Original Article

OPTIMIZATION OF PROSTHETIC TREATMENT OF PATIENTS WITH DENTAL TISSUE USING METAL-FREE RESTORATIONS

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ABSTRACT

Both ceramics and metal are widely used as a material of choice for dental tissue restoration. However, metal-free ones provide higher aesthetic and adaptive performance. In addition, it was studied out that last years have comprehended a dramatic upsurge in the patients' non-metallic materials demand, occasionally induced by metal-phobia or alleged allergies. The research aims to improve the effectiveness of treatment of patients with defects using ceramic restorations in hard dental tissues. We have treated 60 patients using metal-free restorations made by pressing and milling (2 groups both with 30 patients). For results analysis we used several criteria (accuracy of fit of the restoration, color matching, probability of a cement connection loss, the presence of chips of the restoration in the oral cavity) and counted statistics probability of groups comparisons. We discovered several advantages of milled restorations in adhesion to dental tissues and color matching. Hence, it is highly recommended to use metal-free constructions for the prosthetic restoration of hard tooth tissues.

Key words: Metal-free restorations, Pressing, Milling, Dentition aesthetics.

Introduction

Metal ceramic crowns have a 94% success rate over Ten years. Still, metal-framed ceramics do not provide optimal aesthetics and accuracy [1, 2] compared to all-ceramic restorations [3], biocompatibility, and soft tissue interaction, which has led to the clinical preference for all-ceramic restorations, especially in the anterior tooth group [4-9]. The long-term success of ceramic restorations is highly dependent on marginal and intrinsic precision [10]. An increase in the marginal gap accelerates the process of cement dissolution and micro-cooling, which can lead to the development of hypersensitivity, secondary caries and pulpitis, and the appearance of pigmentation along the transition line. In addition, there is a possibility of periodontal tissue inflammation due to the growth of the subgingival microbial biofilm and changes in its qualitative composition [11].

Pressed ceramics is one of the most popular restoration systems. It is easy to manufacture and has excellent marginal accuracy, transparency, good mechanical properties, low shrinkage, lower porosity, and less brittleness than conventional feldspar ceramics [12]. The first generation of heat-pressed ceramics includes IPS Empress, replaced by IPS e.max Press (lithium disilicate glass-ceramic tablet for the pressing technique), which does not have the disadvantages of its predecessor [13].

The outstanding quality of soft tissue reaction is the most vital point of LS2. In vitro, this material unveils high levels of biocompatibility, not only due to low plaque retention but also to the adhesion and propagation of human epithelial cells [14] and human gingival fibroblasts [15], particularly when its surface is polished [1]. Even when the endodontic prognosis is unfortunate, the all-ceramic restorations have a good adaptation [16]. A successful therapeutic solution for endodontically treated posterior teeth approved another 3-year randomized trial that LS2 partial crowns can be used as premolar or molars, and with or without the use of fiber posts [17].

Lithium disilicate blocks are available for clinical CAD / CAM systems, allowing one-visit manufacturing of restorations using intraoral optical imaging and in-office milling. Theoretically, there is no dimensional deformation of the denture base, which is why milling is considered the most reproducible technique [18]. After the grinding, the pre-crystallized crowns must be subjected to a high-temperature crystallization process to achieve their final strength [19]. The CAD crowns have been shown to exhibit high fracture resistance, suitable for posterior, monolithic restorations [20], and more resistant to fatigue in cyclic loading than veneered zirconia, which is more prone to chipping [20, 21].

The study aims to improve the efficiency of orthopedic treatment of patients with hard defects using metal-free restorations and developing an algorithm for choosing a particular technology depending on the clinical situation and determining its effect on the size of the marginal gap of the restoration.

Materials and Methods

We have examined and treated 60 patients at the Department of Prosthetic Dentistry of Sechenov University and the private clinic "Nanostom" from 2018 to 2021. There have

been 40 women and 20 men aged 25-45 years among the patients, and the average age was 34.5 ± 5.6 years. The leading diagnosis was K02.1, "Caries extending into dentin." We identified unsuccessful fillings in the teeth area, requiring replacement for restoration — an onlay, a crown, and an endocrown.

The study randomly assigned the patients to conduct two groups of 30 people.

Group 1 consisted of patients (10 men and 20 women) who underwent tooth restoration involving metal-free restorations made with the pressing method.

Group 2 included patients (10 men and 20 women) who underwent tooth restoration with metal-free restorations manufactured using the milling method.

In our study, we used several research methods:
Measurement of the thickness of fit checkers to determine the accuracy of the restoration's fit;

1. Replica (copy) technique;
2. X-ray research methods (direct bite images);
3. Analysis of dental photographs.

When analyzing the results of the restorations, we relied on the following criteria, some of which were coded using a point scoring system for ease of calculation:

1. Accuracy of fit of the restoration (in microns, with the satisfactory result being a gap of fewer than 80 microns), we measured the absolute values using a micrometer;
2. Color matching (Vita scale; Points: 0 — conformity, 1 — incomplete conformity, 2 — inconsistency);
3. Probability of a cement connection loss (Points: 0 — no, 1 — yes);
4. The presence of chips (Points: 0 — no chips, 1 — small chips of the restoration in the oral cavity).

Results and Discussion

Based on our study results and evaluation criteria analysis, a statistically significant difference in the ratio of the adherence of the restoration to the tooth tissues. The advantage by about 10 microns was on the side of milled onlays, crowns, or endocrowns compared to the pressed ones.

The color matching of the restoration was significantly more accurate in milled metal-free restorations than in the pressed ones ($p < 0.05$).

The probability of a cement connection loss in pressed metal-free restorations was higher than in the milled ones. However, the difference was not statistically significant ($p > 0.05$), which was confirmed by the analysis of 4-field tables and the chi-square value.

We determined the presence of chips both at the stage of making metal-free restorations and in the oral cavity during fixation and chewing. We considered the latter the most significant for clinical practice and assessing the results. Thus, at the manufacturing stage, the strength was predominantly higher in pressed metal-free restorations; however, during fixation and chewing processes, a smaller number of chips, as well as their complete absence, was determined in milled metal-free restorations ($p < 0.05$). However, this was not confirmed by statistical analysis.

Minimally invasive preparation for the dental structure's maximum conservation is considered the golden standard of teeth restoration, as restoration's fracture risk correlates with the extent of invasion while preparing a tooth [22]. The endocrowns with the design concept orientated towards the restoration of the damaged issues are getting more popular advantages of their preservation of most of the hard dental tissues, a decrease of the need in supporting retention geometry, and both time and money-saving due to the smaller number of procedures. Furthermore, the dental CAD/CAM-systems elaboration provides new means of a construction in-office and an automatic production of all the ceramic restorations, especially the ceramic endocrowns that combine both the crown and the core.

According to the systematic review R. A. Al-Dabbagh and co-authors [23], in seven studies, the endocrowns and the traditional crowns were compared in terms of fracture resistance and frequency of catastrophic inconsistency: the first research was dedicated to incisors, the fourth one to premolars and the second one to molars. In addition, the first marginal study of the adaptation of the endocrowns to the premolars' tissues was assessed [24]. As reported by the results of the analysis of the incisors, fracture strength for the polymeric ceramics endocrowns and the traditional doesn't differ significantly (869 ± 247,8 H and 580,0 ± 295,4 H). However, the frequency of catastrophic inconsistency of the endocrowns was 100% in comparison to the traditional crowns, for which it was 0% [25]. A similar situation occurred while comparing the ceramic endocrowns from lithium disilicate and the traditional crowns, for which fracture resistance didn't differ statistically (915,9 ± 182,1 H and 646,8 H respectively) and the frequency of catastrophic inconsistency was 85% and 0%.

Our agreement research results show that the frequency of catastrophic inconsistency has not gone beyond 10% for all types of restorations, regardless of the method they were made.

Nonetheless, no significant differences were found between the two fabrication methods regarding the marginal discrepancy or mechanical performance (MD) [26-28]. The CAD-CAM and hot-press techniques for producing monolithic lithium disilicate crowns produced MD values of less than 120 μm, within the clinically acceptable range [26].

In addition, the long-term outcome of the all-ceramic restorations was unfortunate due to the high clinical fail rate,

as is observed by Merlind Becker [29]. In contrast, in another research [30], the chairside lithium disilicate glass-ceramic exhibited a high survival rate [31] after four years in function and were shown to be a viable and reliable treatment option for posterior teeth.

Even though the ceramic restorations made by milling show better accuracy and aesthetic characteristics in the research we conducted, it is was investigated that press-ceramic restorations have a better adaptation [32]. Moreover, the pressed lithium-disilicate monolithic crowns have better fatigue performance and internal fit [33] than CAD/CAM milled crowns, especially when treated with self-etching ceramic primer [34].

On the other hand, according to the following study [35], the smoother, more homogeneous tooth topography (<0.05) in comparison to the pressing technique was achieved through the milling.

Conclusion

When it is necessary to restore hard tooth tissues with an onlay, crown, or endocrown, it is highly recommended to use metal-free constructions to achieve a good aesthetic result with an adequate restoration of function.

According to the clinical study results, there were several advantages of the metal-free restorations made with the milling method compared to the pressing method. Those included better adhesion of the restoration, more precise color matching, and overall better quality of the structure in the oral cavity. These advantages make it possible to recommend using milled metal-free restorations in the presence of clear boundaries in the preparation area. In case ofb "torn" borders in the preparation area, it is preferable to use pressed metal-free restorations.

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