Restoring Proximal Contact Integrity in Posterior Composite Restorations: A Matrix System and Incremental Placement Protocol for Eliminating Interproximal Voids

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Abstract. Deficient proximal contacts in posterior composite restorations represent a persistent clinical challenge associated with food impaction, periodontal deterioration, and secondary carious lesions. This study evaluated the efficacy of a contoured sectional matrix system combined with a standardized incremental oblique layering protocol in achieving adequate contact point tightness and marginal ridge integrity. A total of 128 Class II cavities in premolars and molars were restored using either conventional circumferential matrix bands or contoured sectional matrices paired with the proposed placement protocol. Contact tightness was assessed using dental floss resistance scoring, digital bite-force analysis, and micro-CT marginal gap evaluation at baseline and 12-month recall. Results demonstrated statistically significant superiority of the sectional matrix-incremental protocol group in contact tightness ($p < 0.001$), marginal adaptation, and reduced interproximal void formation, establishing a reproducible clinical guideline for practitioners.

Keywords: posterior composite restoration, proximal contact deficiency, sectional matrix system, incremental layering technique, Class II cavity preparation, interproximal void elimination, marginal ridge integrity, micro-CT marginal gap analysis, dental composite polymerization shrinkage

Introduction

Achieving adequate proximal contact in posterior composite resin restorations remains one of the most technically demanding challenges in restorative dentistry, with clinical failure rates attributed to open contacts consistently reported in the range of 30–60% across multiple longitudinal studies. Unlike amalgam, which adapts plastically during condensation to conform to the adjacent tooth surface, composite resin undergoes

volumetric polymerization shrinkage of approximately 1.5–5.0%, generating internal stresses that frequently result in marginal gap formation, insufficient contact point tightness, and the entrapment of interproximal voids. These deficiencies carry substantial clinical consequences: open or weak proximal contacts are directly implicated in food impaction, plaque retention, periodontal pocket formation, and the acceleration of secondary carious lesions at the gingival margin — all of which contribute significantly to the premature failure of posterior restorations and increased patient burden in terms of retreatment costs and morbidity. The global prevalence of posterior dental caries requiring Class II restorative intervention continues to rise, with the 2023–2025 Global Burden of Disease data indicating that untreated carious lesions in permanent posterior teeth affect over 2.3 billion individuals worldwide. As composite resin has largely supplanted dental amalgam in both direct restorative practice and regulatory acceptance — with amalgam phase-downs mandated under the Minamata Convention and echoed in updated European Union dental regulations effective 2025 — the clinical community faces an urgent, unresolved imperative: establishing reproducible, evidence-based protocols that reliably overcome the inherent material limitations of direct composite placement in posterior interproximal contexts. Previous investigations have independently addressed matrix system selection, wedge design, separation force magnitude, and incremental placement geometry; however, no unified protocol has systematically integrated contoured sectional matrix technology with a rigorously defined oblique incremental layering sequence validated against both biomechanical and radiographic outcome parameters. The present study addresses this gap by introducing a combined matrix-placement protocol specifically engineered to counteract polymerization shrinkage vectors at the proximal box, redistribute cervical adaptation forces, and ensure predictable contact point reconstruction across a heterogeneous sample of premolar and molar Class II preparations. This paper is structured as follows: Section 2 reviews the biomechanical and material science rationale underlying proximal contact deficiency in composite restorations. Section 3 details the materials, matrix systems, and incremental placement protocol employed. Section 4 presents quantitative outcomes from micro-CT marginal gap analysis, dental floss resistance scoring, and digital bite-force measurements at baseline and 12-month follow-up. Section 5 discusses clinical implications, limitations, and recommendations for translating the protocol into routine restorative practice.

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