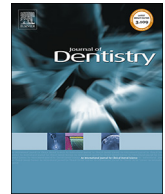




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## A practice based longevity study on single-unit crowns

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### ABSTRACT

**Objectives:** This retrospective longitudinal study aimed to assess the longevity of single unit crowns placed by several dentists and to investigate risk factors associated with crown failures.

**Methods:** From patient files, longevity of 3404 full crown restorations placed in 1557 patients by 8 Dutch dentists between 1996 and 2011 were analyzed. Annual failure rates (AFRs) were calculated and variables associated with failure (success and survival of crowns) were assessed by multivariate Cox-regressions analysis with shared frailty for patients.

**Results:** Most of crowns were PFM (63.8%) placed in molars (58.1%) and non endodontically treated teeth (65.4%). The observation time of restorations varied from 3 weeks to 11 years with a mean of 7 years, resulting in a mean AFR at 11 years of 2.1% and 0.7% for success and survival of crowns, respectively. Among dentists a relevant variation for type of interventions was observed with AFR varying between 1.2% and 3.5%. The most significant risk factor for failure of crowns was the presence of an endodontic treatment, resulting in Hazard ratios of 1.31 for success [95%CI 1.07–1.61] and 1.89 [95%CI 1.35–2.65] for survival of crowns. Tooth type, tooth position (jaw) and gender showed also a significant influence on success of crowns. For survival, increase in patients' age results in a higher risk for failure.

**Conclusions:** Overall, crowns placed by a selected group of dentist showed a good to acceptable success and survival rates, mainly dependent from the practice. The presence of an endodontically treated tooth was a significant risk factor leading to more failures.

### 1. Introduction

Restorative work is still the core business of dentists around the world. Especially in the higher developed countries many direct restorations are placed for treating caries defects and fractured teeth. For larger defects and more seriously compromised teeth, an alternative restorative solution is placing a crown, covering all tooth surfaces, requiring a preparation that will reduce the remaining natural tooth. Traditionally, crowns were made from full metal (mostly gold) and with increasing demands for esthetics, porcelain fused to metal crowns (PFM) were introduced and still used nowadays for many indications.

During the last decade, full ceramic crowns, designed from several different materials have become popular. Cementation of traditional crowns was done with traditional cements, like zinc-Phosphate, Polycarboxylate or glass-ionomer cements. The new full ceramic crowns are most of the time cemented using adhesive materials, which might lead to a better retention of the crown as well as reduced microleakage.

Crowns are relatively expensive restorations and therefore, it can be expected that they show a good longevity. Systematic reviews have shown that PFM crowns show annual failure rates (AFR) of 0.8–0.9% [1,2], Lithium-disilicate ceramic crowns show AFR of 0.7% while other types of ceramic crowns exhibited a somewhat higher AFR of 1.8–2% [2]. Although these systematic reviews are based on randomized clinical trials, that are considered as the highest available level of evidence, one has to take into account that observation times of the included clinical studies are relatively short, especially for a full crown restoration, and AFR tend to increase with increasing observation time [3]. Moreover, in these clinical trials often a relatively 'low risk' patient population is treated as for example bruxing patients are excluded in many study protocols [4].

Therefore, it can be expected that crowns, when placed by general dentists, will show more failures as more high risk patients will be included and procedures are done during routine practice hours instead of following meticulously a research protocol without time pressure. Longevity data from crowns placed by general dentists are limited

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showing results varying from excellent performance in specialized practices [5,6], good performance of 1–2% AFR and less favorable failures rates of 3–5% in studies done in common general practices [7–9] or based on insurance data [10]. These data are important as they express the outcome of regular care instead of high quality clinical research protocols.

In the Netherlands, almost all general practices use electronic patient files (EPF) and based on these files, a database on the survival of crowns placed in general practice can be designed. Since these types of data are relatively scarce, the aim of the present study was to assess the longevity of single unit crowns placed by several general practices in the Netherlands and to investigate risk factors associated with crown failures.

## 2. Materials and methods

This study is reported in accordance with the REporting of studies Conducted using Observational Routinely collected health Data (RECORD) [11]

### 2.1. Study design and setting

This was a retrospective longitudinal study, carried out by secondary data collection in a practice-based research network in The Netherlands. Data from single unit crown restorations, placed in both anterior and posterior permanent teeth, recorded by the electronic patient files of 8 dentists working in their general dental practices. Within these practices, only crowns from those patients that visited the practice for regular check-up at least once a year were included. Crowns that were placed between 1996 and 2011 were collected from the Electronic Patient Files (EPF). Data was digitally extracted and transformed into an Excel data file. Researchers visited the practices and were given access to the electronic patient files (EPF) to check data on all placed crowns during the observation period, respecting privacy regulations related to the EPF. Design and protocol were approved by the local ethics committee, METC (CMO file nr. 2013/483).

### 2.2. Sample and variables

For each restoration, a set of variables was available from the EPF as collected by the dentists during their regular practice hours. The following data were extracted:

1. *Patient level:* gender and age were recorded, being the patient's age used as a continuous variable. The periodontal health status of the patient was also collected which is expressed by a screening index named DPSI (A for DPSI 0,1,2; B for DPSI 3 and 4 and C for DPSI 5) [12]. In this index the A score represents absence of periodontitis, while B and C scores represent increasingly severe stages of periodontitis.
2. *Tooth level:* the tooth type was categorized in anterior teeth, premolars and molars, and categorized also by jaw (upper and lower). The type of single unit crown was categorized as full metal (FM), Porcelain fused to metal (PFM) or full-ceramic crown (FC). Moreover, it was checked by radiographs if the tooth was endodontically treated.

### 2.3. Outcome

For each crown restoration three dates were recorded: the date of placement of the crown, the date of an intervention on the crown (if present) and the date of the last check-up which was considered as the censoring date. The following three options could be valid as outcome:

1. When during the observation period no intervention was done on a crown, the restoration was considered as a success and censored at

the last check-up date.

2. The restoration was considered as failed if a crown was replaced or the involved tooth was extracted during the observation period
3. In those cases when interventions on the tooth did not lead to replacement or removal of the crown, in case of a repair, an endodontic treatment, or dislodgement and recementation of the crown, the status of the crown at the end of the observation time was considered as 'survived' [13].

Reasons for placement of restorations could not be retrieved from the EPF. The reasons for failure or intervention were collected from the EPF by interpretation of the treatment code that was used for the intervention: extraction, endodontic treatment, direct restoration, crown recementation and placement of a new crown.

### 2.4. Statistical methods

Statistical analyses were performed using STATA 12 software package (StataCorp LP; College Station, TX, USA) and R version (Foundation for Statistical Computing, Vienna, Austria). The longevity of the crowns was explored by Kaplan Meier statistics, survival tables and curves were created. Descriptive statistics was used to report frequency distributions of restorations by independent variables. Out of the survival tables, mean Annual Failure Rate (AFR) for 5 and 11 years was calculated according to the formula:  $(1-y)10 = (1-x)$ , in which 'y' expresses the mean AFR, and 'x' the total failure. The proportional-hazards test was assessed for each variable. To compare influence of different variables on the outcomes survival and success, a multivariate Cox-regression analysis with clustering data for patients with multiple restorations was conducted. Hazard ratios (HRs) with respective 95% confidence intervals (CIs) were determined. The dentist variable was included in adjustment of both models but the effect was not presented. A significance level of 5% was used for all analyses.

## 3. Results

From the patient files of 8 Dutch dentists, data on 3404 full crown restorations placed in 1557 patients [female (59.5%) and male (40.5%); Age range 16–85; mean age 48 years] were retrieved. The number of crowns performed per dentist varied from 171 to 783. The distribution of single unit crowns as well as patient and tooth related variables are shown in Table 1. Most of crowns were PFM (63.8%) placed in molars (58.1%) and non endodontically treated teeth (65.4%). The mean observation time of the crowns was 7 years. The mean annual failure rate calculated for the success of crowns was 2.0% at 5 years and 2.1% at 11 years and for the survival was 0.6% at 5 years and 0.7% at 11 years (Fig. 1).

In Fig. 2, the interventions performed by each dentist during the observation period are shown, divided in success and survival of crowns. Most interventions were due to endodontic complications (28.7%) and dislodgement and recementation (25.1%) considering the survival of treatment. For success of crowns, extraction was the predominant (71%) intervention. From the results it can be seen that a considerable variation among dentists existed for type of interventions and for annual failure rates varying from 1.2% to 3.5% (success in 5 yrs) (Fig. 4). Variation in type of interventions was also observed between endodontically and non-endodontically treated teeth. For non-endodontically treated teeth the most frequent intervention during the first two years of observation time was an endodontic treatment. Over the years, the number of extractions gradually increased. On the other hand, for endodontically treated teeth, recementation was the most common intervention in the first 4 years of follow-up. (Fig. 3)

Two multivariate cox-regression analyses were performed and results are shown in Table 2. For the success of single unit crowns, restorations placed in anterior teeth [HR 1.46 (1.05–2.03)] and molars [HR 1.24 (0.99–1.57)] showed a higher risk for failure compared to

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