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CAD/CAM-titanium-ceramic single crowns with non-anatomic coping-design. A six-year follow-up study

Objectives

Due to the increasing price of gold CAD/CAM titanium-ceramic restorations were developed to give alternative to the established metal-ceramic restorations with a high gold content. Despite the advantages of excellent biocompatibility, high corrosion resistance and appropriate strength titanium has made the casting process difficult caused by the high affinity of molten titanium to investment materials [1]. It was found that the adhesive bond between titanium and porcelain was compromised due to the existence of reactive layers. Furthermore the titanium's coefficient of thermal expansion is significantly lower than that of conventional noble metal alloys, therefore titanium required special low-fusing porcelain with a low coefficient of thermal expansion to be veneered. Nowadays titanium coping were fabricated using CAD/CAM technology. Earlier versions of CAD software were limited to design non-anatomic metal copings in even thicknesses. As a result, crowns were fabricated with excess of unsupported veneering porcelain in certain areas. However, there is a lack of data about the clinical performance of CAD/CAM titanium-ceramic crowns with non-anatomic coping design and low-fusing veneering porcelain.

The present study reports the clinical results of CAD/CAM titanium-ceramic single crowns with non-anatomic coping design. Fractures of the veneering porcelain were examined after a follow-up of six years.

Material and Methods

This prospective clinical trial was designed according to the Consolidated Standards of Reporting Trials (CONSORT) recommendations for improving the quality of clinical trials. The requirements of the Helsinki declaration were fulfilled and approved by the Ethical Committee of the University Halle-Wittenberg (#05032004).

A total of 41 crowns were fabricated for 21 patients. The titanium copings were CAD/CAM milled (Everest CAD/CAM system, KaVo Biberach, Germany) with an even thickness of 0.5mm, and low-fusing veneering porcelain (Vita Titanium Porcelain, VITA Zahnfabrik Bad Saeckingen, Germany) was added incrementally (Fig 1-2). The crowns were cemented using zinc-phosphate cement. The patients were recalled yearly after cementation to examine for the presence of any complications. The crown was categorized as "success" if it was free from any mechanical complications, while it was categorized as "survival" if it was functioning in place with mechanical complication(s), but not replaced. The success and survival rates were estimated using the Kaplan-Meier analysis [2].

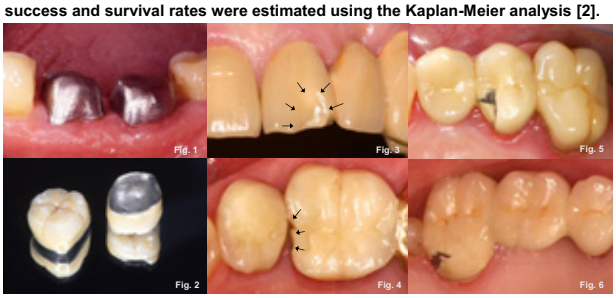

Fig. 1-2 Titanium copings and low-fusing veneering procelain
Fig. 3-4 Cohesive porcelain fractures (chipping)
Fig. 5-6 Adhesive porcelain fractures

Results

At the 6-year recall 3 patients (4 crowns) were lost to follow-up due to medical conditions or address changes. Mechanical complications summed up to 10 cohesive (Fig. 3-4) and 2 adhesive porcelain fractures (Fig. 5-6) that resulted in the replacement of 2 crowns. The fractured crowns were found in 1 anterior crown and 11 posterior crowns. The 2 crowns that needed to be replaced were both posterior crowns.

The fracture of the porcelain caused loss of either occlusal or proximal contact. One biologic complication was found during the follow-up examinations. One root filled tooth was extracted due to recurrent apical periodontitis. Therefore, the Kaplan-Meier cumulative success rate of CAD/CAM titanium-ceramic crowns with regard to mechanical complications was 67.8% ± 7.7SE (Fig. 7). The Kaplan-Meier cumulative survival rate of CAD/CAM titanium-ceramic crowns with regard to function was 91.3% ± 4.8SE (Fig. 8).

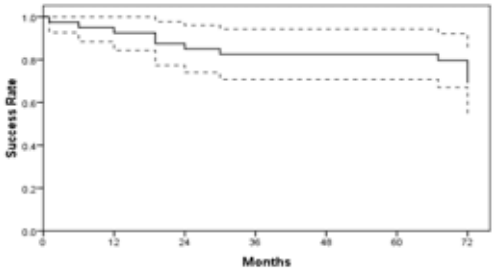

Fig. 7 Success rate of CAD/CAM titanium-ceramic crown over 6 years by Kaplan-Meier cumulative analysis with 95% confidence interval

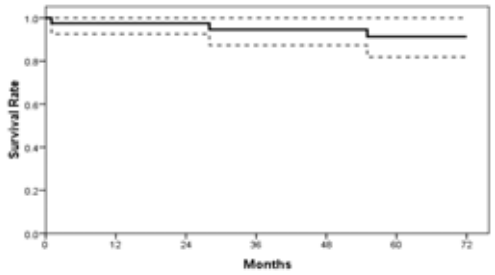

Fig. 8 Survival rate of CAD/CAM titanium-ceramic crown over 6 years by Kaplan-Meier cumulative analysis with 95% confidence interval.

The present clinical study demonstrated that the CAD/CAM titanium-ceramic single crowns with non-anatomic coping design developed several veneering porcelain fractures, primarily for the posterior crowns. Cohesive fractures of the porcelain were observed particularly. They often developed in areas where shear occlusal force occurred e.g. the proximal marginal ridges or distolingual cusps of mandibular molars. The fractures may have been due to the lack of metal support resulting from the coping design. Hence current CAD-software is able to design metal copings in reduced tooth size which provides adequate support and a uniform thickness for the veneering porcelain. But the problem of poor design does not only belong to CAD/CAM titanium copings. It is true for all porcelain-fused-to-metal and zirconia-core crowns [3]. The compromised bond strength between titanium and porcelain as previously described seems to be solved by the advancements in dental technology [4]. Furthermore no secondary caries or de-cementation was detected during the 6-year observation period. This indicates that the marginal accuracy and internal fit of titanium copings even with earlier versions of the CAD software used were acceptable [5].

Conclusion

The clinical performances of the CAD/CAM titanium-ceramic crowns with non-anatomic coping design for 6 years were poor. To avoid veneering porcelain fracture modern CAD-software with tools to design proper coping should be used.

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