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A retrospective evaluation of zirconia-fixed partial dentures in general practices: An up to 13-year study

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ARTICLE INFO

Article history:
Received 7 March 2014
Received in revised form
27 June 2014
Accepted 14 November 2014

Keywords:
CAD/CAM
Ceramics
Clinical study
General practices
HIPed Y-TZP
FPD
Zirconia

ABSTRACT

Objectives. To evaluate zirconia-based fixed partial dentures (FPDs) after more than 8 years in clinical service.

Methods. Patients treated between 2000 and 2004 with zirconia FPDs were identified from the records of a manufacturer of FPD substructures. Of the 45 patients who met the inclusion criteria 30 attended the appointment and 33 FPDs were evaluated using modified California Dental Association (CDA) criteria. In addition, plaque and the bleeding index were registered. Patient satisfaction with the restorations was evaluated using a 10-point visual analog scale (VAS).

Results. All the FPDs were made using CAD/CAM and hot isostatic pressed yttria-tetragonal zirconia polycrystal (HIPed Y-TZP) ceramic (Denzir) and were placed within general practices. The mean observation period was 9.6 ± 1.6 years (range 3.0–13.1 years). The CDA rating was 90% satisfactory for the surface. Corresponding figures for anatomic form, color and margin integrity were 94%, 100% and 94%, respectively. Regarding surface three (9.7%) FPDs exhibited veneer chipping and were rated 'not acceptable'. For margin integrity two (6.5%) were rated 'not acceptable' because of caries. For anatomic form two (6.1%) were rated 'not acceptable' due to two lost FPDs. No significant differences were seen between the FPDs and controls for plaque and bleeding. The Kaplan–Meier survival rate (still in clinical function) was 94%, the success rate (technical events accounted for) 91% and (biological events accounted for) 73%. Based on the VAS the mean value for patient satisfaction was 9.3 ± 1.2.

Significance. Ninety-four percent of the FPDs were still in clinical function. HIPed Y-TZP could serve as an alternative for FPD treatments similar to those in the current study.

1. Introduction

To date gold alloys have traditionally been the most widely used cast metal for dental applications [1] but gold alloys are now used less often, mainly because the cost has increased during the past few years [1]. Among materials often used for crowns and fixed partial dentures (FPDs) are cobalt chromium alloys and commercially pure titanium [2]. However, increased demands for, among others, more esthetic materials have led

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http://dx.doi.org/10.1016/j.dental.2014.11.009
0109-5641/

to a shift to metal-free materials for dental restorations [1] and there is now widespread use of ceramics in dental restorations and other biomechanical applications, such as hip joint implants [3–5]. In this context it should be noted that the properties of dental ceramics are very dependent on the manufacturing technique and composition of the material [6,7] and that most ceramic materials are brittle which could influence the mechanical behavior of dental restorations [8,9].

At the end of the 20th century alumina and zirconia oxide ceramics with improved mechanical properties, compared to dental ceramics previously used, became available to dentistry through the development of computer aided design/computer aided manufacturing (CAD/CAM) techniques [10]. Zirconia-based ceramics in particular have been used since then as a core material for dental FPDs and single crowns [11,12]. Today zirconia-based ceramic dental restorations are made in a variety of ways; either using prefabricated blocks of hot isostatic pressed (HIPed) zirconia or in different presintered stages that are then sintered after the milling of the restoration [11,12].

Pure zirconia exists in three phases: cubic (C) at >2370 °C, tetragonal (T) at 1170–2370 °C and monocline (M) between 0 and 1170 °C [13,14]. Since it is the tetragonal phase that is of particular interest for dental applications, dental zirconia ceramics are stabilized using yttria, often called yttria-tetragonal zirconia polycrystal (Y-TZP), to reduce the phase transformation $T \rightarrow M$ at room temperature [15]. However, despite stabilizing with yttria the number of monocline crystals in zirconia ceramics can increase over time, so-called low temperature degradation (LTD), which could affect the properties of the material [16]. It is, therefore, of interest to evaluate the clinical outcome of FPDs made of Y-TZP that have been in clinical service for a relatively long time. In a survey of the literature in the database (PubMed) only two papers were found that addressed the clinical results of zirconia-based FPDs that have been in clinical service for more than 8 years [17,18]. The aim of the present study was, therefore, to evaluate zirconia-based FPDs that have been in clinical service for more than 8 years.

2. Materials and methods

2.1. Ethical considerations

Before the present study started it was approved by the regional Ethics Review Board at Umeå University, Umeå, Sweden (Dnr 2013-124-31M). Written and oral informed consent was given by all of the participants in accordance with the Helsinki Declaration.

2.2. Patient recruitment

Patients treated with zirconia ceramic FPDs were identified from the records of a manufacturer (Cad.esthetics, Skellefteå, Sweden) of zirconia-based ceramic core materials for all-ceramic FPDs. The inclusion criteria were that the FPDs should have been made between 2000 and 2004 and placed in patients treated in general practices and living within a distance of 200 km from Umeå University, Umeå, Sweden. Using the patients' social security numbers it was then possible to track individuals who had received zirconia ceramic FPDs between 2000 and 2004. These patients received written information by mail about the purpose of the study. Thereafter they were telephoned and asked if they wanted to participate in the study. The patients were informed that they could decide to withdraw from the study at any time and without any explanation.

2.3. Clinical evaluation

The clinical examination was performed in accordance with a slightly modified version (Table 1 a–d) of the California Dental Association (CDA) quality evaluation system [19,20] by two of the authors (AH and HL). The two examiners worked in pairs but independently of each other. Each time there was a difference in the rating of a given FPD, both examiners looked at the case and then resolved their disagreement. In addition, the patients were interviewed to discover whether any complications had occurred during the time the FPDs had been in use and for them to rate their satisfaction with the FPDs on a 10-point visual analog scale (VAS). Point 1 on the VAS corresponded to 'not satisfied at all' and point 10 'completely satisfied'.

Moreover, plaque and bleeding on probing were recorded by one of the examiners for each FPD unit. By moving a periodontal probe in the marginal part of the restoration plaque and bleeding were diagnosed as not present (0) or present (1). The homologous surfaces of the teeth not treated with zirconia were used as controls. When homologous teeth were lost a control was selected from another quadrant.

Any chipping fracture was registered and classified according to Crisp et al. [21] (Table 2). In addition, wear on the veneer ceramic, the antagonist and the rest of the dentition were registered. Clinical photographs were taken of all FPDs evaluated. Finally the patients were informed orally about the clinical findings and, if necessary, referred to their ordinary dentist. After the clinical examination all results were encoded and subjected to statistical analysis.

2.4. Statistical analysis

Kaplan–Meier was used to analyze the data concerning the FPDs' survival (defined as all evaluated FPDs still in the mouth even if events were identified) and success rates (defined as intact survival with satisfactory quality of surface, anatomic contour, function and esthetics). Pearson's chi-squared test was used at a significance level of $p < 0.05$ to analyze the data obtained for the plaque and bleeding conditions.

3. Results

Fifty-eight zirconia FPD frameworks intended for 56 patients who met the inclusion criteria were registered. It was possible to contact 45 of these patients. Fifteen could not participate in the study; seven did not want to attend the study, three were unavailable, two reported a lack of time, one was sick and unable to attend the appointment, one had died and one patient reported that 7 years ago the FPD had been removed because of extraction. In all, 30 patients attended the appointment, 24 females and 6 males, with 32 zirconia FPDs were