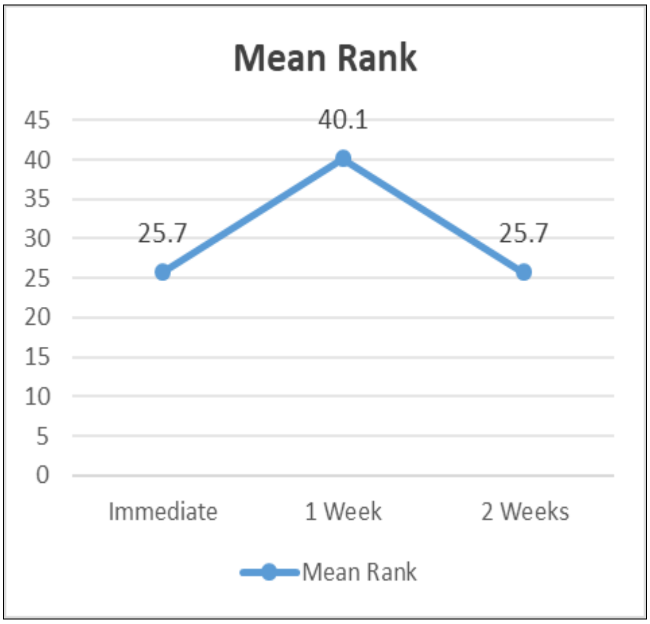
Mean Rank Analysis

The mean rank analysis further supported the superiority of the 1-week interval.

The 1-week group exhibited the highest mean rank (40.10), indicating consistently greater SBS values compared with the Immediate and 2-week groups, both of which demonstrated identical mean ranks (25.70). These findings reinforce the observation that a one-week waiting period after diode laser desensitization provides a more favorable dentin substrate for adhesive bonding.

Table 5: Mean Rank Distribution

Group	n	Mean Rank
Immediate	20	25.70
One Week	20	40.10
Two Weeks	20	25.70



Summary of Findings

The findings of the present study indicate that the time interval between diode laser desensitization and adhesive cementation significantly influences the shear bond strength of self-adhesive resin cement to dentin.

Among the three evaluated intervals, bonding performed one week after diode laser irradiation produced the highest shear bond strength, significantly outperforming immediate bonding. In contrast, extending the waiting period to two weeks did not confer additional benefit and resulted in bond strengths comparable to those observed with immediate cementation. These findings suggest that a one-week delay following diode laser desensitization may provide the most favorable dentin substrate for resin cement adhesion, thereby potentially improving the retention and longevity of indirect restorations.

Discussion

Dentin hypersensitivity remains a common clinical problem encountered following tooth preparation for indirect restorations, gingival recession, periodontal therapy, and non-carious cervical lesions [3]. In prosthodontic practice, postoperative sensitivity following crown preparation may compromise patient comfort and influence treatment acceptance. Various chemical and physical desensitization techniques have been proposed to reduce dentinal hypersensitivity; however, diode lasers have gained considerable popularity owing to their minimally invasive nature, rapid clinical application, and ability to achieve long-lasting dentinal tubule occlusion [5]. While laser desensitization effectively reduces dentin permeability, the thermal and morphological changes induced by laser irradiation may influence subsequent adhesive procedures. Therefore, understanding the optimal interval between diode laser desensitization and definitive adhesive cementation is of significant clinical importance.

The present *in vitro* study evaluated the influence of three clinically relevant time intervals-immediate, one week, and two weeks after 980-nm diode laser desensitization - on the shear bond strength (SBS) of a self-adhesive resin cement to dentin. The results demonstrated a statistically significant difference among the experimental groups (Kruskal–Wallis, p = 0.011). The one-week group exhibited the highest mean SBS (12.67 ± 3.62 MPa), followed by the two-week group (10.60 ± 5.25 MPa) and the immediate group (9.93 ± 3.38 MPa). Pairwise analysis further showed that the one-week group achieved significantly higher SBS than the immediate group, while no significant difference was observed between the immediate and two-week groups after Bonferroni correction.

These findings suggest that the interval between diode laser desensitization and adhesive cementation plays an important role in determining resin–dentin bond strength. The study hypothesis that different waiting periods would influence adhesive performance was therefore supported.

One of the principal mechanisms responsible for dentin hypersensitivity is explained by Brännström's hydrodynamic theory [1], which proposes that movement of fluid within exposed dentinal tubules stimulates mechanoreceptors associated with pulpal Aδ nerve fibers, resulting in pain. High-power diode lasers reduce dentin hypersensitivity primarily by decreasing dentinal permeability through melting and resolidification of peritubular dentin, narrowing or occluding dentinal tubules, and reducing dentinal fluid movement. Additionally, diode laser irradiation may exert a direct analgesic effect by temporarily altering nerve conduction and reducing the excitability of pulpal nerve fibers.

Although these changes are beneficial for desensitization, they also modify the dentin substrate available for adhesive bonding. Successful bonding of resin cement depends on adequate surface energy, preservation of collagen architecture, appropriate dentin permeability, and intimate interaction between resin monomers and the mineralized dentin surface [5]. Laser irradiation induces localized thermal effects that may produce collagen dehydration, smear layer modification, partial recrystallization of hydroxyapatite, and alterations in dentinal tubule morphology. Consequently, the timing of adhesive procedures following laser treatment may influence the quality of resin infiltration and the stability of the adhesive interface.

The significantly lower SBS observed in the immediate group may be attributed to acute laser-induced thermal alterations. Immediately after irradiation, dentin is likely to exhibit transient dehydration, reduced surface wettability, and partial collapse of the collagen network. These changes may impair the diffusion of acidic functional monomers present in self-adhesive resin cements and limit micromechanical interlocking with the dentin substrate. Furthermore, the immediate post-laser period may be characterized by occluded dentinal tubules and reduced permeability, thereby restricting the penetration of resin into superficial dentin.

In contrast, the one-week group demonstrated the highest SBS among all experimental groups. A plausible explanation is that the one-week interval permits stabilization of the laser-modified dentin surface. During this period, gradual rehydration of the collagen matrix, redistribution of dentinal moisture, and stabilization of the mineralized surface may create a more favorable substrate for resin infiltration while maintaining sufficient tubular occlusion to reduce fluid movement. This balance between structural recovery and preservation of laser-induced modifications may explain the superior adhesive performance observed after one week.

The findings also suggest that extending the waiting period to two weeks does not further improve adhesive bonding. Although the mean SBS of the two-week group remained higher than that of the immediate group, the difference was not statistically significant. It is possible that prolonged storage in distilled water allows additional mineral deposition or surface maturation, reducing dentin permeability beyond the level optimal for resin penetration. Alternatively, aging of the laser-modified surface may reduce the beneficial effects observed during the first week. The greater variability in SBS observed within the two-week group may also reflect heterogeneous changes in the dentin substrate during storage.

The present findings are, in agreement with the concept that laser-induced dentin changes are dynamic rather than static. Previous investigations evaluating immediate bonding after laser desensitization have reported conflicting outcomes, with both increases and decreases in bond strength depending on laser parameters, adhesive systems, and testing methods [6]. Such discrepancies highlight the importance of standardizing clinical protocols, including the interval between laser application and definitive cementation.

Our findings partially agree with the observations of Garcia Lda *et al*. [9], who reported improved bond strength of self-adhesive resin cement following 980-nm diode laser irradiation. The authors suggested that laser-induced surface roughening and modification of dentin morphology enhanced micromechanical retention. However, their study primarily evaluated the effect of laser application itself and did not investigate different post-laser waiting intervals. The present study extends their findings by demonstrating that the timing of adhesive cementation is an additional determinant of bond strength.

Conversely, Prabhakar *et al* [4]. reported lower bond strength following diode laser desensitization compared with bioactive glass and hydroxyapatite-based desensitizing agents. Differences between the two investigations may be attributed to variations in laser parameters, adhesive materials, dentin substrate, and experimental design. In the present study, all specimens received identical laser treatment, allowing the influence of post-laser waiting time to be evaluated independently of laser application itself.

The results also support the observations of studies demonstrating that dentin undergoes progressive physicochemical changes after laser irradiation. Surface dehydration, collagen contraction, recrystallization of hydroxyapatite, and alterations in smear layer morphology are time-dependent phenomena. Consequently, immediate adhesive procedures may not accurately represent the optimal clinical condition for bonding. Allowing an interval between laser treatment and cementation may facilitate partial recovery of the dentin substrate while preserving the desensitizing effect.

An additional consideration is the use of a self-adhesive resin cement (RelyX U200). Self-adhesive resin cements rely on acidic functional monomers that simultaneously demineralize and infiltrate the dentin surface. Their interaction with laser-modified dentin may differ from that of conventional etch-and-rinse or self-etch adhesive systems. Therefore, the results of the present study should be interpreted specifically in relation to self-adhesive resin cements and may not necessarily be extrapolated to other adhesive strategies.

The clinical implications of the present findings are noteworthy. During fixed prosthodontic procedures, clinicians frequently perform dentin desensitization immediately after tooth preparation before provisionalization. Definitive adhesive cementation is often scheduled several days later. The present study suggests that delaying definitive cementation for approximately one week following diode laser desensitization may improve resin–dentin bond strength while maintaining the benefits of laser-induced desensitization. Such an approach may enhance the retention and longevity of indirect restorations and reduce the likelihood of adhesive failure.

Despite these promising findings, certain limitations should be acknowledged. This investigation was conducted under controlled laboratory conditions that cannot fully replicate the complex oral environment. Factors such as thermal cycling, cyclic mechanical loading, salivary proteins, biofilm formation, pH fluctuations, and long-term water sorption were not evaluated. Furthermore, only one diode laser wavelength, one laser parameter, and one self-adhesive resin cement were investigated. The inclusion of scanning electron microscopy (SEM), energy-dispersive X-ray spectroscopy (EDS), or failure mode analysis would have provided additional insight into the mechanisms underlying the observed differences in bond strength.

Future studies should investigate the influence of different laser wavelengths, power settings, irradiation modes, adhesive systems, and storage periods on resin–dentin bonding. Long-term aging protocols, thermocycling, fatigue loading, and clinical trials are also necessary to determine whether the improvements observed under laboratory conditions translate into enhanced clinical performance and restoration longevity.

Within the limitations of this *in vitro* study, the findings indicate that the timing of adhesive cementation following diode laser desensitization is an important factor influencing resin–dentin bond strength. A one-week waiting period produced the highest shear bond strength, suggesting that this interval allows favorable stabilization of the laser-modified dentin surface and provides a more suitable substrate for adhesive bonding than either immediate or two-week delayed cementation.

Conclusion

Within the limitations of this *in vitro* study, the following conclusions can be drawn:

1. The interval between 980-nm diode laser desensitization and adhesive cementation significantly influences the shear bond strength of self-adhesive resin cement to dentin.
2. The 1-week delayed bonding group demonstrated the highest mean shear bond strength (12.67 ± 3.62 MPa), which was significantly greater than that of the immediate bonding group ($p = 0.005$).
3. No statistically significant difference was observed between the Immediate and 2-week groups ($p = 0.828$), indicating that prolonging the waiting period beyond one week did not provide additional improvement in adhesive performance.

The findings suggest that a one-week waiting period following diode laser desensitization provides the most favorable dentin substrate for bonding with self-adhesive resin cement.

Therefore, when diode laser desensitization is performed before indirect restorative procedures, delaying definitive adhesive cementation for approximately one week may enhance bond strength and potentially improve the longevity of indirect restorations.

Clinical Significance

The present study has direct clinical relevance for restorative dentists, prosthodontists, and endodontists.

Diode laser desensitization is increasingly employed after tooth preparation to reduce postoperative dentin hypersensitivity before definitive restoration. However, clinicians often remain uncertain regarding the optimal timing of adhesive cementation following laser treatment.

The results of the present investigation suggest that waiting one week after 980-nm diode laser desensitization before cementing indirect restorations with a self-adhesive resin cement provides superior resin–dentin bond strength compared with immediate cementation.

Improved bond strength may contribute to:

- Increased retention of indirect restorations.
- Reduced marginal leakage.
- Improved resistance to debonding.
- Enhanced marginal integrity.
- Reduced postoperative sensitivity.
- Improved long-term clinical success.

These findings provide clinicians with evidence-based guidance regarding the timing of definitive adhesive procedures following diode laser desensitization.

Limitations

Despite the encouraging findings, several limitations should be acknowledged.

1. *In vitro* design

The study was performed under laboratory conditions and therefore cannot completely reproduce the complex oral environment.

2. Lack of thermal and mechanical aging

Thermocycling, cyclic loading, and long-term water storage were not performed.

Consequently, long-term durability of the adhesive interface could not be evaluated.

3. Single laser parameter

Only one laser wavelength 980 nm and one power setting 1W continuous mode were evaluated.

Different laser settings may produce different adhesive outcomes.

4. Single resin cement

Only RelyX U200 self-adhesive resin cement was investigated.

Results cannot necessarily be extrapolated to other adhesive systems.

5. Surface characterization was not performed

Scanning Electron Microscopy (SEM), Atomic Force Microscopy (AFM)

Energy Dispersive X-ray Spectroscopy (EDS) were not performed.

These techniques could have provided additional evidence regarding laser-induced changes in dentin morphology.

6. Failure mode analysis was not evaluated

The present investigation measured only shear bond strength.

Failure mode analysis (adhesive/cohesive/mixed failure) would have provided additional insight into the nature of bond failure.

7. Clinical studies are required

Long-term randomized clinical trials are necessary before these findings can be generalized to routine clinical practice.

Future Recommendations

- Future studies should investigate
- Different diode laser wavelengths and power settings
- Pulsed versus continuous laser modes
- Universal adhesives
- Self-etch, Total-etch systems
- Different resin cements
- Thermocycling
- Fatigue loading
- SEM evaluation
- Failure mode analysis

- Clinical randomized controlled trials

Acknowledgements
The authors express their sincere gratitude to the Department of Conservative Dentistry and Endodontics, A.J. Institute of Dental Sciences, Mangalore, for providing laboratory facilities and technical support throughout this study.
The authors also thank the Department of Oral and Maxillofacial Surgery for providing freshly extracted teeth used in this investigation.

Funding
The present study did not receive any external funding.
Conflict of Interest
The authors declare that there are no conflicts of interest related to this study.

Ethical Approval
The study protocol was approved by the Institutional Ethics Committee of A.J. Institute of Dental Sciences, Mangalore.
Protocol no: AJSRB/CONS25/72.
The study utilized extracted human teeth obtained after informed consent and routine dental extraction procedures.

References
1. Brännström M. A hydrodynamic mechanism in the transmission of pain-producing stimuli through dentin. In: *Sensitivity of Dentin*. Oxford: Pergamon Press, 1963.
2. Grossman LI. A systematic method for the treatment of hypersensitive dentin. *J Am Dent Assoc*,1935:22:592–602.
3. Anithakumari R, Sureshbabu NM, Pradeep. The effect of desensitizing agents on the bond strength of dentin bonding agents: A systematic review. J Conserv Dent,2022:25(6):580-587. doi: 10.4103/jcd.jcd_248_21. Epub 2022 Oct 13. PMID: 36591577; PMCID: PMC9795680.
4. Garcia LD, Naves LZ, Correr-Sobrinho L, Consani S, Pires-De-Souza FD. Bond strength of a self-adhesive resinous cement to root dentin irradiated with a 980-nm diode laser. Acta Odontologica Scandinavica,2010:68(3):171-
5. Pion LA, Matos LL, Gimenez T, Palma-Dibb RG, Faraoni JJ. Treatment outcome for dentin hypersensitivity with laser therapy: Systematic review and meta-analysis. Dental and medical problems,2023:60(1):153-66. marto CM, *et al*. Clinical effectiveness of laser therapy in dentin hypersensitivity: Systematic review and meta-analysis. *J Oral Rehabil*. 2019.
6. Majidinia S, Shirazi AS, Boruziniat A, Riahi N. Effect of low-and high-level laser therapy on the treatment of dentin hypersensitivity: an umbrella review. Journal of Lasers in Medical Sciences,2024:27:15:41. AlShaafi MM. Factors affecting polymerization of resin-based composites. *Saudi Dent J*. 2017.
7. Van Meerbeek B, Yoshihara K, Yoshida Y, Mine AJ, KL VL. State of the art of self-etch adhesives. Dental materials. 2011 Jan 1. Ferracane JL. Resin composite - State of the art. *Dent Mater*,2011:27(1):17-28
8. Pashley DH, Tay FR. Aggressiveness of contemporary self-etching adhesives: Part II: etching effects on unground enamel. Dental Materials. 2001 Sep 1. Yoshida Y, *et al*. Functional monomers and their interaction with dentin. *J Dent Res*, 2012:17(5):430-44
9. Garcia Lda F, Naves LZ, Correr-Sobrinho L, Consani S, Pires-De-Souza Fde C. Bond strength of a self-adhesive resinous cement to root dentin irradiated with a 980-nm diode laser. Acta Odontol Scand. 2010 May;68(3):171-9. doi: 10.3109/00016351003636390. Epub 2010 Mar 3. Erratum in: Acta Odontol Scand,2010:68(4):248. PMID: 20199168.
10. Breschi L, Maravic T, Cunha SR, Comba A, Cadenaro M, Pashley DH, *et al* Mazzoni A. Dentin bonding systems: From dentin collagen structure to bond preservation and clinical applications. Dental Materials,2018:34(1):78-96.
11. Ashraf S, Elawsya ME, Mahmoud SH. Impact of Different Universal Adhesive Systems on the Fracture Resistance of Premolar Teeth with MOD Composite Restoration: A Literature Review. J Dent Oral Epidemiol, 2026, 6(1).
12. Van Meerbeek B, Yoshihara K, Yoshida Y, Mine AJ, KL VL. State of the art of self-etch adhesives. Dental materials,2011:27(1):17-28.
13. Breschi L, Maravic T, Cunha SR, Comba A, Cadenaro M, Pashley DH, *et al*, Mazzoni A. Dentin bonding systems: From dentin collagen structure to bond preservation and clinical applications. Dental Materials,2018:34(1):78-96.
14. Maravic T, Mazzitelli C, Mayer-Santos E, Mancuso E, Gracis S, Breschi L, *et al*. Current Trends for Cementation in Prosthodontics: Part 1—The Substrate. Polymers. 2025 Feb 20. Cvikl B, Moritz A. The current status of laser applications in conservative dentistry. *Clin Oral Investig*,2021:17(5): 566
15. Sachelarie L, Cristea R, Burlui E, Hurjui LL. Laser technology in dentistry: from clinical applications to future innovations. Dentistry journal,2024:23:12(12):420.
16. Schmidt J, Proesl S, Schulz-Kornas E, Haak R, Meyer-Lückel H, Campus G, Esteves-Oliveira M. Systematic review and network meta-analysis of restorative therapy and adhesive strategies in root caries lesions. Journal of dentistry, tjäderhane L. Dentin bonding and hybrid layer degradation: Mechanisms and strategies for long-term stability. *Dent Mater*,2024:142:104776.
17. Perdigão J, Araujo E, Ramos RQ, Gomes G, Pizzolotto L. Adhesive luting of indirect restorations: Current concepts and evidence. *J Esthet Restor Dent*, 2021.
18. de Oliveira DCRS, de Menezes LR, de Paula DM, *et al*. Effect of laser irradiation on dentin morphology and adhesive performance: A systematic review. *Lasers Med Sci*, 2023.