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Cobalt-chromium alloys in fixed prosthodontics

Manufacturing techniques, biological and mechanical aspects

Akademisk avhandling

Som för avläggande av odontologie doktorsexamen vid Sahlgrenska akademin, Göteborgs universitet kommer att offentligen försvaras i sal: Arvid Carlsson, Academicum, Medicinaregatan 3, fredagen den 25 mars 2022, klockan 9.00.

av Maria Kassapidou

Fakultetsopponent:

Per Vult von Steyern, professor, Malmö Universitet, Sverige

Avhandlingen baseras på följande delarbeten

I. Kassapidou M, Franke Stenport V, Hjalmarsson L, Johansson CB. Cobalt-chromium alloys in fixed prosthodontics in Sweden. Acta Biomaterialia Odontologica Scandinavica. 2017;3(1):53-62.

II. Kassapidou M, Hjalmarsson L, Johansson CB, Hammarstrom Johansson P, Morisbak E, Wennerberg A, Franke Stenport V. Cobalt-chromium alloys fabricated with four different techniques: Ion release, toxicity of released elements and surface roughness. Dental materials : official publication of the Academy of Dental Materials. 2020;36(11):e352-e63.

III. Kassapidou M, Franke Stenport V, Johansson C, Syverud M, Hammarström Johansson P, Börjesson J, Hjalmarsson L. Cobalt-Chromium alloys in fixed prosthodontics; investigations of mechanical properties and microstructure. 2021 (submitted).

IV. Kassapidou M, Stenport VF, Johansson CB, Östberg AK, Hammarström Johansson P, Hjalmarsson L. Inflammatory Response to Cobalt-Chromium Alloys Fabricated With Different Techniques J Oral Maxillofac Res 2021;12(4):e3.

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Avdelningen för oral protetik och odontologisk materialvetenskap, Institutionen för Odontologi, Sahlgrenska Akademin, Göteborgs universitet, Sverige, 2022.

Abstract

Gold and its alloys have been the dominant framework materials in metal-ceramic constructions when substantial loss of tooth substance or missing teeth needs to be replaced. However, base metal alloys, such as cobalt-chromium (Co-Cr), have been introduced due to increased gold price. Co-Cr alloys possess beneficial mechanical properties because the alloys can, even with small dimensions, resist high chewing forces and exhibit an acceptable bond to the surface porcelain layer. Yet, the biocompatibility of Co-Cr alloys has been questioned. The overall aim of the present thesis is to increase our knowledge about Co-Cr alloys that are used in fixed prosthodontics.

Results from Study I, which was a survey directed to all dental laboratories in Sweden, demonstrated that more than thirty different Co-Cr alloys were reported to be used in fixed prosthodontics. Besides the various chemical composition among the reported alloys, they were also manufactured by four different techniques; cast, milled, laser melted and pre-sintered milled. Based on the results from Study I, five Co-Cr alloys manufactured by four techniques, together with commercially pure titanium (c.p. Ti) grade 4 and Ti6Al4V ELI, were further included in Studies II-IV. *In vitro* studies were conducted in order to evaluate ion release, cell viability and inflammatory response. The effect of material combinations was also investigated. The mechanical properties and material structure with regards to yield strength, elongation after fracture, hardness, elastic modulus, surface roughness and microstructure were evaluated. The effect of heat treatment was also investigated on the above-mentioned parameters. The total ion release from all materials was extremely low, yet highest for the cast Co-Cr alloys in acidic conditions. The combination of Co-Cr, Ti6Al4V ELI and c.p. Ti showed lower total ion release compared with the non-presence of c.p. Ti. All tested materials demonstrated non-cytotoxic effects, although the highest inflammatory response from cells exposed to the materials was observed for the cast and pre-sintered milled Co-Cr materials. Overall, the laser melted Co-Cr demonstrated the highest values in mechanical properties.

Conclusion: *In vitro* biological aspects and mechanical properties are influenced by the choice of manufacturing technique, heat treatment and microstructure of the materials. In order to evaluate these findings, more clinical studies are needed.

Keywords: prosthodontics, cobalt-chromium, manufacturing techniques

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