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CASE REPORT

MANUAL COPY- MILLING, AN ALTERNATIVE TO CAD/CAM METHOD FOR ZIRCONIA RESTORATIONS

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ABSTRACT

Zirconia ceramic is used as a metal substitute and is behind development of digital dentistry, which is based on computer-aided design and computer-aided manufacturing and helps decreasing laboratory work, reducing time and chance of error but it is a sensitive technique which also needs expensive unit. On the other hand, copy milling technique is based on a manually designed copings or frameworks with wax or composite that will be duplicate based on pantographic principle. It is an easy and economical method to produce zirconia frameworks for dental restorations. The purpose of this article is to present the principle, the advantages and the implementation of this technique, through a clinical case.

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INTRODUCTION

The need for stronger material for metal-free restoration has made zirconia ceramics a promising material for anterior and posterior restoration. Zirconia ceramics combine many favorable properties such as low thermal conductivity, high chemical and thermal stability and high refractive index (Leib *et al*., 2015). Zirconia is provided to dental laboratories in various sized blocks and can be milled into single unit coping or multiple-unit fixed bridge frameworks (Helvey, 2008). It is widely used as a biomaterial by CAD/CAM technology. Alongside the automated industrial fabrication of zircon elements, a 'manual' method has appeared in 2003, the Zirkonzahn procedure by the Italian ceramicist Enrico Steger (Fouquier, 2010).

Principle: Manual copy milling is based on pantographic principle that is used to duplicate keys, to copy or enlarge paintings and for engraving.

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It is a precise technique with a well-known working process: after making a model which is tried in the mouth, an oversized duplicate is made in a block of raw zircon, using burs and sculpturing technique with a pantograph named Zirkograph (Fig.1), then it undergoes an adapted heat treatment or sintering returning it to the exact dimension (Fig.2), all the while endowing it with exceptional physicochemical properties (Fouquier, 2010; Reichert, 2007).

Advantages

The manual copy-milling method offers dental technician the mastery over all phases of the fabrication of zirconia prosthesis (Fouquier, 2010).The user of this technique also benefits from a similar flexibility than in the casting technique, e.g. expansion controls as well as delicate framework design up to fully anatomical crowns. He also can correct any discrepancies found in the tooth preparation by compensating during the wax of the pattern (Reichert *et al*., 2007). Despite the low cost of the milling machines, the results are comparable to those of standard industrial fabrication, which has been, until now, unavoidable and expensive (Fouquier, 2010).

Zirconia blocks: The zirconia block has a density barcode label, so the copy milling machine can be adjusted properly to allow for shrinkage during the sintering phase (Fig. 3).

The simplicity of use of copy milling system makes it a common system for laboratory applications (Karl *et al*., 2012). When using a manual-aided design/manual-aided manufacturing method, a pre-sintered block of zirconiais milled at a larger dimension to compensate for 20% to 25% shrinkage during the sintering stage. The sintering allows achieving maximum strength (Kohorst *et al*., 2007).Those blocks are easier and faster to mill and produce less amount of wear on the milling machine (Raidgrodski, 2004).

Case report: A 35-year-old female patient came to our department in order to restore his first right maxillary molar which presented abnormal dental structure and pulpitis (Fig.4). The patient presented a good general condition and was highly motivated. After consent from the patient, rehabilitation of the molar was planned using manual copy-milled zirconia single crown, manufactured with Zirkonzahn® manual milling-machine, following manufacturer's instructions. After the endodontic treatment of the tooth, a prefabricated quartz fiber post was directly bonded in the palatal canal and a composite core build-up was performed as a foundation for the final restoration (Fig. 5 and 6). A two step putty wash polyvinylsiloxane impression of the prepared teeth was made and poured in type IV gypsum. A coping was manually fabricated in light cured composite. The composite was applied by successive additions, fixed by repeated curing with the fast curing mode (5 secondes) of LED curing light (Fig. 7, 8, 9).

A polishing was carried out because the irregularities of material causes roughness of palpation and thus irregularities of milling. Fit of marginal adaptation of the coping was checked on the die and on the tooth (Fig. 10,11 and 12). After the clinical trial, the pattern was placed into the pantographic machine (of the firm Zirkonzahn®), to reproduce it in a TZP zirconia block. The copying arm of the machine traced the composite pattern while the cutting arm, which has a carbide cutter, milled a selected pre-sintered block of zirconia. The final shape is 1,24 times oversized. It is a dimensional adjustment to compensate the shrinkage that occurs during post-machining heat treatment. The zirconia coping obtained was dissociated from the blank with a straight fissure bur and placed in an oven for a cycle of 15h or more at 1500°C during the sintering phase. A clinical fitting was conducted again with the final coping (Fig. 13) which was veneered with porcelain to recreate the natural appearance of the tooth (Fig. 14 and 15).

DISCUSSION

Patient requests for more aesthetic and biologically ‘safe’ materials have led to an increased demand for metal-free restorations. Industrial dense polycrystalline ceramics such as alumina, zirconia and alumina-zirconia composites are currently available with the application of CAD⁄ CAM technology using a networked machining center. In particular, yttrium partially stabilized tetragonal zirconia polycrystalline (YTZP) has a very high fracture toughness from 5 to 10 MPa m1⁄2. Zirconia-based fixed dental prostheses perform reasonably well and can serve as an alternative to metal-ceramic dental.

Fig.1. The Zirkograph of Enrico Steger [3]

Fig. 2. Coping before and after sintering

Fig. 3. Presintered block of zirconia

Fig. 4. A Preoperative occlusal view of the damaged first right maxillary molar

Fig. 5: Post space was prepared in the conventionalmanner after endodontic treatment

Fig. 6. Control of the prosthetic space created by the wax up silicone key

Fig.7. Modelling of the coping with a lightcured composite

Fig. 8. Composite coping on the die

Fig.9. Light curing of the composite coping.

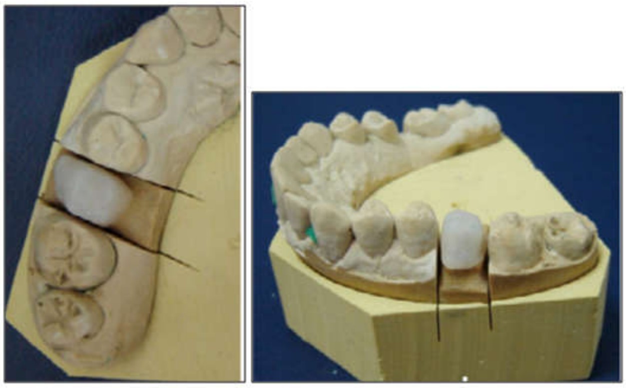

Fig. 10 and 11. Composite coping delivered on the cast.

Fig. 12: The check of marginal adaptation on the tooth and if necessary addition of resin.

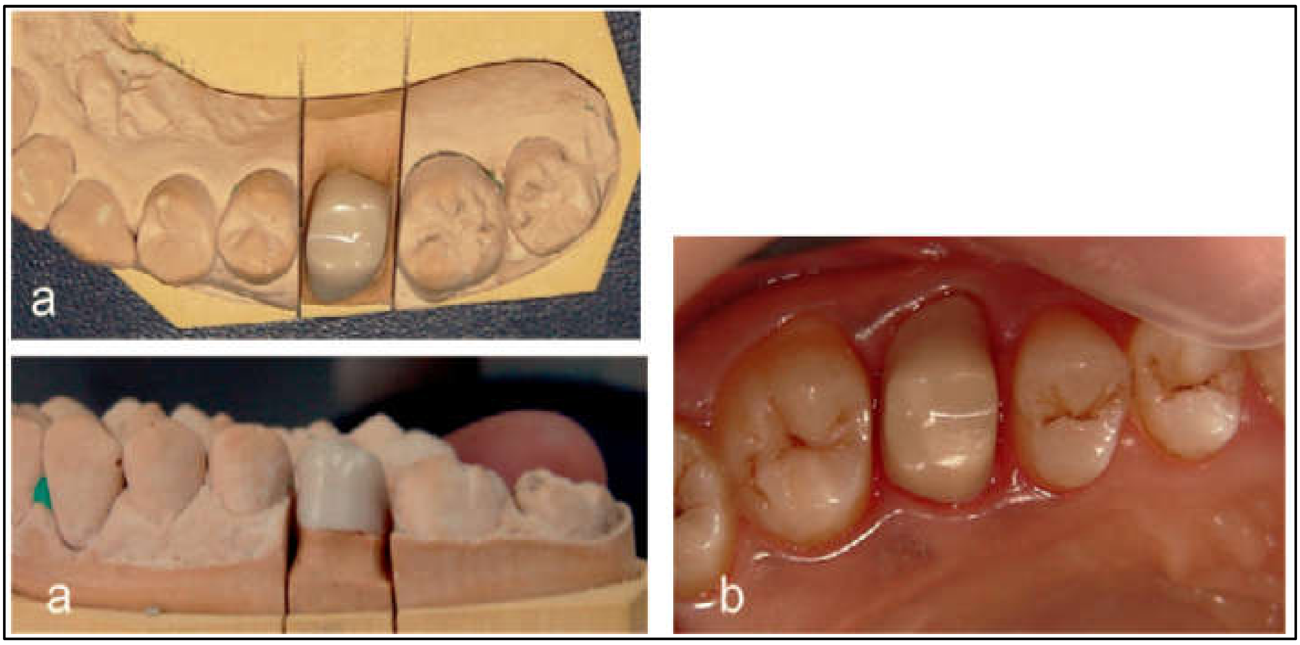

Fig. 13. The adaptation and fit of the zirconia coping were verified on the master cast and on the tooth

Fig. 14. Ceramic crown made with zirconia coping andlayered with porcelain.

Fig. 15. Clinical view of the crown after cementation

High-strength zirconia frameworks can be viable for the fabrication of full and partial coverage crowns, fixed partial dentures, veneers, posts and/or cores, implant abutments, using computer-aided design/computer-aided manufacturing (CAD/CAM) technology. The advantages of this technology are decreasing laboratory work, automation by machine, and production of similar multiple restorations while the disadvantages include technique sensitivity and expensive unit. To overcome disadvantages, copy milling was introduced due to its economic set-up (Karl *et al*., 2012; Davidowitz, 2011). Indeed, for patients with limited financial means who want metal-free restorations, laboratory costs will be less as compared with the cost of using a CAD/CAM system. *Partiyan et al.* compared the fracture resistance of three-unit zirconia fixed partial denture with modified framework fabricated using the two techniques: CAD/CAM technology and manual copy milling. The result of the study indicated that the type of milling technique has no additional impact on the fracture resistance of the restorations (Partiyan *et al*., 2017). *Suarez et al.* in 2015 compared marginal fit of zirconia copings following two different systems: CAD/CAM Cerec In Lab (Sirona®) and CAD/CAM Zirkonzahn system (Zirkonzahn®) as well as a Zirkograph 025 ECO (Zirkonzahn®) pantograph system. Marginal discrepancy values of the Zirkograph 025 ECO system (Zirkonzahn®) were above those obtained with the CAD/CAM Zirkonzahn system, but below to those achieved with the CAD/CAM CerecInLab (Sirona®) system. Statistically significant differences between both assessed CAD/CAM groups could be due to factors related to the digitization of each system. Both systems are subject to limitations related to the scanning finite resolution. Statistically significant differences were established between Zirkograph 025 ECO (Zirkonzahn®) pantographic system and the metallic copings control group. Mean marginal discrepancy was found to be below 120 µm, and therefore, was clinically accepted. The greater marginal discrepancy of pantographic systems is due to the greater influence exerted by applied manual procedures (Suárez *et al*., 2015). *Park et al* established statistically significant differences between CAD/CAM and pantographic systems, and determined that the pantographic system exhibited better coping marginal precision. The conclusion of his study was that the copy milling system may produce more accurate zirconia restorations than the CAD/CAM system. So, the technician's skill of a copy milling system may not be a determining factor influencing the accuracy of a single zirconia core (Park *et al*., 2012).

Conclusion

Although computer aided manufacturing techniques promises excellent results, copy-milling of zirconia ceramic and especially manual copy-milling is a low cost alternative to CAD/CAM fabrication methods. One of the advantages of the manual copy-milling systems is that individualized components and restorations, such as endodontic posts and cores, can be fabricated. In the other hand, copy-milled zirconia copings proved to be as successful as CAD milled zirconia copings in several in vitro studies. Thus, the clinician should be aware and can make the choice of the restoration fabrication technique based on available materials and patient's demands.

Conflicts of Interest: The authors declare that there are no conflicts of interest regarding the publication of this paper.

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