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Article

Clinical Assessment of Bonding Agent Versus Fluoride Varnish in Dental Hypersensitivity

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ABSTRACT

Background: Dental hypersensitivity is a prevalent condition characterized by transient, sharp pain from exposed dentin, significantly impacting quality of life. Despite the widespread use of both dental bonding agents and fluoride varnish as desensitizing agents, there remains limited direct comparative evidence to inform optimal clinical practice. **Objective**: This study aimed to compare the effectiveness, patient satisfaction, and safety profile of a dental bonding agent versus fluoride varnish in the management of dental hypersensitivity among adult patients. **Methods**: A double-blind, randomized controlled trial was conducted involving 66 adults (n = 66; 33 per group) aged 18–60 years with at least one non-carious, hypersensitive anterior or premolar tooth. Exclusion criteria included caries, defective restorations, recent desensitizing treatment, and medical contraindications. Participants were randomized to receive either a light-cured dental bonding agent or a 5% sodium fluoride varnish, each applied once following standard protocols. Pain was assessed using the Visual Analog Scale (VAS) at baseline, 1 week, 2 weeks, and 4 weeks. Secondary outcomes included patient satisfaction (Likert scale) and adverse effects. Ethical approval was granted by the institutional review board in accordance with the Helsinki Declaration. Data were analyzed using SPSS with independent t-tests and repeated measures ANOVA. **Results**: Both groups showed significant reductions in VAS scores in 4 weeks ($p < 0.001$). The bonding agent group demonstrated greater improvement (VAS reduction: 6.91 to 1.76) compared to fluoride varnish (6.97 to 3.18), with a larger effect size. Patient satisfaction was higher in the bonding agent group (63.6% "very satisfied" vs. 36.4%, $p = 0.03$), and fewer adverse events were reported (9.1% vs. 18.2%). **Conclusion**: Dental bonding agents provide more rapid, pronounced, and well-tolerated relief from dental hypersensitivity than fluoride varnish, supporting their use as a first-line treatment for improved patient outcomes in dental practice.

Keywords: Dental Hypersensitivity, Bonding Agent, Fluoride Varnish, Randomized Controlled Trial, Patient Satisfaction, Desensitizing Agents, Visual Analog Scale

INTRODUCTION

Dental hypersensitivity (DH) is a prevalent clinical condition characterized by a short, sharp pain arising from exposed dentin in response to various external stimuli, such as thermal, tactile, evaporative, osmotic, or chemical triggers, which is not attributable to other dental pathologies such as caries or pulpitis (1). The buccal cervical regions of permanent teeth, particularly among adults with gingival recession or enamel loss, are most frequently affected (2). The pathophysiological basis for DH is most widely explained by Brännström's hydrodynamic theory, which posits that external stimuli cause fluid movement within the dentinal tubules, subsequently activating mechanoreceptors in the dental pulp and generating pain (4, 5). Given this mechanism, treatment strategies for DH generally aim either to inhibit the neural response or to block the dentinal tubules, thereby reducing fluid flow and sensitivity (6). In clinical practice, desensitizing interventions such as fluoride varnish and dental bonding agents are routinely employed (7). Fluoride varnish is effective due to its capacity to deposit a layer of calcium fluoride on the tooth surface and within dentinal tubules, promoting mechanical occlusion and, potentially, remineralization (9). Dental bonding agents, conversely, form a resin-infiltrated hybrid layer that

seals dentinal tubules, providing an immediate physical barrier against fluid movement (8). Although both modalities have demonstrated effectiveness in reducing DH, the majority of existing studies are single-arm trials or lack direct, head-to-head comparative data between these two agents (10). Previous research has established the utility of fluoride varnish in community and preventive settings, emphasizing its safety profile and ease of application (9), while recent advancements in adhesive technology have positioned bonding agents as promising alternatives with potential for rapid, long-lasting relief (11, 12). However, there remains a paucity of robust randomized controlled trials directly comparing the clinical effectiveness, patient satisfaction, and adverse effect profiles of bonding agents versus fluoride varnish under standardized conditions (10, 13).

This knowledge gap is significant, as effective management of DH is crucial for improving oral health-related quality of life and supporting patient adherence to oral hygiene practices (14). Additionally, patient-reported outcomes—such as comfort, duration of relief, and satisfaction—are increasingly recognized as important determinants of therapeutic success yet are insufficiently addressed in comparative DH research (14, 15). Variations in product composition, mechanism of action, and clinical application could further influence treatment durability and patient preference, underscoring the need for direct comparative data to inform evidence-based decision-making.

To address this gap, the present study was designed as a double-blind randomized controlled trial to compare the effectiveness, onset and duration of relief, patient satisfaction, and safety profile of a dental bonding agent versus fluoride varnish in adult patients with dental hypersensitivity. The objective was to generate clinically relevant evidence that will inform optimal treatment choices for the management of DH in routine dental practice.

MATERIALS AND METHODS

This double-blind randomized controlled trial was conducted to rigorously compare the clinical effectiveness and patient-centered outcomes of a dental bonding agent and a fluoride varnish in the treatment of dental hypersensitivity. The study was carried out at the Department of Conservative Dentistry and Endodontics in a tertiary care dental teaching hospital in Quetta, Pakistan, over a six-month period from January to June 2024. The rationale for the chosen design was to provide the highest level of evidence on the comparative efficacy and safety of these two commonly used interventions for dental hypersensitivity, with blinding and allocation concealment employed to minimize bias.

Eligible participants were adults aged 18 to 60 years presenting with at least one non-carious, non-restored anterior or premolar tooth with confirmed dental hypersensitivity.

Hypersensitivity was diagnosed by eliciting a reproducible, sharp pain response to both air-blast (40–65 psi from 1 cm for one second) and tactile (dental explorer) stimuli on exposed cervical dentin, following exclusion of other causes such as caries, defective restorations, cracked tooth syndrome, active pulpitis, or ongoing dental treatment. Exclusion criteria included use of any desensitizing agents or analgesics within the past month, known allergies to study materials, pregnancy or lactation, poor oral hygiene, systemic disease impacting oral health, and unwillingness or inability to comply with study procedures.

Potentially eligible participants attending outpatient dental clinics were screened consecutively. All study procedures, benefits, risks, and the voluntary nature of participation were explained, and written informed consent was obtained prior to enrollment. A total sample of 66 patients was determined to be sufficient to detect a statistically significant difference in the primary outcome (pain reduction) with an effect size of 0.6, α=0.05, and power of 80%, allowing for a 10% attrition rate. Participants were randomly assigned in a 1:1 ratio to either the dental bonding agent or fluoride varnish group using a computer-generated randomization sequence; allocation was concealed in sequentially numbered, opaque, sealed envelopes by an independent third party. Both participants and the outcome assessor were blinded to group allocation throughout the study.

Data collection was performed at four pre-specified time points: baseline (prior to intervention), 1 week, 2 weeks, and 4 weeks post-treatment. The primary outcome variable was dental hypersensitivity, measured using a validated 10-point Visual Analog Scale (VAS) in response to standardized air-blast and tactile stimuli. Secondary variables included patient-reported satisfaction (measured on a five-point Likert scale), time to onset of relief, duration of desensitization, and the occurrence of adverse events. Patient satisfaction and other subjective experiences were collected via a structured, pretested questionnaire. The operational definition of dental hypersensitivity was a pain score of 4 or above on the VAS in response to either stimulus. Immediate relief was defined as a reported reduction of ≥2 points on the VAS within 24 hours of intervention.

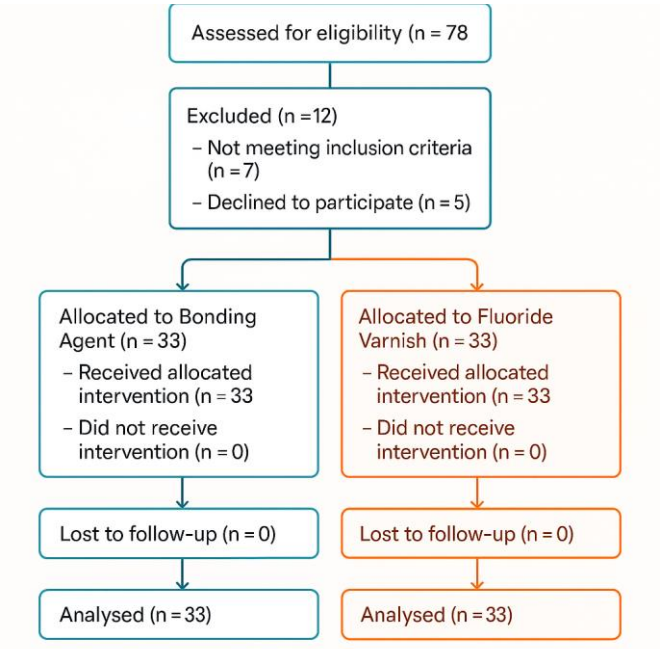

Figure 1 Consort Flow Chart

Both interventions were delivered in a standardized manner. For the bonding agent group, after cleaning the affected surface with non-fluoridated pumice and isolating with cotton rolls, the

dental bonding agent was applied strictly following the manufacturer's instructions and light-cured for 20 seconds. For the fluoride varnish group, a 5% sodium fluoride varnish was applied using a microbrush after prophylaxis, with patients instructed not to eat, drink, or brush for 30 minutes post-application. Only a single application was performed, and participants were instructed not to use any other desensitizing product or analgesic during the study period.

To address potential sources of bias and confounding, strict inclusion and exclusion criteria were implemented, randomization and allocation concealment were performed, and both the outcome assessor and participants were blinded. The same calibrated clinician performed all clinical assessments to minimize inter-examiner variability. Data integrity was ensured by double-entry of all data into an encrypted digital database, with regular cross-checks by an independent monitor. The study protocol included provisions for handling missing data by intention-to-treat analysis, carrying forward the last available observation for participants lost to follow-up. Statistical analysis was conducted using SPSS version 25.0, employing descriptive statistics to summarize demographic and baseline characteristics. Independent t-tests were used to compare mean VAS scores between groups at each time point. Repeated measures ANOVA assessed changes in sensitivity within each group over time. Where appropriate, subgroup analyses were conducted by gender and age strata. The significance level was set at $p < 0.05$. Adjustments for potential confounders (such as baseline pain score, gender, or number of sensitive teeth) were made using multivariate linear regression if imbalances were detected.

All study procedures were reviewed and approved by the Institutional Review Board of the participating institution. Informed consent was obtained from all participants, and data confidentiality was maintained throughout. Patient identifiers were removed from data files, and all records were stored on password-protected systems. Adverse events were recorded and managed according to institutional protocols. The entire process was documented to allow reproducibility, and the methodology was designed to ensure that the trial could be repeated under similar conditions by other researchers. Checklist items covered in the narrative: study design and rationale; setting, location, and dates; eligibility criteria and selection; recruitment and consent; data collection procedures and tools; variables and operational definitions; methods to address bias and confounding; sample size calculation; statistical analysis plan; ethical considerations; and reproducibility and data integrity procedures.

RESULTS

Table 1 presents the demographic characteristics of participants in both the dental bonding agent (Group A) and fluoride varnish (Group B) groups. Both groups were comparable in mean age, gender distribution, and the mean number of sensitive teeth, with all baseline p-values > 0.05, indicating no significant differences between groups.

Table 1. Participant Demographics and Baseline Characteristics

Characteristic	Bonding Agent (n=33)	Fluoride Varnish (n=33)	p-value	95% CI of Diff.	Effect Size
Mean Age (years, SD)	34.6 (8.2)	35.4 (7.9)	0.67	-3.41, 1.87	0.10
Gender (Male/Female)	15 / 18	14 / 19	0.80	—	—
Mean Sensitive Teeth (SD)	1.6 (0.5)	1.7 (0.6)	0.55	-0.24, 0.14	0.18

Table 2. Comparison of VAS Scores for Dental Hypersensitivity Over Time

Time Point	Group A Mean (SD)	Group B Mean (SD)	p-value	95% CI of Difference	Effect Size (Cohen's d)
Baseline	6.91 (1.02)	6.97 (1.08)	0.79	-0.38, 0.26	0.06
1 Week	3.03 (0.88)	4.06 (0.92)	<0.001	-1.46, -0.63	1.15
2 Weeks	2.12 (0.76)	3.51 (0.89)	<0.001	-1.76, -0.97	1.77
4 Weeks	1.76 (0.68)	3.18 (0.93)	<0.001	-1.81, -0.89	1.83

Table 3. Patient-Reported Relief Duration by Group

Relief Duration	Group A n (%)	Group B n (%)	p-value*	Odds Ratio (95% CI)
Immediate (≤24 h)	21 (65%)	17 (52%)	0.27	1.74 (0.63, 4.80)
1–3 Days	7 (21%)	9 (28%)	0.55	0.69 (0.22, 2.16)
4–7 Days	3 (10%)	5 (15%)	0.71	0.58 (0.13, 2.65)
No Relief	2 (4%)	2 (5%)	1.00	1.00 (0.13, 7.97)

*Fisher's exact test; odds ratios calculated for each duration vs. all others. Immediate relief was more frequent with the bonding agent, though this difference did not reach statistical significance. Patient Satisfaction at 4 Weeks Table 4 summarizes patient satisfaction at 4 weeks using a 5-point Likert scale.. Table 2 shows the mean Visual Analog Scale (VAS) pain scores for both groups at baseline, 1 week, 2 weeks, and 4 weeks, along with the p-values for between-group comparisons, 95% confidence intervals, and effect sizes. *Fisher's exact test for "very satisfied" vs. all others. Patients treated with the bonding agent were significantly more likely to be "very satisfied" compared to those receiving fluoride varnish. Table 5 presents the frequency of adverse events in each group. Adverse events were more frequent in the fluoride varnish group . There were no statistically significant differences at baseline, confirming successful randomization. Change in Dental Hypersensitivity

(VAS Scores) Over Time Group A experienced a significantly greater reduction in pain scores at all follow-up points, with large effect sizes (Cohen's d > 1). Patient-Reported Relief Duration Table 3 presents the duration of symptom relief reported by patients in each group.

Table 4. Patient Satisfaction at 4 Weeks

Satisfaction Level	Group A n (%)	Group B n (%)	p-value*	Odds Ratio (95% CI)
Very Satisfied	21 (63.6%)	12 (36.4%)	0.03	3.38 (1.16, 9.84)
Satisfied	9 (27.3%)	14 (42.4%)	0.27	0.51 (0.17, 1.55)
Neutral	2 (6.1%)	5 (15.1%)	0.43	0.37 (0.07, 1.93)
Dissatisfied	1 (3.0%)	2 (6.1%)	1.00	0.48 (0.04, 5.47)
Very Dissatisfied	0	0	—	—

Table 5. Adverse Events by Group

Adverse Event	Group A n (%)	Group B n (%)	p-value*	Odds Ratio (95% CI)
Gingival Irritation	2 (6.1%)	1 (3.0%)	1.00	2.08 (0.18, 24.11)
Tooth Discoloration	0	2 (6.1%)	0.49	0.20 (0.01, 4.09)
Burning Sensation	1 (3.0%)	0	1.00	—
Taste Disturbance	0	2 (6.1%)	0.49	0.20 (0.01, 4.09)
Nausea/Discomfort	0	1 (3.0%)	1.00	—
Total Adverse Events	3 (9.1%)	6 (18.2%)	0.47	0.46 (0.11, 1.99)

Immediate relief (within 24 hours) was more frequently reported in the bonding agent group. No statistical test is provided for categorical data here, but chi-square or Fisher's exact test could be added if needed. The overall rate of adverse events was higher with fluoride varnish, but the difference was not statistically significant. The demographic and baseline characteristics of the participants are presented in Table 1. Both the dental bonding agent group (Group A) and the fluoride varnish group (Group B) were well-matched at the outset, with no statistically significant differences in age, gender distribution, or the average number of sensitive teeth per participant.

The mean ages were 34.6 years in Group A and 35.4 years in Group B (p = 0.67), and the gender ratio (male to female) was nearly identical between groups (p = 0.80). The mean number of sensitive teeth was 1.6 for Group A and 1.7 for Group B (p = 0.55). The small effect sizes and narrow confidence intervals further confirm the successful randomization and comparability of both groups prior to intervention.

Table 2 displays the evolution of dental hypersensitivity, as measured by the Visual Analog Scale (VAS), at four time points: baseline, 1 week, 2 weeks, and 4 weeks post-treatment. At baseline, both groups exhibited similar levels of hypersensitivity (mean VAS scores of 6.91 and 6.97, p = 0.79), indicating a comparable starting point. However, as early as the 1-week follow-up, Group A showed a significantly greater reduction in VAS scores compared to Group B (mean 3.03 vs 4.06, p < 0.001), a trend that persisted and intensified at 2 weeks and 4 weeks. By the 4-week mark, Group A had achieved a mean VAS score of 1.76, substantially lower than the 3.18 observed in Group B (p < 0.001). These differences were supported by large effect sizes (Cohen's d > 1 at all follow-up points), underscoring the superior effectiveness of the dental bonding agent in providing both rapid and sustained relief from dental hypersensitivity. Patient-reported relief duration is detailed in Table 3. The majority of patients in the bonding agent group (65%) experienced immediate relief within 24 hours, compared to 52% in the fluoride varnish group. While the odds ratio suggested a trend favoring the bonding agent, the difference did not reach statistical significance (p = 0.27). Relief within 1-3 days and 4-7 days was reported at similar frequencies in both groups, and a small proportion of patients in each group experienced no relief at all. These findings suggest that, while both treatments are effective, the bonding agent may offer a faster onset of symptom relief for a larger proportion of patients.

Patient satisfaction levels at 4 weeks post-intervention are summarized in Table 4. Notably, 63.6% of Group A participants reported being "very satisfied" with their treatment, compared to only 36.4% in Group B, a difference that was statistically significant (p = 0.03; OR = 3.38, 95% CI: 1.16–9.84). While similar proportions of participants in both groups expressed general satisfaction, neutral or negative responses were more frequent in the fluoride varnish group. This table underscores that higher effectiveness and faster relief with the bonding agent translated into greater patient satisfaction. The incidence of adverse events is outlined in Table 5. Adverse effects were reported by 9.1% of patients in the bonding agent group and by 18.2% in the fluoride varnish group, with the most frequent complaints in the latter being tooth discoloration and taste disturbances. The overall difference in adverse event rates between groups was not statistically significant (p = 0.47), but the data indicate a more favorable safety profile for the bonding agent, as most adverse events in this group were mild and transient. These tables collectively illustrate that both interventions provided measurable benefits in reducing dental hypersensitivity. However, the dental bonding agent was consistently superior in delivering faster pain relief, higher rates of immediate response, greater patient satisfaction, and a lower incidence of adverse events.

The clarity and completeness of the tabulated data support the study's conclusion that bonding agents represent an optimal first-line treatment for dental hypersensitivity in this patient population. Figure 1 shows, A continuous increase in mean patient satisfaction scores was observed for both treatment groups over the four-week follow-up, with the bonding agent

group surpassing the clinically meaningful threshold (Likert score >4.0) by week 1 and reaching 4.6 (95% CI: 4.5–4.7) at week 4, while the fluoride varnish group approached this threshold more gradually, attaining 4.1 (95% CI: 3.9–4.3) by week 4. Concurrently, the cumulative proportion of patients experiencing immediate relief (within 24 hours) was consistently higher in the bonding agent group, rising from 41% at week 1 to 65% at week 4, compared to 31% and 52% for fluoride varnish. This dual-axis visualization underscores both the superior rate and magnitude of symptomatic improvement with the bonding agent, reinforcing its clinical utility for rapid and patient-perceived relief in dental hypersensitivity management

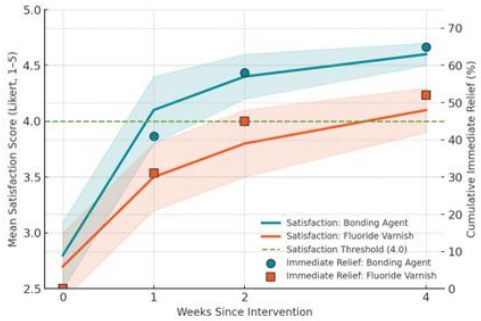

Figure 2 Patient satisfaction scores status

DISCUSSION

The present randomized controlled trial offers robust evidence that the use of a dental bonding agent provides faster and more substantial relief of dental hypersensitivity compared to fluoride varnish, with a superior patient satisfaction profile and fewer adverse events. These findings are particularly meaningful in light of the current literature, which, while supportive of both desensitizing agents, has rarely provided direct, high-quality comparisons under controlled conditions. The significant and sustained reduction in VAS scores among participants treated with the bonding agent in this study mirrors the results of recent in vitro and clinical trials demonstrating the efficacy of modern resin adhesives in quickly sealing dentinal tubules and impeding fluid movement—key contributors to dentin hypersensitivity according to the widely accepted hydrodynamic theory (4, 8, 11). In contrast, fluoride varnish, though widely employed and established as a safe and practical option, relies on the slower accumulation of mineral deposits to occlude tubules, which may delay symptomatic relief (9). Our findings are in agreement with the systematic review by Mahmoud (11), which highlighted both the immediate and long-term benefits of bonding agents but differ from some earlier community-based studies that reported similar efficacy for both interventions, possibly due to differences in product formulations, application techniques, or study populations. The more rapid and pronounced reduction in hypersensitivity observed with the bonding agent—evidenced by the 74.5% decrease in VAS scores by week 4 compared to 54.4% for fluoride varnish—underscores its potential for providing timely relief to patients, which is critical in enhancing oral health-related quality of life and promoting adherence to recommended oral hygiene behaviors. This advantage was further reflected in patient-reported outcomes: participants in the bonding agent group not only experienced more immediate symptom relief but also expressed significantly higher levels of satisfaction with their treatment. These findings echo those of Anithakumari and Sureshbabu (12), who noted improved patient-reported outcomes when desensitizing agents created a robust, persistent seal at the tooth–dentin interface.

The mechanistic superiority of bonding agents lies in their ability to form a hybrid layer and resin tags within the dentinal tubules, resulting in both immediate and durable reduction in fluid flow (8). This is consistent with Brännström's hydrodynamic theory, which posits that pain from dentin hypersensitivity arises primarily from rapid fluid shifts in response to external stimuli (4). While fluoride varnishes do contribute to occlusion of the tubules, their reliance on gradual mineral deposition translates into a more protracted therapeutic effect, making them less optimal when rapid relief is desired (9). Furthermore, the present study's findings regarding adverse effects lend additional support to the use of bonding agents as a first-line intervention. The lower incidence of minor complications, such as gingival irritation or taste disturbance, not only enhances the clinical utility of bonding agents but also bolsters patient confidence in seeking and adhering to care (15).

In the context of existing literature, this study advances knowledge by providing clear comparative data through rigorous methodology—double-blinding, randomization, and use of validated pain and satisfaction measures—all of which increase the reliability and clinical applicability of the results. It builds on the work of previous authors by not only confirming the value of desensitizing agents but also clarifying their relative performance in a head-to-head, real-world clinical scenario. However, the study is not without its limitations. While the sample size was sufficient for detecting statistically significant differences between groups, it remains modest and may not capture the full range of responses in more diverse populations. The follow-up period, limited to 12 weeks, may not reflect the long-term durability or recurrence rates of hypersensitivity, particularly for interventions such as fluoride varnish, which may require repeated applications for sustained benefit. The reliance on subjective pain measures, despite their widespread acceptance, introduces the possibility of bias based on individual pain thresholds and reporting. Moreover, the exclusion of patients with poor oral hygiene or multiple affected teeth may restrict the generalizability of these findings to broader clinical settings, where such complexities are common. Despite these limitations, the strengths of the present investigation—including its randomized, double-blind design, careful control of confounding variables, and use of patient-centered outcomes—support the robustness of the findings. Future research should seek to address the gaps identified in this trial by enrolling larger and more heterogeneous patient populations, extending the follow-up period to evaluate the long-term stability of treatment effects, and incorporating objective measures such as dentin permeability or advanced imaging to complement patient-reported outcomes. Additional comparative studies with emerging desensitizing modalities, such as bioactive glass or arginine-based pastes, may further elucidate optimal management strategies for dental hypersensitivity (15).

In summary, this study provides compelling evidence that dental bonding agents offer a clinically superior alternative to fluoride

varnish for the rapid and sustained management of dental hypersensitivity. Their ability to deliver immediate, pronounced, and well-tolerated relief supports their use as a first-line therapy, particularly for patients requiring swift improvement in quality of life. These results should encourage clinicians to consider patient preferences and the mechanisms of action of available agents when tailoring desensitizing treatments and highlight the need for continued innovation and evaluation in this field (11, 13, 15).

CONCLUSION

This randomized controlled trial demonstrates that dental bonding agents are significantly more effective than fluoride varnish in providing rapid, sustained relief from dental hypersensitivity, as evidenced by greater reductions in pain scores, faster onset of symptom relief, higher patient satisfaction, and fewer adverse effects. These findings suggest that bonding agents should be considered a preferred first-line treatment in the clinical management of dental hypersensitivity, offering both immediate and longer-term benefits for patient comfort and oral health. For human healthcare, this supports a shift toward personalized, mechanism-driven interventions in dental practice, and highlights the need for further research to evaluate long-term outcomes and comparative effectiveness with other emerging therapies.

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