LITERATURE REVIEW

FELDSPATHIC CERAMICS IN POSTERIOR TEETH BY CAD/CAM TECHNIQUE: A LITERATURE REVIEW

CERÂMICAS FELDSPÁTICAS EM DENTES POSTERIORES PELA TÉCNICA CAD/CAM: UMA REVISÃO DE LITERATURA

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ABSTRACT

The present study aims to evaluate the indication of the use of feldspathic ceramics in posterior teeth, by the CAD/CAM technique (Computer-aided design [CAD] and computer-aided manufacturing [CAM]), in a high demand treatment unit, through a literature review. An advanced search was carried out in the PubMed database, covering the last 15 years and using the following MeSH search terms: “dental crowns”, “CAD/CAM system”, “porcelain” and “review”. Thirty out of the 47 articles initially surveyed were selected to compose the final sample. From the present study, it was possible to conclude that the use of feldspathic ceramics developed by the CAD/CAM technique is safe in posterior teeth, whether the technique is respected. This technique is an excellent option for dental treatment in institutions of high restorative demand that have high levels of demand and readiness, promoting celerity, avoiding the use of temporary restorations, also reducing the number of urgencies in prosthesis.

Keywords: porcelain, dental crowns, computer-aided design, longevity.

RESUMO

O objetivo do presente estudo foi avaliar a indicação do uso das cerâmicas feldspáticas em dentes posteriores, pela técnica CAD/CAM (*Computer-aided design* [CAD] e *computer-aided manufacturing* [CAM]) *chairside*, em uma unidade de alta demanda, por meio de uma revisão de literatura. Uma pesquisa avançada foi realizada a partir da base de dados do PubMed, compreendendo os últimos 15 anos e utilizando os seguintes termos MeSH para pesquisa: “dental crowns”, “CAD/CAM system”, “porcelain” e “review”. Dos 47 artigos levantados inicialmente, 30 foram selecionados para compor a amostra final. A partir do presente estudo foi possível concluir que o uso das cerâmicas feldspáticas desenvolvidas pela técnica CAD/CAM é seguro em dentes posteriores, desde que respeitada a técnica. Esta técnica constitui-se em excelente opção para tratamento odontológico em instituições de alta demanda restauradora que possuem altos níveis de exigência e prontidão, promovendo celeridade, evitando o uso de restaurações provisórias, reduzindo também a quantidade de urgências em prótese.

Palavras-chave: porcelana, coroas dentais, desenho assistido por computador, longevidade.

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INTRODUCTION

Ceramic restorations obtained by CAD/CAM technology (Computer-aided design [CAD] and computer-aided manufacturing [CAM]) can also called chairside, when made in the dental office by the dentist, in a single appointment. This technique, developed in the 1980s, has become popular over the years and has brought restorative dentistry into a digital age (1,2,3).

The improvement of the software and hardware of the CAD/CAM equipment was accompanied by an improvement in the mechanical and optical properties of the materials available for milling. Ceramics that require additional sintering processes or glass infiltration in the laboratory do not qualify as chairside. On the other hand, feldspathic ceramic restorations that, with manual finishing and polishing, reach a satisfactory clinical level, can be fabricated in a single appointment. This category of materials combines the advantages of all-ceramic restoration, such as esthetics, biocompatibility, and durability, with the advantages of being manufactured in chairside mode, by the CAD/CAM system (short term, cost efficiency and quality control) (4, 5.6).

Although glass ceramics present better mechanical properties in vitro compared to feldspathic ceramics (7), Petridis et al.,did not report in their systematic review a statistically significant differences between the complication rates of feldspathic and glassy restorations (8). Furthermore, Wittneleen et al. in 2009 published a systematic review in which it was found that milled glass ceramics had a higher failure rate compared to feldspathic ceramics (9).

The literature has recommended the use of feldspathic ceramic in anterior single crowns, questioning its use in posterior ones (7,10,11). However, there is a lack of longitudinal studies on the longevity of posterior single-unit restorations when milling prefabricated feldspathic ceramic blocks. Lu et al., in a study published in 2018, found a success rate of more than 90% of milled feldspathic restorations after 3 years (1). Cerec Blocks®, Cerec Blocks PC® and Mark II® feldspathic blocks have flexural strength greater than 100 Mpa in vitro, satisfying the requirements of the ISO 6872/2008 standard for clinical use in posterior teeth. Added to this is the fact that the strength of such crowns increases after adhesive cementation (4, 12).

Dentistry in the Brazilian Navy deals with a complex and demanding system that requires a great number of care appointments with high levels of readiness, mainly regarding the dental treatment of their militaries. With the advent of CAD/CAM technology, new treatment options could be offered to a greater number of patients, quickly and resolutely, avoiding the use of temporary restorations, whose loosening can be problematic for the crew on board (13).

Restorations obtained by the CAD/CAM technique, in chairside mode, using feldspathic blocks can represent a revolution in the oral health care model, in terms of the prosthesis area, given the speed of the restoration process, without losing aesthetics and with cost reduction. Thus, a greater number of military personnel and their relatives can be assisted, increasing resolution and reducing scheduling.

In this sense, the purpose of this study is to evaluate the indication of the use of feldspathic ceramics in posterior teeth, by the CAD/CAM technique, in an institution of high restorative demand, through a literature review.

LITERATURE REVIEW

An advanced search was carried out using the PubMed database, looking for studies that could justify the indication of feldspathic restorations in posterior teeth, using the CAD/CAM technique. The research period comprised the last fifteen years and the MeSH terms used in the search using the boolean operator ”AND” were: “dental crowns”, “CAD/CAM”, “dental porcelain” and “review”.

An initial survey was carried out with 47 articles, which were reduced to 30 after an analysis of titles and abstracts. According to the exclusion criteria adopted, only articles published after January 2006 were considered. The full text of all articles of possible relevance was obtained for full reading.

Moreover, studies that focused on oral rehabilitation through dental implants were discarded. A potential article was discarded due to the risk of misinterpretation, as it was produced in Russian and only the abstract was translated into English.

The development of digital devices in the 1980s led researchers to study possible applications in dentistry. The objective was to provide clinicians, within the scope of private practices, with the possibility of scanning the tooth to be rehabilitated, creating a virtual model and milling the restoration from prefabricated ceramic blocks. The result of the process would be an indirect restoration that could be cemented in the same appointment, in a practical and fast way. As a result, the Cerec System® was developed in 1985 in Switzerland and was introduced to the market more widely in 1988 (2,5,14).

Currently, indirect all-ceramic restorations have been the main replacement for ceramic-coated metallic restorations in daily clinical practice (10). A wide range of materials has been used in the production of esthetic crowns, among them, feldspathic ceramic, the first to be used in dentistry, is also presented in powder and liquid form or in prefabricated blocks for milling. Other materials such as glass ceramics, based on leucite and lithium disilicate, are excellent options for indirect

restorations, given their high mechanical strength compared to feldspathic (5,15,16,17,18). Despite this, the difference among the clinical performance of these ceramics requires elucidation, since the adhesive bond to the tooth promotes an increase in the strength of restorations (12,19).

The choice of ceramic for each type of indirect restoration

Lambert et al. published a review in 2017 to guide the clinician in choosing the most appropriate ceramic for each type of CAD/CAM indirect restoration. According to the authors, no material has ideal clinical properties to be indicated as universal, with feldspathic blocks being more suitable for anterior teeth and those based on zirconia for infrastructure of posterior teeth (15). Besides, a meta-analysis published in 2018, based on eleven randomized trials and three prospective studies, pointed to a higher failure rate between single crowns and partial restorations tooth-supported made using CAD/CAM technology compared to those performed using the traditional technique. conventional (72 failures in 1209 restorations). The type of material and the technique used were the most frequent reasons for the failures that occurred. The study suggests that new research should evaluate the different generations and limitations of the existing CAD/CAM software, to better justify the presented failure rate (20).

Saglam et al. in an *in vitro* study published in 2021, after analyzing 20 endocrowns cemented in extracted teeth, concluded that polymer-infiltrated ceramic crowns presented higher fracture resistance compared to feldspathic crowns performed by the CAD/CAM technique (21). Aziz et al. argues that operator experience has no significant effect on the clinical performance of CAD-CAM lithium disilicate crowns evaluated over a 6-year study, opposing arguments on technical difficulty (16).

In contrast, a prospective clinical study that evaluated after 17 years 187 feldspathic ceramic restorations performed using CAD/CAM technology had a success rate of 88.7%, which is close to the success rate of gold restorations, reaffirming the indication of the use of such ceramics in daily clinical practice in posterior teeth. It is also important to note that three of the patients who presented multiple fractures were diagnosed with bruxism, which suggests that this specific group should be considered at high risk for this type of restoration (22).

Stona et al., 2015, after an in vitro study of ceramic restorations on implants, developed by Cerec®, found that feldspathics showed lower resistance to fatigue cycles performed in the laboratory compared to leucites and lithium disilicate. However, the three ceramics showed sufficient strength to withstand mastication forces after adhesive cementation (23).

Wittneben et al. (9) found in a systematic review on different types of ceramics milled using the CAD/CAM technique, that aluminum oxide-based ceramic restorations associated with magnesium oxide and resin-based composites presented a failure rate close to that of feldspathic ceramics. On the other hand, ceramized glass restorations had a greater number of failures. Despite this, the study showed success rates greater than 91.6% for CAD/CAM restorations after 5 years. Another systematic review published in 2012 indicated that feldspathic ceramic and glass-ceramized crowns had a clinical survival of more than 5 years with very low failure rates (8). In addition, after a systematic review of 55 articles on metal-free ceramics published in 2015, Sailer et al. reported a 90.7 to 96.6% survival rate of crowns 5 years after cementation (10). Following the same line of research, in a clinical study, in which 159 milled ceramic restorations (inlays and onlays) were evaluated, a success rate of 95.5% was found after 5 years, with no significant difference between CEREC Blocks® and IPS Empress CAD® (24).

Success of ceramic restorations

In 2016, Collares et al. created an online database in which 167 dentists between 1994 and 2014 could register the ceramic restorations produced in their daily clinical practice. 5,791 indirect restorations were cemented in 5,523 patients and followed up over the years, with the techniques used and possible failures always recorded online in Ceramic Success Analysis (CSA). Despite recognized biases, such as, lack of standardization of the material, the techniques used and the professionals invited, the study observed a high success rate of ceramic restorations with a failure rate of less than 1% per year in 15 years of follow-up. Risk factors for durability of all ceramic types were cervical depth of cavity preparation, presence of glass ionomer in the cement line and use of simplified adhesive systems. The authors also highlighted the difficulty in reaching expressive samples for the development of standardized clinical studies (25).

Klink et al. 2013 in their study, associated that the success of CAD/CAM restorations is associated more with patient factors and restoration type than with the adhesive protocol (18). Morimoto et al. published a systematic review on the survival rate of ceramic and resin inlays, onlays and overlays, finding a success rate of feldspathic restorations between 92 to 95% after 5 years and 91% in 10 years. The main causes of failure were the appearance of fracture or chip (26).

Currently on the market, the clinician has a wide range of options for prefabricated ceramic blocks for milling. Among them, Cerec Blocks® are manufactured from fine powder grains that produce a feldspathic ceramic almost free of porosities,

implying greater resistance and a better degree of polishing of the restorations (16). In addition, they are etchable using hydrofluoric acid, in order to create micromechanical retentions for adhesive cementation systems. The flexural strength of feldspathic blocks is approximately 112 or 120 MPa when polished or glazed, respectively (23). Added to this is the fact that milled ceramic blocks have greater resistance to fracture when compared to the traditional method (powder and liquid), as they have lower porosity and high concentration of crystals (16,27).

DISCUSSION

New technologies and materials are routinely introduced into dental practice. Ideally, clinicians should have evidence-based dentistry as a guide to a successful treatment plan (9). The present study aimed to carry out a literature review on the indication of the use of feldspathic ceramics in posterior teeth by the CAD/CAM technique and its applicability in an institution with high restorative demand. Nevertheless, obtaining a clear view of the mechanical properties of ceramics used by the CAD/CAM technique is difficult, due to the difficulty of standardizing research, testing methods and how the results are expressed (4,28,29). Studies on the clinical behavior of feldspathic and vitreous ceramics are lacking and it is necessary to conduct an extensive and detailed systematic review of these different types of ceramics, pointing out their failures and time of occurrence, which could generate integrated scientific evidence (19).

According to Nejatidanesh *et al*., the main cause of fractures of metal-free ceramic restorations followed in their study was the absence of the minimum thickness of material recommended by the manufacturer (24), which leads us to believe that the sensitivity of the technique may affect more the success rate of the works than the ceramic material itself, in contrast to the findings by Aziz et al. (16).

It is well known that is possible to compensate for technical sensitivity through immersive operator training by developing competence for the new procedure. The introduction of this technology in dentistry of the Brazilian Navy, compulsorily encouraged the development of training for dentists, who underwent a learning curve in the early years. As reported by Walker *et al*, most university graduates until 2009 did not receive any training on working with CAD/CAM (30).

It is noteworthy that despite having inferior in vitro mechanical properties compared to other ceramics, feldspathic blocks present a satisfactory clinical index of durability, presenting sufficient strength to withstand normal masticatory loads (8,10,14,22,23,25,26). Given the practicality of milling, which does not require the use of ovens for sintering or glazing, in addition to presenting sufficient aesthetics and strength, feldspathic ceramic blocks can be a good material option for public sector dental clinics that require productivity and speed to meet the high demand of patients.

One of the limitations of the present study was the lack of available studies on the specific topic under analysis. Another difficulty observed was finding articles that used the same standardized research methods. Variations in the choice of ceramic materials, types of restoration (inlay/onlay/crown/tabletops), reassessment time, positioning of the tooth in the arch, substrate evaluated, finishing and cementation form make it difficult to make a clear and fair comparison of the results obtained. More long-term prospective clinical studies with a significant sample of feldspathic ceramic restorations performed by the CAD/CAM technique on posterior teeth need to be developed.

CONCLUSION

The use of feldspathic ceramics developed by the CAD/CAM technique is safe in posterior teeth, as long as the technique is respected. It is an excellent option for dental treatment in institutions of high restorative demand that have high levels of demand and readiness, promoting celerity, avoiding the use of temporary restorations, also reducing the number of emergencies in prosthesis.

The authors declare no conflicts of interest.

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