Influence of digital manufacturing and abutment design on full-arch implant prostheses. An in-vitro study

Achieving accurate fit in implant-supported prostheses is critical to avoid mechanical complications; however, the influence of digital manufacturing techniques and abutment designs on misfit and preload remains unclear. This study evaluated the impact of different manufacturing techniques (CAD-cast, 3D printing) and abutment connection types (engaging [E], non-engaging [NE]) on the misfit and preload of implant-supported cantilevered fixed dental prostheses (ICFDPs). Misfit was measured at six points using scanning electron microscopy, and preload was assessed via eight strain gauges placed buccally and lingually on four implants. Frameworks were torqued to 35 Ncm, retorqued after 10 minutes, and subjected to 200,000 cycles of loading. Mean preload values ranged from 173.4 ± 79.5 Ncm (PF) to 330 ± 253.2 Ncm (3DP). Preload trends varied depending on the abutment type and manufacturing technique, with the 3DP group showing higher preload in engaging (E) abutments, whereas the CAD-cast group showed the opposite pattern. Although preload values varied numerically, these differences were not statistically significant ($P = 0.5$). In terms of misfit, significant differences were observed between groups ($P < 0.05$), except between CAD-cast E (86.4±17.8µm) and 3DP E (84.1±19.2µm). Additionally, E and NE abutments showed significant differences in misfit within both CAD-cast and 3DP groups. Overall, 3DP frameworks showed superior fit over CAD-cast. These findings suggest that 3DP may offer improved clinical outcomes in terms of implant-abutment fit.

Keywords: framework; digital manufacturing; 3d printing, abutment connection design, misfit, cantilever, implant-supported FDP, full-arch