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Clinical performance of posterior metal-free polymer crowns with and without fiber reinforcement
One-year results of a randomised clinical trial

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ABSTRACT

Objectives: The aim of this study was to evaluate the clinical performance of posterior, metal-free polymer crowns with and without a glass-fiber framework, in comparison to metal–ceramic crowns.

Methods: After randomisation, 80 single crowns, manufactured from a newly designed polymer composite, were set in posterior teeth. Half of these received a glass-fiber framework, while half were prepared without any framework stabilisation. All polymer crowns were adhesively luted with resin cement. As the control group, 40 conventional metal–ceramic crowns were inserted with hybrid cement. Documentation included failures and other complications, as well as gingival/plaque status and aesthetic performance.

Results: During the 12-month observation period, eight polymer crowns and three metal–ceramic crowns showed clinically relevant complications. The most frequent complications were root canal treatments ($n = 4$) and decementation ($n = 4$) of the crowns. A total of two crowns (one polymer crown with fiber network and one crown of the control group) had to be replaced.

After 12 months, polymer crowns with glass-fiber framework exhibited significantly higher plaque accumulation ($p = 0.005$) and gingival index ($p = 0.04$) than metal–ceramic crowns, while no significant differences could be demonstrated for polymer crowns without fiber reinforcement.

Postoperative sensibility and aesthetic performance did not differ significantly between the groups.

Conclusions: Within a 12-month observation period, posterior polymer crowns with and without glass-fiber framework demonstrated acceptable stability and aesthetic performance.

Polymer crowns with fiber framework showed significant higher plaque accumulation and gingival index than metal–ceramic crowns.

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1. Introduction

Metal and metal–ceramic crowns are clinically successful,[1] but the visibility of metal and the change in natural tooth translucency is aesthetically unfavorable. The desire for natural looking restorations has encouraged research in the last decades on metal-free, tooth coloured materials for dental restorations.

As early all-ceramic restorations exhibited high failure rates,[2] an alternative has been seen in the use of reinforced composite materials. In recent years, there have been several in vitro[3–5] and in vivo studies[6,7] of the properties of these composites and promising results have been reported for crowns,[8] and for fixed partial dentures.[9]

However, although these materials seem to provide excellent aesthetics,[10] some authors do not recommend composite materials for permanent restorations,[11,12] because of their unstable aesthetics, their increased wear[13] and their liability to plaque accumulation.[14]

With the introduction of polymer composites, it seemed to be possible to eliminate these disadvantages of composites and to exploit their advantages, including the simple laboratory procedure, the lower costs and the possibility of repair.

Additionally, this new generation of composites has given promising in vitro results with respect to colour change,[15] wear[16] and fracture resistance.[17]

Meanwhile, initial promising results from clinical studies on metal-free polymer crowns have been presented.[18]

However, the lack of randomised control groups prevents unbiased comparison with conventional metal–ceramic crowns. Furthermore, the clinical benefit of fiber reinforcement remains unclear, since in vitro results have demonstrated acceptable fracture resistance values with non-reinforced posterior single molar crowns.[14,19]

The objective of this present prospective clinical study was then the assessment of the clinical performance of a new experimental microfilled polymer material (Trend HP®) with or without fiber network stabilisation for manufacturing posterior crowns, compared with a metal–ceramic control group.

2. Material and methods

Participants for this study were recruited from patients visiting the Department of Prosthodontics. The university's review board approved the study and all patients signed an informed consent form. Criteria for excluding patients from the study were being under the age of 18 or being incapable of taking out a contract, pregnancy or lactation, unacceptable oral hygiene status, clenching or grinding of teeth or known allergic reaction to the applied materials, all evaluated from answers to specific questions by the examiner.

The study group consisted of 66 patients (37 females and 29 males), aged between 22 and 73 years, with a mean age of 46 (S.D.: 11.9) years.

These 66 patients received a total of 120 posterior single crowns, divided into three groups: 40 polymer crowns with framework stabilisation (group 1), 40 polymer crowns without framework stabilisation (group 2) and 40 metal–ceramic crowns (control group). Patients received a maximum of three crowns. If the indication for three crowns was given, one crown from each of the two test groups as well as the control group was randomly assigned to the abutment teeth. Patients with the indication for two posterior crowns received two crowns, randomly assigned to the abutment teeth, from different groups.

Clinical treatment – from six dentists – and laboratory procedures followed a standardised scheme. After the removal of old restorative materials and caries excavation, the teeth were built up with Rebilda SC® (Voco GmbH, Cuxhaven, Germany), according to the manufacturer's instructions. The minimal occlusal reduction was 1.5 mm and the axial reduction (chamfer design) was set at 0.8 mm. An attempt was made to keep the convergence preparation angle to the target of 6°. Impressions were made using polyether material (Impregum®, 3MEspe, Seefeld, Germany). Stone casts (Fujirock®, GC Europe, Leuven, Belgium) were poured and mounted in an articulator and the crowns were then fabricated by three previously trained dental technicians.

The polymer crowns were made of a polymer material (Trend HP®, Ivoclar Vivadent, Ellwangen, Germany), consisting of a microfilled urethane dimethacrylate material, polymerised under heat and pressure according to the manufacturer's protocol. Polymer crowns of group 1 received a glass-fiber framework (Vectris®, Ivoclar Vivadent), while polymer crowns of group 2 were made without any additional stabilisation.

When manufacturing polymer crowns with Vectris® stabilisation, the stone casts were insulated twice using a model separator (Vectris® model separator, Ivoclar Vivadent) and the woven fiber prepags (Single®, Ivoclar Vivadent) were adapted to the working dies and deepdrawn in a vacuum pressure process onto the insulated casts, after pre-treatment of the working dies with a thinly flowing resin (Glue®, Ivoclar Vivadent). During this process the woven fibres were formed into a cap (thickness 0.5 mm) and were light cured for 10 min (Vectris VS 1; Ivoclar Vivadent). The laminate copings were then cut, using silicone burs, 0.5–1 mm above the finishing line. After airborne abrasion with 50 μm alumina oxide particles, the surfaces were silane coated (Vectris wetting agent®, Ivoclar Vivadent) for 60 s and light cured for 20 s (Targis Quick®, Ivoclar Vivadent) after coating with a liner (New Composite liner®, Ivoclar Vivadent).

For polymer crowns without framework stabilisation, the working dies were coated three times with insulation material (Vectris® model separator) and, by following the same scheme as for reinforced crowns, a liner (thickness 0.2–0.3 mm) was added to the insulated casts.

The shapes of the crowns were modelled with the veneering material (Trend HP®) according to the manufacturers instructions, finished using carbide and silicone burs, and polished with polishing paste (Universal Polierpaste®, Ivoclar Vivadent), preserving a minimum thickness of 1.5 mm.

As control group, metal–ceramic crowns (IPS d.Sign96®; IPS d.Sign®; Ivoclar Vivadent) were made according to the manufacturer's instructions.

After try in and clinical occlusal adjustment, the polymer crowns were repolished using a polishing paste (Universal Polierpaste®, Ivoclar Vivadent), preserving minimum occlusal dimensions of 1 mm. Prior to cementation, the inner surface