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CAD/CAM Fiber-Reinforced Composite Adhesive Splint

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Abstract: ***Splinting of periodontally-involved mobile teeth can be very challenging and technically demanding, in order to achieve long-term stability, function and esthetics. Traditionally splinting is done with different materials such as: steel wire, fixed dentures/restorations or fiber-reinforced materials. All of them are having different advantages and disadvantages. CAD/CAM technology is a modern method introduced to dentistry offering the possibility of producing durable splints for stabilization of periodontally-involved teeth. This clinical approach demonstrates the use of CAD/CAM fiber-reinforced composite material as an alternative method for the fabrication of indirect splints to immobilize periodontally compromised teeth. This new material can be used in patients allergic to metals, meeting the high esthetic demand of ceramics and presenting lighter weight compared to ceramic. Conclusions: The use of CAD/CAM fiber-reinforced composite materials could be considered as a successful alternative method for splinting mandibular mobile incisors***

Keywords: mobile teeth, splinting, CAD/CAM, fiber-reinforced composite resin

1. Introduction

Periodontitis causes inflammation and periodontal bone loss, which results in tooth mobility. [1] The mechanism of tooth mobility includes resorption of the alveolar bone, loss of attachment, widening of the periodontal ligament space and occlusal trauma. The occlusal trauma is considered secondary, as the tissue destruction occurs in the presence of normal occlusal forces acting on mobile teeth. Tooth mobility results in occlusal instability, masticatory dysfunction, impaired esthetics and the end result – an impaired quality of life. The treatment involves specific treatment of the periodontal disease, depending on its stage and grade (usually nonsurgical and surgical), occlusal therapy and splinting. Sometimes the treatment of periodontitis and occlusal adjustment might be enough to control the clinical situation and restore function, especially in Miller grade I tooth mobility [2]. However, in Miller grade II or III mobility, splinting is required in addition to the periodontal treatment and occlusal adjustment.

The rationale for splinting is primarily to distribute the occlusal forces, restore the physiological occlusion and functional comfort during mastication [3]. Splinting should not be done as a sole procedure, but with adequate treatment of the periodontal disease. It is insufficient to perform a simple procedure of mobility reduction, without understanding of the etiology of the excessive tooth mobility.

According to the glossary of prosthodontic terms, a splint is defined as “a rigid or flexible device that maintains in position a displaced or movable part.” Splinting in dentistry is defined as joining of two or more teeth into a rigid unit by means of fixed or removable restorations or devices [4]. A periodontal splint is an appliance, used for maintaining or stabilizing mobile teeth in their functional position [5].

Splinting has been used since ancient times. Conventional splints are made of stainless steel, cobalt chrome cast metal alloys, acrylic resins and composite resins. However the splints used for indirect or direct splinting have shown some disadvantages. The materials could only retain mechanically around the resin and they were not chemically integrated within the splint. The interface created between the composite resin or acrylic resin and wire, pins, or grid mesh had the potential of creating shear planes and stress concentrations that would lead to cracking of the composite resin and thus, failure.

Most often periodontally compromised teeth are immobilized using a direct splinting technique in the dental office. Direct splints (Kevlar fibers, polyethylene mats, wire nets or twist flex wires) are bonded to the teeth. A compromised plaque control might be expected because of the additional accumulation of plaque at the splinted margins, which can lead to gingival inflammation and further progression of the disease and alveolar bone loss. Syme and Fried stated that periodontal and caries risk assessment, periodontal debridement and optimal prophylaxis during professional follow-up are critical to splint longevity. Other disadvantages include impaired phonetics, risk of crown fracture and mesial shift [6].

The ideal splint should meet the following requirements [7]:

- Optimal stabilization of teeth included;
- Extension around the arch in a way that anteroposterior and faciolingual forces are counteracted;

- No interference with occlusion;
- No mechanical or chemical irritation to the gingival margins and papillae, cheeks, lips, tongue or pulp;
- Interdental spaces should not be blocked;
- Esthetically acceptable;
- Easily fabricated, easy handling, easy maintenance;
- Inexpensive.

CAM/CAM fabricated splints meet many of the requirements of the ideal splint. Currently this advanced technique is successfully used in many different areas of dentistry [8], [9]. High precision and aesthetic designs can be made digitally, using software in order to minimize the human error factor, which directly influences the accuracy of the splint [10], [11].

New CAD/CAM fiber-reinforced composite splints have a wide range of indications as a material used for permanent or temporary dental restorations. It combines high flexural strength possessing a physiologically perfect modulus of elasticity, together with excellent bond strength, when it is bonded to dental veneering composite [12]. It is a good alternative material for direct splinting methods due to the ease-of-use protocol. Additional advantages include some technical characteristics such as the possibility of achieving an extremely smooth surface, which allows the patient to maintain the optimal level of oral hygiene.

Adhesive splints, designed and fabricated with CAD/CAM software can be used for temporary (less than 6 months) or provisional stabilization (from a few months up to several years) [10], [11].

2. Case Report

A 38-year old male patient was referred to us with a chief complaint of discomfort while biting and increased tooth mobility of lower incisors.The patient was diagnosed as a periodontitis case, stage III, grade B according to the new classification of periodontal diseases and conditions (2017). He had more than 5 mm clinical attachment loss in the most affected anterior region; more than 33% bone loss (mainly horizontal, as well as vertical in the molars); class II furcation involvement. Lower anterior teeth had II degree mobility (Fig. 1).

Figure 1: Initial situation

The treatment plan consisted of nonsurgical periodontal treatment – complete scaling and root planning and stabilization of the lower anterior with a splint fabricated from CAD/CAM glass fiber-reinforced composite disks (Trilor®, BiolorenS.r.I.). Surgical treatment of infrabony defects was planned as a second stage treatment procedure, after complete resolution of the gingival inflammation.

After periodontal debridement, the patient was scanned with an intraoral scanner (Trios, 3Shape). The splint was designed to stabilize lower teeth lingually from lower right to lower left canine. The thickness of the splint measured as a the cross sectional width of 0.6 mm and the apical outline of the splint has an offset of 2mm from the gingival margins (Fig. 2).

Figure 2: CAD of the splint

The building material of the splint consists of resin and a multi-directional reinforcement of fiberglass. The production method ensures a secure level of adhesion between the fibers and the resin matrix. This method amplifies the specific application of this biomaterial when used as a splint (Fig. 3).

Figure 3: The milling process of the splint

After milling, the splint was covered with GC Optiglaze (Fig.4). Optiglaze is a nano-filled, light-cured, protective coating for direct and indirect restorations made of composite resin. It provides an esthetic and glossy surface to composite restorations, artificial teeth, removable dentures, provisional crowns and custom acrylic trays. It can also be used instead of mechanical polishing in areas difficult to polishing such as occlusal grooves or interproximal areas of indirect composite restorations [5]. This nano-coating is a revolutionary material which effectively seals the outer layer of the direct and indirect composite restorations to create a smooth and glossy surface. However, to the best of our knowledge, there are no reports in the literature evaluating the use of Optiglaze as protective coatings for indirect splints.

Figure 4: The splint covered with GC Optiglaze

After fitting the splint's contact surface, the teeth were sandblasted with Al2O3 (particle size 50µm, Renfert Basic Classic; RenfertGmbh& Co - Hilzingen) at a pressure of 2 to 3 bars. Silane coupling agent was applied (Monobond Plus by IvoclarVivadent).

The enamel surfaces were etched with 37% phosphoric acid gel for 20 seconds. The splint was cemented with dual cure resin cement (Variolink Esthetic DC, IvoclarVivadent) (Fig. 5).

Figure 5: Intraoral view of the cemented splint

The patient was given the instructions to keep the oral hygiene on a high level with special care for the interproximal surfaces.Follow-up visits were scheduled every 6 months.

3. Conclusion

On critical analysis, this fiber-reinforced composite materials surface couldn't be polished to a high standard. The relatively rough surface enhances microbial adhesion particularly after long-term intra-oral use. The use of a light-curing protective coating such as GC Optiglaze provides a smoother surface and reduces the microbial adhesion [5].

4. Discussion

Tooth mobility is an important clinical parameter and its presence is one of the risk factors for the progression of periodontal disease. Tooth stabilization with the help of splinting has been recommended for the periodontally compromised dentition to improve patient's comfort and the masticatory function.

The glass fiber-reinforced material - Trilor has a low specific weight that enables the fabrication of lighter restorations compared to the other materials used before for the same purpose. Trilor provides higher patient satisfaction and comfort during function. This material has several advantages such as: being durable and resilient, requires no firing, possesses unique mechanical properties with high flexural and compressive characteristics, it is biocompatible and adjustable, due to its insolubility in water and low reactivity with other materials. Trilor could be suitable for patients allergic to metals or sensitive to metallic taste. The high degree of polishability of the splint leads to less plaque retention and color stability over time.

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