

Low Thermal Degradation of monolithic zirconia dental prostheses: 1-yr results of a prospective clinical study with *ex vivo* analyses

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INTRODUCTION: Recent introduction of computer-aided design/computer-aided manufacturing (CAD/CAM) monolithic zirconia dental prostheses raises the issue of material low thermal degradation (LTD), a well-known problem with zirconia hip prostheses. This phenomenon could be accentuated by masticatory mechanical stress. Until now zirconia LTD process has only been studied *in vitro*. The main objective of this study was to evaluate the *in vivo* LTD of zirconia restorations on implants and natural teeth using an original protocol including *ex vivo* analyses of zirconia crystalline microstructure, focusing on the effect of occlusal stress and protection by a glaze layer. Secondary objectives included the investigation of the general behaviour of monolithic restorations and the study of material wear process.

METHODS: 74 posterior monolithic zirconia restorations including 101 tooth elements (molars and premolars) were included in a 5-year prospective clinical trial. On each element, several areas between 1 and 2 mm² (6 on molars, 4 on premolars) were determined on restoration surface: areas submitted or non-submitted to mastication mechanical stress, glazed or non-glazed. Before prosthesis placement, *ex vivo* analyses regarding LTD and wear were performed using Raman spectroscopy, SEM analysis and 3D laser profilometry. After placement, restorations were clinically evaluated following criteria of the World Dental Federation (FDI), complemented by the analysis of fracture clinical risk factors. Two independent examiners performed the evaluations. Clinical evaluation and *ex vivo* analyses were carried out after 6 months and then each year for up to 5 years.

RESULTS: 96 elements have been evaluated at baseline, 6-months and 1-year follow-up. 59.6% of patients suffered from bruxism. The element

transformation rate (TR), defined as the percentage of elements in which transformation was detected, was 17.8% at baseline (restorations which were grinded for occlusal adjustments) and 41.1% at 1 year respectively. Critical TR, which is related to elements showing a monoclinic volumetric fraction > 50% (Cri-TR), was of 7.9% at baseline and 8.4% at 1 year. 14.5% of buccal/palatal and 7.6% of occlusal areas exhibited transformation. Monolithic zirconia restorations showed very good short-term clinical results, with a survival rate of 93.2% and a success rate of 83.8% after a mean observation period of 391.2 ± 58.3 days. Failures were related to screw-retained restoration abutment debonding (5.4%), cemented restoration debonding (4.1%), peri-implantitis disease (2.7%), core and restoration debonding (1.4%), Lava Plus crown fracture (1.4%) and root fracture (1.4%). No significant zirconia wear was observable, while glaze wear was observed on 100% of occlusal contact points (fig.1).



Fig. 1: SEM observation of glaze wear on occlusal contact points after 1 year, compared to baseline reference view.

DISCUSSION & CONCLUSIONS: TR and Cri-TR were shown to increase with time, indicating that zirconia LTD develops *in vivo* after one year. A monoclinic volumetric fraction > 50% is commonly considered as a threshold beyond which material properties can be affected by the LTD process. Yet, this process had no impact on the clinical performance of restorations at 1 year. Glaze wears out rapidly and consequently cannot protect from the LTD. Areas submitted to occlusal stress were found to be less sensitive to LTD than

lingual and buccal areas: this finding has to be further explored.