MODERN METHODS FOR IMPROVING THE AESTHETIC APPEARANCE AND SURFACE SMOOTHNESS OF PROSTHETIC CROWNS

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Relevance: Modern prosthetic dentistry faces continually increasing patient demands for the aesthetics of dental restorations. Traditional full-cast metal crowns, while highly functional, absolutely do not meet modern aesthetic standards. Porcelain-fused-to-metal (PFM) constructions, long considered a compromise, have several disadvantages: the risk of exposing the metal margin, insufficient translucency, and "graying" of the gingival tissues. In this context, the study and implementation of modern methods become highly relevant, including digital (CAD/CAM) fabrication, the use of metal-free materials (zirconia, lithium disilicate), and the application of Digital Smile Design (DSD). These technologies are aimed not only at improving optical properties (color, translucency) but also at achieving ideal surface harmony (microtexture, smoothness), which directly impacts biocompatibility and restoration longevity.
Keywords: Aesthetic dentistry, CAD/CAM, Zirconia, E.max (lithium disilicate), PFM, cast crowns, surface smoothness, Digital Smile Design (DSD), aesthetic integration.

Introduction: The goal of prosthetic treatment is not only the restoration of masticatory function but also the complete aesthetic integration of the restoration into the dentofacial system. The evolution of materials has progressed from full-cast metal crowns to PFM, and today, to all-ceramic restorations. The challenge of achieving a natural appearance includes not only color matching but also recreating the complex light interplay inherent in natural teeth, as well as creating a smooth surface resistant to pigmentation and plaque accumulation. The purpose of this study is to comparatively analyze modern digital and metal-free methods for improving the aesthetic and surface characteristics of crowns against traditional (cast and PFM) approaches.
Materials and Methods: For the comparative analysis, 3 groups of patients (n=90) requiring single crowns were formed: Group 1 (Control) - PFM crowns, fabricated using the traditional casting method with manual ceramic layering. Group 2 - Monolithic zirconia (ZrO2) crowns, fabricated using CAD/CAM technology followed by polishing and glazing. Group 3 - Lithium disilicate (E.max) crowns, fabricated by pressing or CAD/CAM milling with individual characterization.
Evaluation was conducted based on the following parameters: Aesthetic Integration - Assessment of color and translucency matching using a spectrophotometer (VITA Easyshade). Surface Smoothness - Measurement of surface roughness (Ra) using an Atomic Force Microscope (AFM) before and after an artificial aging procedure (thermocycling). Soft Tissue Aesthetics - Visual assessment for the absence of a "gray" gingival margin after 6 months. Patient Satisfaction- Questionnaire using a 10-point Visual Analog Scale (VAS).
Results: Aesthetics: Lithium disilicate restorations (Group 3) demonstrated the best translucency and color integration (mean VAS score 9.5 ± 0.4). Zirconia crowns (Group 2) showed high aesthetic results (VAS 8.8 ± 0.6), significantly surpassing PFM (Group 1) (VAS 7.1 ± 1.1), which often exhibited inadequate opacity. Surface Harmony - The lowest surface roughness (Ra) after polishing was achieved with monolithic zirconia (Ra = 0.05 μm), which theoretically reduces bacterial adhesion. Glazed ceramics (Group 3 and Group 1) had similar, but slightly higher, values (Ra ≈ 0.08-0.12 μm).

Gingival Health - In 35% of cases in Group 1 (PFM), slight darkening of the gingival margin was observed, which was absent in Groups 2 and 3 ($p < 0.05$).

Conclusion: Modern methods based on digital CAD/CAM technologies and the use of metal-free materials (zirconia, lithium disilicate) demonstrate significant superiority in improving the aesthetic appearance and surface harmony of crowns compared to traditional cast and PFM constructions. They provide not only better optical integration but also create a smoother, more biocompatible surface, which promotes periodontal health and restoration longevity. The use of Digital Smile Design (DSD) at the planning stage further allows for the harmonization of the crown's shape and position with the patient's individual facial features.

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