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Corresponding Author:
Thanasak Rakmanee, Division of Restorative Dentistry, Faculty of Dentistry, Thammasat University, Pathum Thani 12120, Thailand
E-mail: rthanasa@tu.ac.th

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How Do CAD/CAM Hybrid Materials Perform Under Cyclic Fatigue and High Occlusal Loads? A Mini-review Article

Pacharaporn Pattanasukwasan[1], Thanasak Rakmanee[1], Nantawan Krajangta[1], Keiichi Hosaka[2], Awiruth Klaisiri[1]

[1]Division of Restorative Dentistry, Faculty of Dentistry, Thammasat University, Thailand
[2]Department of Regenerative Dental Medicine, Graduate School of Medical and Dental Sciences, Tokushima University, Japan

Abstract

The rapid advancement of computer-aided design and manufacturing (CAD/CAM) technology has transformed restorative dentistry, offering materials that combine esthetic quality with mechanical durability for indirect restorations. This mini-review evaluates the fatigue resistance and fracture behavior of CAD/CAM hybrid materials, particularly under cyclic loading and high occlusal forces. The analysis encompasses both subtractive (milling) and additive (3D printing) manufacturing methods, emphasizing each method's advantages and limitations. Hybrid materials, such as polymer-infiltrated ceramic networks (e.g., Vita Enamic®), high-density resin composites (e.g., Cerasmart®), and laser-sintered composites (e.g., Edelweiss CAD/CAM BLOCK®), are discussed in terms of their mechanical properties, including flexural strength, hardness, and resilience under fatigue.

Data from *in vitro* studies indicate that hybrid materials maintain high durability under static and cyclic fatigue conditions when fabricated at optimal thicknesses (1.0-1.5 mm), withstanding forces well beyond typical masticatory loads. These properties make hybrid ceramics suitable for minimally invasive restorations that preserve tooth structure and minimize wear on opposing dentition. However, thinner restorations (≤0.8 mm) demonstrate increased susceptibility to fracture under high occlusal forces, particularly in patients with bruxism. The review underscores the need for standardized fatigue testing protocols that mimic clinical conditions more accurately to improve predictive validity.

Keywords: CAD/CAM, cyclic fatigue, fracture resistance, hybrid materials