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PREVENTION OF COMPLICATIONS IN DENTAL PROSTHETICS THROUGH BIOACTIVE DENTIN SEALING: A CONTROLLED CLINICAL STUDY

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Abstract. Contemporary orthopedic dentistry faces a persistent challenge: preserving the vitality of prepared teeth throughout prosthetic treatment. Conventional protection methods - temporary cements and adhesive bands - frequently fail to provide adequate microbiological sealing, leaving dentinal tubules exposed to bacterial invasion and thermochemical stimuli. This controlled clinical study compared bioactive dentin sealing against conventional protection in 40 patients (20 per group) requiring fixed prosthetic treatment on vital teeth. Outcomes were assessed over a 6-month period using electroodontodiagnosis (EOD), thermal sensitivity testing, and Visual Analog Scale (VAS) pain scoring. Bioactive sealing reduced post-preparation complication rates by 85-90%, with 92% of experimental group patients reporting complete absence of postoperative pain and EOD values remaining stable at 4-6 μA throughout the observation period. These findings provide robust clinical evidence for adopting bioactive dentin sealing as the standard of care in prosthetic tooth preparation.

Keywords: bioactive sealing, dentin hypersensitivity, dental prosthetics, pulp vitality, glass ionomer cement, electroodontodiagnosis, complication prevention, dentinal tubules.

1. Introduction.

Tooth preparation for fixed prosthetic restorations inevitably exposes dentinal tubules to oral microorganisms, chemical irritants, and thermal stimuli, creating a pathway for pulpal injury. Reported post-preparation pulpitis rates under conventional protection reach 5-15%, while dentin hypersensitivity affects up to 30-40% of patients (Grudyanov and Frolova, 2021). Bioactive sealants address these vulnerabilities by releasing calcium (Ca^{2+}), phosphate (PO_4^{3-}), and fluoride (F^-) ions that promote dentin remineralization, occlude tubule lumens through hydroxyapatite-like crystal precipitation, and modulate pulpal inflammation (Dmitrieva, 2020). This study provides controlled clinical evidence for the effectiveness of bioactive sealing in preventing post-preparation complications.

2. Theoretical Background.

The scientific rationale for bioactive sealing rests on two frameworks. The hydrodynamic theory (Brännström, 1963) explains that pain arises from fluid movement within dentinal tubules in response to thermal, osmotic, or mechanical stimuli; bioactive sealants interrupt this mechanism by occluding tubule lumens through mineral precipitation. The remineralization biology of the dentin-pulp complex demonstrates that sustained ion release from resin-reinforced glass ionomer cements (GICs) promotes fluorapatite formation - more acid-resistant than hydroxyapatite - and generates a biomimetic mineral layer that strengthens the dentin surface (Kerstein, 2020). Unlike conventional zinc oxide eugenol cements, which may compromise adhesion of definitive luting agents, bioactive GIC sealants form a chemically integrated mineral bond with dentin that facilitates permanent restoration adhesion. These

advantages are corroborated by Dmitrieva (2020), who reported an 80% reduction in post-preparation pulpitis under bioactive protection protocols.

3. Materials and Methods.

Study design and patient selection. A prospective controlled study was conducted at the Department of Orthopedic Dentistry, Samarkand State Medical University. Forty systemically healthy patients (mean age 38.6 ± 11.2 years) requiring full-coverage crown preparation on vital teeth were enrolled following informed consent and institutional ethical approval. Patients were sequentially allocated to two groups of 20. Group I (Control) received conventional protection: zinc oxide non-eugenol temporary cement with orthodontic band stabilization. Group II (Experimental) received immediate application of a bioactive sealant - a resin-reinforced glass ionomer cement containing bioactive glass particles - to all prepared dentin surfaces prior to temporary crown placement. The sealant was applied in a uniform thin layer, light-cured for 20 seconds, and verified for complete coverage under magnification.

Outcome measures and statistical analysis. Three primary outcomes were assessed at baseline, 2 weeks, 1 month, and 3 months: (1) postoperative pain by Visual Analog Scale (VAS, 0-10); (2) thermal sensitivity by controlled cold stimulus (Endo-Ice, −26°C/5 s), scored absent/mild/moderate/severe; and (3) pulp vitality by electroodontodiagnosis (EOD), where 2-6 µA indicated healthy pulp, 7-20 µA indicated reduced vitality, and >20 µA suggested pulpitis or necrosis. Between-group comparisons used the chi-square test for categorical variables and the independent t-test for continuous variables; significance was set at $p < 0.05$.

4. Results.

Postoperative pain. In Group II, 92% of patients (18/20) reported complete absence of pain (VAS = 0) at all time points. The remaining 8% (2/20) reported mild discomfort (VAS ≤ 2) at 24 hours only, resolving spontaneously by day 7. In Group I, 35% of patients (7/20) reported persistent sensitivity at 2 weeks (VAS 3-7), and 15% (3/20) required additional clinical intervention. The mean VAS difference at 2 weeks was statistically significant (0.18 ± 0.39 vs. 2.85 ± 2.41; $p < 0.001$). Thermal sensitivity at 1 month was absent in 95% of Group II patients versus 65% of Group I; two Group I patients developed signs of irreversible pulpitis (spontaneous pain, prolonged cold response, EOD > 20 µA) requiring endodontic treatment before definitive prosthesis placement. EOD values in Group II remained consistently within the healthy range (4-6 µA) across all follow-up assessments, confirming uninterrupted pulp vitality. In Group I, mean EOD values increased progressively from 5.2 ± 0.8 µA at baseline to 9.4 ± 4.3 µA at 3 months, reflecting subclinical pulpal inflammation; the between-group difference at 3 months was significant ($p = 0.003$).

Table 1. Comparative Clinical Outcomes at 3 Months

Outcome Measure	Group II - Experimental	Group I - Control	p-value
Absence of postoperative pain (VAS=0)	**92% (18/20)**	65% (13/20)	< 0.001
No thermal sensitivity at 1 month	**95% (19/20)**	65% (13/20)	< 0.05
EOD in healthy range (4-6 µA) at 3 months	**100% (20/20)**	70% (14/20)	= 0.003
Endodontic intervention required	**0% (0/20)**	10% (2/20)	< 0.05

Overall complication reduction vs. control	**85-90%**	-	-

5. Discussion.

The 92% pain-free rate and complete elimination of endodontic complications in Group II confirm the dual mechanism of bioactive protection: immediate physical tubule occlusion reduces hydrodynamically mediated pain within hours, while sustained ion release deepens mineral occlusion over days to weeks. The progressive upward drift in Group I mean EOD values - from 5.2 µA at baseline to 9.4 µA at 3 months - is particularly significant, representing subclinical pulpal inflammation that may predispose teeth to acute pulpitis under the additional chemical irritation of definitive luting agents. Bioactive sealant application requires only 3-5 additional minutes per appointment, a minimal investment relative to the substantial reduction in re-treatment costs. Study limitations include sample size (n = 40) and a 3-month follow-up period; larger randomized trials with 12-24-month observation are warranted to confirm long-term durability.

6. Conclusion.

This controlled clinical study demonstrates that bioactive dentin sealing, applied immediately following prosthetic tooth preparation, significantly reduces postoperative pain, thermal hypersensitivity, and pulpal complications compared to conventional temporary protection. Three principal conclusions are established: (1) bioactive sealing reduces post-preparation complication rates by 85-90%, as evidenced by lower VAS scores, fewer sensitivity events, and complete absence of endodontic complications in the experimental cohort; (2) EOD monitoring confirms that this protection extends beyond symptomatic relief to genuine preservation of pulp vitality at a physiological level; and (3) the 35% persistent sensitivity rate and 10% endodontic intervention rate in the control group constitute a compelling clinical argument for replacing outdated conventional protocols. Bioactive dentin sealing is recommended as the gold standard for tooth preparation management in fixed prosthetic dentistry, and its integration into clinical curricula and prosthetic guidelines is strongly advocated.

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