Influence of data acquisition method on the marginal adaptation and the 3D internal fit of CAD\CAM crowns

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Dedication

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Introduction

Throughout the years dentistry has gone through numerous developments in knowledge, techniques and technology. Among many of the more recent challenges is the approach to making high quality restorations in a short space of time. Dental CAD/CAM is the process by which the model of a prepared tooth is digitally scanned and these data are then used to generate a coping/restoration design (CAD) which in turn is used to generate a cutting path for manufacturing the coping/restoration (CAM).

THE CEREC system designed for the fabrication of indirect restorations. Since its development in 1984, the Cerec system has undergone several technical modifications. The first generation system, Cerec 1, was designed for chairside fabrication of intracoronal restorations such as inlays, onlays, and/or veneers, whereas the Cerec 2 was introduced in 1994 with redesigned software and hardware to fabricate complete crowns in addition to intracoronal restorations. The Cerec 3 system was introduced to the dental profession in 2003 and has several improvements over the Cerec 2 system.

These improvements include: an enhanced intraoral optical camera able to reproduce finer detail and depth of scale and improved software capable of recording the preparation much faster. Additionally, the Cerec 3 system allows more flexible and more true-to-detail grinding than the Cerec 2, which in turn should lead to a better fitting crown with improved occlusal morphology and design.

"Digital impression" for CAD-CAM dental restorations is the process where hardware modules connected in system record topographic structures, teeth and surrounding soft and hard tissue. There are three possible ways for this: recording intraoral tooth preparation, recording extraoral plaster models or recording the conventional impression.

Improper handling with the scanning device is one of the harmful errors in procedure of intraoral "digital impression". Improper handling of the scanner by the therapist includes the scanner instability in the mouth of the patient and improper positioning and angle of the scanner to the scanned object.

The marginal integrity of CAD/CAM restorations has been evaluated in numerous investigations criteria by means of visual inspection and tactile perception with a sharp explorer. In these studies, the majority of the CAD/CAM restorations were found to have acceptable marginal integrity according to USPHS (United States Public Health Service) criteria.

Different finish line preparation designs, rounded versus sharp internal line angles, Class I versus Class II inlays, and differences in the degree of axial wall convergence, and luting space may have an effect on marginal adaptation of Cerec indirect restorations. Results from studies imply that even though the finish line preparation design does not appear to have an effect on the marginal fit of ceramo-metal restorations; it may be an influencing factor on the marginal adaptation of Cerec-fabricated crowns.

Statement of the problem

CAD/CAM systems have not completely replaced traditional impression taking. Optical impression is technique sensitive. One of the sources of inaccuracy in utilising the CEREC Chairside CAD/CAM system has been the difficulty of accurately positioning the intraoral camera relative to the path of insertion of the preparation and restoration. Undercuts would preclude the digital acquisition, and there are instances where it is difficult for scanners to read the image (e.g., preparations with long subgingival margins or bevels). The instability of the scanner in the mouth of the patient, incorrect position and angle of the scanner to the object (due to limited mouth opening), contrast spray applied in uneven layer, leads to errors during optical impression taking.

Review of literature

I - Historical perspective

Early development of ceramic materials took place in China and Europe during the period of industrial revolution. Ceramics were the first materials to be made artificially by humans and porcelain was among the first materials to be used for early laboratory research. The plastic properties of mud and clay were discovered by chance. Historically, three basic types of ceramic materials were developed. Stoneware first appeared in China, earthenware and thirdly porcelain which was produced by fluxing “Chine stone” with white China clay to produce white translucent stoneware. Many attempts to discover the secret of Chinese porcelain gave rise to the development of a scientific approach to the synthesis of materials. The majority of the early Chinese porcelain was called hard paste porcelain which was composed of:
50% Kaolinite (Al2 O3 SiO2 2H2O),
25% Feldspar (K2O AL2O3 6SiO2),
25% Quartz SiO22. [1]

The first porcelain used in dentistry in the eighteenth century was originally based upon the triaxial porcelain composition which falls into the mullite zone of the K2O AL2O3 SiO2 phase diagram. [1]

In 1723, Fauchard first used porcelain to enamel the metal bases of dentures. He was also credited with recognizing the potential of porcelain

enamels and initiating experiments that would lead to further advances in the use of porcelain in dentistry. De Chament, a frensh dentist, introduced the first porcelain denture tooth in 1789. In 1808, Fonzi, an Italian dentist, formed individual porcelain teeth that contained embedded platinum pins. Fonzi called these teeth “terrametallic incorruptibles” and their esthetic and mechanical versatility provided a major advance in prosthetic dentistry. Ash developed an improved version of the platinum tooth in 1837. In 1885, Logan introduced the Richmond Crown, in which porcelain was fused to a platinum post. In 1903, Dr. Charles Land introduced the first ceramic crown. Early dental porcelains were relatively white and opaque, but 64 years after the introduction of porcelain to dentistry, Elias Wildman was able to formulate much more translucent porcelain with shades much closer to natural teeth. In 1958, the first dental porcelain for veneering was introduced, which led to the widespread use of metal-ceramic restorations in the 1960s and beyond, followed by the invention of the porcelain jacket crown that was popularized in the 1960s by McLean. In 1963, Vita Zahnfabrik introduced the first commercial porcelain. The 1970s saw the advent of early experiments in CAD/CAM crown fabrication, followed by an influx of ceramic-based restorative systems from the 1980s through to the present day.[2] The history of porcelain as a dental material thus only goes back just over 200 years. [1]

Dental ceramics are essentially oxide-based glass-ceramic systems. They possess three essential features which are ease of fabrication of complex shapes, sufficient mechanical and corrosion resistance, and aesthetic appeal. Tremendous advances have been made in the mechanical properties and fabrication methods of these materials over the last few decades. The earliest