ABSTRACT

Effect of nanostructure incorporation on the mechanical properties of experimental dental ceramics: a systematic review and synthesis of dense bovine hydroxyapatite bioceramics with 3Y-TZP nanoparticles

The aim of this study was to investigate the role of nanostructures on the mechanical properties of ceramic dental materials and to summarize processing and synthesis methodologies for novel ceramics in Dentistry (article 1), and to produce and characterize bovine hydroxyapatite (HA) ceramic composite with addition of 3Y-TZP sintered by different firing curves (article 2). On the article 1, a systematic review was performed guided by PRISMA 2020 statement and registered on PROSPERO (CRD42020201110). The selection criteria included *in vitro* studies that address results on nanomaterials-modified experimental ceramics for dental application. Most articles studied zirconia, glass-ceramic, and hydroxyapatite matrixes reinforced mainly with metallic oxides having various particle shapes. The most commonly used nanostructures and those that were associated with better mechanical properties for the materials studied are ZrO_2 and Al_2O_3. On article 2, for experimental ceramic production, HA was extracted from bovine bones and nanoparticulated. Discs of pure HA and with 1, 5 and 10wt% 3Y-TZP were subjected to uniaxial and isostatic pressing. Dilatometry analysis was performed by a 1300ºC sintering temperature. Three different firing curves were designed for groups sintering: conventional, 1300ºC; 2-step, 1292ºC; 2-step, 1420ºC. The samples were analyzed by X-ray diffraction (XRD), biaxial flexural strength (BFS), Vickers microhardness (VH) and Field emission scan electron microscopy (FE-SEM). Twenty-two articles were selected for analysis for the systematic review. Most articles studied zirconia, glass-ceramic, and hydroxyapatite matrixes reinforced mainly with metallic oxides having various particle shapes. The most commonly used nanostructures and those that were associated with better mechanical properties for the materials studied are ZrO_2 and Al_2O_3. On the experimental phase, dilatometry signaled the need for sintering optimization in groups added with 3Y-TZP. XRD demonstrated the characteristic crystallographic peaks of HA in the pure groups and with 1% 3Y-TZP, and decomposition of HA into β-TCP and formation of calcium zirconate in the groups with 5 and 10% 3Y-TZP. The groups of pure HA sintered by the conventional curve (131.3 ± 13.5 MPa; 401 ± 12.7 GPa) and HA+1%3Y-TZP (145 ± 8.6 MPa; 507 ± 47.9 GPa), HA+5%3Y-TZP (68.1 ± 14.2 MPa;