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The Use of Glass-Ceramic Crowns to Enhance Smile

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1. Introduction

Crowns are prescribed by dentists for anterior teeth for several reasons. Among them is extensive caries eading to considerable loss of tooth structure , in addition, trauma resulting in fracture of a portion of the crown may lead to the need for crown restoration. Malformed teeth may also need crowns to correct anatomical deficiencies. The current typical choice of a crown prescribed by the dentist for an upper incisor is either glass-ceramic or zirconia-based whether in the monolithic or bi-layered form. This is due to a move away from metal-based crowns and is largely attributed to the development of highly accurate computer-aided design and computer-aided manufacturing (CAD-CAM) technology [1]. This enabled the fabrication of crowns from zirconia or glass-ceramic blanks [2]. In addition, the introduction of zirconia and glass-ceramic materials with excellent aesthetic and mechanical properties has further accelerated the transition away from the cream-metal crowns [2-4]. Several clinical studies have reported favourable outcomes for non-metallic crowns, even when provided by predoctoral dental students [5-10].

When fabricated in the monolithic form, CAD-CAM crowns eliminate the interface between underlying coping and the veneering porcelain, thereby virtually eliminating the problem of veneer delamination. Monolithic crowns also exhibit uniform translucency, while their final aesthetic characterization can be achieved through surface staining and glazing. Furthermore, some CAD-CAM systems permit chairside fabrication of crowns with a scanner and a milling machine thereby eliminating the need for fabrication of provisional restorations. This render the process of providing a crown more efficient.

2. Case Details

2.1. Diagnosis and Treatment Planning

A female patient in her late twenties without any medical issues presented complaining of poor aesthetic appearance of recently placed crowns on her upper front teeth. Because she was unable to return to the original treating dentist located abroad, she sought treatment locally where she resided. Clinical examination revealed two Ceram metal crowns on her upper central incisors that fell below the standard of aesthetics Figure 1). The underlying metal copings were visible through the thin veneering porcelain, producing a greyish appearance and reduced aesthetics. The surrounding gingival tissues were inflamed, exhibiting gingivitis and enema consistent with a response to defective crown margins and plaque accumulation [11,12]. In addition, the crowns appeared disproportionately wide compared with the adjacent lateral incisors. The patient requested replacement of the crowns with more aesthetically pleasing ones and also expressed interest in whitening her teeth.

Diagnostic models were cast in stone from alginate impressions (Jeltrate Plus, Dentsply/Sirona, USA). Periapical radiographs of the upper central incisors were made and revealed no abnormalities. A treatment plan was developed that included removal of the existing Ceram metal crowns and replacement with well-fitted provisional crowns to allow healing of the inflamed gingival tissues to take place. To improve the mesiodistal proportions of the anterior teeth, composite resin was planned to be added to the mesial aspects of both lateral incisors. At-home bleaching with custom trays and whitening gel was also recommended and was planned to be performed before commencement of treatment. However, the patient elected to postpone tooth whitening until a later date and consented to proceed with the remaining treatment.

Figure 1: Upper central incisors of a young female presenting with suboptimal full ferrometal crowns. The underlying metal copings are visible through the thin veneering porcelain, compromising aesthetics. The surrounding gingival tissues exhibit signs of gingivitis and enema, likely associated with adverse tissue response to the crowns. Additionally, the dimensions of the central incisors appear disproportionate when compared with those of the adjacent laterals.

2.2. Treatment

Following administration of a local anaesthesia, both crowns were removed simultaneously with relative ease using a manual crown remover. The two crowns came out as one piece. After removal, it was noted that the two incisors' preparations exhibited an unusual rough semilunar configuration Figure 2. The preparations lacked essential retention features, including near-parallelism of the axial walls and adequate occlusogingival height. In addition, the lingual finish lines were irregular and required re-establishment. The removed crowns were found to be splinted together at the midline and had ragged margins Figure 3. The axial walls of the two crown preparations were carefully altered using medium grit tapered diamond burs (Brasseler, USA) at high-speed with copious water cooling. As a result, the preparations were reshaped at the proximal aspects to establish proper length and angulation for optimum retention. The lingual surfaces of the teeth were refined with a medium-grit football diamond bur (Brasseler, USA) Figure 4.

Provisional crowns with improved marginal adaptation were fabricated chairside using a dual-polymerized material (Integrity, Dentsply/Sirona, USA). They were subsequently cemented with a eugenol -free clear temporary cement (Temp-Bond NE Clear, Kerr. USA). They remained in place for two weeks to permit initial healing of the gingival tissues.

At the subsequent appointment, the preparations were refined using a fine grit tapered diamond bur with flat end in a high-speed handpiece with copious water cooling. The finish lines were further defined with the flat bur tip. Furthermore, the preparations were smoothened with fine grit So flex discs (3M/ESPE, USA) in preparation for impression taking.

To reduce the medio-distal dimensions of the new crowns, composite resin was bonded to the mesial aspects of the lateral incisors. Following roughening of the mesial surfaces of the lateral incisors with a course grit diamond bur (Brasseler, USA). Acid etching of the enamel surfaces with an etchant followed (Etchrite, 38% phosphoric acid gel, Pulp dent, USA). The etchant was applied to condition the enamel surfaces for 30 seconds. After rinsing, a coat of bonding resin (Scotch bond Multipurpose, 3M/ESPE, USA) was then applied and light polymerized. A layer of resin composite (Z250, 3M/ESPE, USA) was adapted free-hand to the mesial surfaces of the upper laterals following the anatomical features to increase their mesiodistal width. This was finished and polished with So flex discs (3M/ESPE, USA) Figure 6.

A polyvinyl siloxane (PVS) impression material, putty and light-body (Express STD, 3M/ESPE, USA) was used in a stock tray according to standard clinical procedures to obtain an impression of the crown preparations. Jaw relation registration was performed using a PVS material (Blu-Mousse VPS, bite registration material, Parkell, USA).

Two monolithic fully crystalized lithium disilicate glass-ceramic crowns (IPS e. Max, Ivo Clar/Vivadent, USA) were subsequently fabricated at a commercial dental laboratory Figure 5.

The intaglio surfaces of the crowns were etched with a buffered 9% hydrofluoric acid gel (Porcelain Etch, Ultradent, USA) and coated with a silane coupling agent. (Calibra Silane Coupling agent, Dentsply/Sirona, USA).

At the insertion appointment, the temporary crowns were removed and the tooth surfaces were cleaned first with a slurry of pumice in a rubber cup, then with Ivo clean (Ivo Clar/Vivamente, USA). The crowns were then evaluated intraorally for fit and colour Figure 6. Although the shade appeared slightly lighter than the adjacent teeth, this discrepancy was expected to diminish once the patient completed the planned tooth-whitening treatment. The crowns were then definitively cemented using a dual-polymerized resin cement (Panavia SA Cement Universal, Kuraray Noritake , Japan), a reliable resin cement [17] Figure 7.

Figure 2: Appearance of the prepared upper central incisors after crown removal. The preparation design is suboptimal, with inadequate near parallelism of the axial walls, compromising mechanical retention. The preparations are also short. The gingival inflammation affecting both central incisors appears to be directly related to the crown margins.

Figure 3: Intaglio surfaces of the crowns following removal. The margins appear irregular and uneven. The two crowns were splinted together.

Figure 4: Using a tapered diamond bur in a high-speed handpiece, the axial walls were redesigned and the finish line was redefined and repositioned slightly subgingival. The axial walls were modified to achieve near-parallelism, thereby optimizing mechanical retention. The preparations were refined. In addition, the mesial aspects of the maxillary lateral incisors were augmented with resin composite to increase their apparent width and improve proportional harmony. Healing of the gingival tissues can be observed in this image, which was taken two weeks after removal of the original defective crowns and placement of properly fitted provisional crowns.

Figure 5: At a commercial dental laboratory, two lithium disilicate glass ceramic crowns were made.They were monolithic and milled out of IPS e. Max blocks (Ivoclar-Vivadent).

Figure 6: The two fabricated crowns at try in stage. While they appear lighter in colour than the rest of the teeth, the patient had planned to whiten her teeth later.

Figure 7: Two weeks after insertion, the gingival tissues at the crown margins appear to be healing well. Compared with the pretreatment image, a significant aesthetic improvement can be observed.

3. Discussion

The original cream-metal crowns were aesthetically unsatisfactory and were associated with gingival inflammation. The inflammatory response was most likely related to poorly adapted and rough crown margins that promoted plaque accumulation, although the contribution of the nonprecious alloy used cannot be completely excluded [11,12]. Furthermore, less than optimal oral hygiene condition of the patient adversely contributed to the gingival inflammation.

Removal of the original crowns revealed unusual tooth preparations that lacked adequate retention form. Furthermore, the finish lines were poorly defined, particularly on the lingual surfaces. These findings indicate deficiencies in preparation design that compromised the mechanical retention of the crowns which were easily removed together without any drilling with a manual crown remover. Successful crown preparations require two essential features: near-parallel axial walls and adequate occlusogingival height [13-17]. Both features were deficient in the original preparations. Careful modification of the preparations without compromising the pulp established appropriate axial wall geometry and clearly defined finish lines, thereby improving retention and stability.

Following removal of the defective crowns and placement of well-adapted provisional restorations, the gingival tissues showed rapid clinical improvement.

The use of a clear temporary cement with the provisional crowns aided in optimizing their aesthetics during the healing period as a traditional white cement would have contributed to increased opacity.

The original crowns had been splinted together, possibly to compensate for the inadequate retention of the preparations. In addition, the visibility of the metal copings through the veneering porcelain suggests inadequate porcelain thickness or insufficient support of the veneering ceramic during laboratory fabrication.

Monolithic lithium disilicate glass-ceramic crowns (IPS e. Max, Ivo Clar/ Vivadent, USA) were selected to replace the existing unsightly Ceram metal crowns because they provide superior aesthetics through their translucency and the absence of a metal substructure [17]. Resin cement was selected for definitive cementation to maximize bond strength, improve marginal sealing, and enhance the long-term performance of the restorations [17].

When the patient proceeds with the planned tooth-whitening treatment, the composite resin placed on the mesial surfaces of the maxillary lateral incisors is expected to maintain acceptable colour harmony with the surrounding tooth structure [18].

4. Conclusions

1. Careful alteration of inadequately prepared teeth can re-establish acceptable retention form and well-defined finish line.

2. Gingival inflammation associated with poorly fitted cream-metal crowns will resolve following replacement of the faulty crowns with well-fitted ones.

3. Monolithic lithium disilicate glass-ceramic crowns provide excellent aesthetic outcomes for upper anterior teeth

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