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A practice-based research network on the survival of ceramic inlay/onlay restorations

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ABSTRACT

Objective. To evaluate prospectively the longevity of ceramic inlay/onlay restorations placed in a web-based practice-based research network and to investigate risk factors associated with restoration failures.

Materials and methods. Data were collected by a practice-based research network called Ceramic Success Analysis (CSA). 5791 inlay/onlay ceramic restorations were placed in 5523 patients by 167 dentists between 1994 and 2014 in their dental practices. For each restoration specific information related to the tooth, procedures and materials used were recorded. Annual failure rates (AFRs) were calculated and variables associated with failure were assessed by a multivariate Cox-regression analysis with shared frailty.

Results. The mean observation time was 3 years (maximum 15 years) of clinical service, and AFRs at 3 and 10 years follow up were calculated as 1.0% and 1.6%. Restorations with cervical outline in dentin showed a 78% higher risk for failure compared to restorations with margins in enamel. The presence of a liner or base of glass-ionomer cement resulted in a risk for failure twice as large as that of restorations without liner or base material. Restorations performed with simplified adhesive systems (2-step etch-and-rinse and 1-step self-etch) presented a risk of failure 142% higher than restorations performed with adhesives with bonding resin as a separate step (3-step etch-and-rinse and 2-step self-etch). 220 failures were recorded and the most predominant reason for failure was fracture of the restoration or tooth (44.5%).

Conclusions. Ceramic inlay/onlay restorations made from several glass ceramic materials and applied by a large number of dentists showed a good survival. Deep cervical cavity outline, presence of a glass ionomer lining cement, and use of simplified adhesive systems were risk factors for survival.

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1. Introduction

Restorative work is the core business of dentistry. It is estimated that every year 500 million dental direct restorations are placed worldwide [1], of which most are composite resin restorations [2]. Restorations are placed due to caries, fractures, or tooth wear, and a high number of restorative procedures is indicated to replace restorations that have failed [3,4]. As an alternative for direct restorations, indirect restorations may be placed using metal, composite, and/or ceramic restorative materials. Indirect inlay/onlay restorations provide more control over shape and function, particularly in larger defects in posterior teeth. Due to increased esthetic demands by patients, it is likely that most indirect restorations are currently made from ceramic materials.

Indirect ceramic restorations can be made either by a dental technician in the laboratory or by using CAD/CAM systems to make chairside restorations in a single session. Longevity reports vary between 0 and 7.5% annual failure rate (AFR) for ceramic inlays/onlays [5], while for chairside fabricated restorations (in this case the CEREC® system) this is between 0.8% and 4.8% AFR [6]. Indirect ceramic restorations have shown comparable or slightly better clinical performance than direct composite restorations, especially when taking into account the fact that indirect restorations are generally larger [5,7].

The procedure of placing indirect inlay/onlay restorations includes many steps and a wide variation of ceramic materials and luting cements can be used. Some factors related to the materials, such as ceramic properties or characteristics of the adhesive luting technique, have been investigated extensively *in vitro* [8–10]. Clinical studies with limited sample size also have shown the influence of factors related to patients and operators on the clinical outcome of ceramic inlays/onlays [11–14]. However, there is a lack of clinical studies analysing the combined role of different risk factors on restoration longevity and performance, where each factor might be compensating for another. For such study design, a large sample size is mandatory, which is usually hard to achieve in randomized controlled trials (RCTs).

While RCTs allow us to investigate differences between therapies or materials under ideal circumstances, the general dental practitioner is also interested in the outcome of a therapy under 'real world' conditions, i.e. where restoration, patient and practice level factors together influence the results. The sheer number of variables involved in a general practice setting requires a very large number of restorations in a dataset, in order to support a multivariate statistical approach [15–17]. The possibilities of digital data collection offer new opportunities in this respect. In Germany, the initiative was taken in 1994 to start with a longevity survey on indirect ceramic inlay/onlay restorations, mainly using the CEREC system. Since 2008 available as an online platform, dentists can join this group with a certain amount of restorations for which data are uploaded on a website. This resulted in a large data set with information on inlay/onlay restorations placed routinely by dental practitioners and followed up for several years.

The aim of this study was to evaluate prospectively the longevity of ceramic inlay/onlay restorations placed in a web-based practice-based research network and to investigate risk factors associated with restoration failures.

2. Materials and methods

2.1. Practice-based research network

Data for this study were collected by a practice-based research network called Ceramic Success Analysis (CSA). Starting in 1994, the Society for Dental Ceramics (SDC) in Germany invited dentists to make specific recordings on all single ceramic restorations (inlays, onlays, and crowns) that were placed in their dental practices, including CAD-CAM chairside fabricated restorations and restorations manufactured by dental laboratories. In general, dentists who were enrolled in specific continuing education or training courses, especially on CAD-CAM restorations, were invited to join the network and introduce data from their restorations into the database. For becoming a member of the CSA project, each dentist was required to accept security and data protection conditions and had to follow protocols to include cases into the system. Between 1994 and 2007, the dentists used a Microsoft Access programmed databank and sent the data regularly via disc to the SDC. From 2008 onward, data collection was carried out via an internet platform (www.csa-online.net) in several languages, allowing dentists from other countries also to join the network. In total, 167 dentists from six countries (161 from Germany, 2 from Chile, 1 from China, 1 from Spain, 1 from France, and 1 from USA), uploaded data until 2014 on almost 6000 inlay/onlay restorations. Information on operator experience was not collected on this study.

2.2. Data recording

Originally, each professional could initially take part of the study with 50 cases, with a limit of one restoration per patient. Recently, including more than one restoration per patient into the dataset has been made possible. For all restorations recorded data included information such as date of treatment, type of restoration, surfaces included in the preparation, and materials used. Follow up was documented during regular check-up visits in the practice or when a problem occurred. Therefore, this study was a non-interventional trial, which according to guidelines for good clinical practice (Clinical trials – Directive 2001/20/EC), was not subject to Medical Ethical Committee approval. Patient and operator characteristics were analyzed anonymously according to privacy legislation. Dentists placed the restorations using the protocol they considered appropriate for each case with informed consent of the patient. The choice for specific materials, brands, and techniques was at the discretion of the operators.

2.3. Data analysis

The variables that were recorded by the dentists are listed in Table 1 (variables related to teeth and restorative procedures) and Table 2 (variables related to materials used). Both