CASE REPORT

Treatment of Cases with Different Grades of Fluorosis by Lithium Disilicate Glass-Ceramic CAD/CAM Materials: A Case Report of Two Cases

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Abstract

Over exposure to high amount of fluoride during the development of enamel leads to fluorosis. Dental fluorosis is considered to be the most common color disorders of the enamel. It presents with different clinical signs on the enamel of the patients. The diagnosis of dental fluorosis is very challenging in the clinical practice since the enamel defects could be confusing. This case report presented two cases and their treatment for different grades of dental fluorosis to improve the esthetic appearance of the teeth.

Keywords: Dental fluorosis, Fluorosis index, Lithium disilicate glass-ceramic, Microabrasion, Resin infiltration.

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Introduction

The enamel of the teeth experiencing growth-related abnormalities may raise because of dental fluorosis (DF), which is triggered due to repeated exposure to higher concentrations of fluoride during its development. In 1916, this disorder was first described by McKay and GV Black.[1] The fluorosed enamel has a low content of minerals and will be more porous. The severity of fluorosis depends on the time of exposure to fluoride, the body weight of the individual, various nutritional factors, the growth, development, etc.[2]

Esthetics is the major concern for patients with DF in their permanent dentition.[3] Children between the age group of 20 and 30 months who are excessively exposed to fluoride are more susceptible to fluorosis. About 0.05–0.07 mg F/kg/day is considered as safe level for daily fluoride intake.[4] Fluoride is important to prevent and manage dental caries as it stimulates the remineralization of the enamel. Due to the availability of various sources of fluoride, a decline in the prevalence of dental caries and an increase in DF has been seen.[5,6]

Research done in several areas with or without the added fluoride in the drinking water has shown four sources that have increased the risk of dental fluorosis that are: fluoride supplements, fluoride toothpaste, fluoridated drinking water, and formula that has been prescribed for the children.[7]

Lithium disilicate glass ceramic (IPS e.max CAD) restorative materials are ceramics used in dentistry and are characterized by qualities of transparency, hardness, mimic of natural teeth, and strength. Their chief benefits comprise low wear resistance as well as plaque adherence exposure, biocompatibility, and color permanence, as mentioned by several laboratory studies.[8–11]

Dental fluorosis is a signal of fluoride contact during the time of enamel development, while the extent and severity of fluorosis are dependent relatively on the total fluoride dose, frequency, and timing of fluoride exposure.[2] Thylstrup–Fejerskov (TF) index is the utmost frequently utilized procedures for the determination of dental fluorosis level. TF index classifies DF on clinical presence, with scores extending between 0 and 9, so permitting the purpose of the mildest to most severe characteristics of DF. At a grade of 0, the enamel symbolizes the normal translucency. Rising amounts of the ordinal scale of the index represent an increase in intensity in the severity of DF: Scores 1–4 denote collective marks of opacity with no loss of outermost enamel. Grade of 5 or more indicated increasing degrees of loss of outermost enamel.[12,13]

Nowadays, the differential diagnosis between level of fluorosis and other lesions affected the teeth surfaces depending on various factors such as the damage caused to the enamel, etc.[14] The clinical manifestation of the affected teeth differs from white streaks (mild form) to brown (moderate form) to dark brown or black (severe form) discoloration.[12,14] The different treatment options suggested for DF are: microabrasion, bleaching, veneers, and/or full crowns.[13] The objective of this article was to describe and illustrate, with a case series, the treatment of moderate-to-severe dental fluorosis to improve the esthetic appearance of the teeth.

Case Reports

Case #1

A 41-year-old female patient reported to King Khalid University, Dental Clinics in May 2022 with a chief complaint of discolored brown teeth on smiling. She complained of severe dental fluorosis

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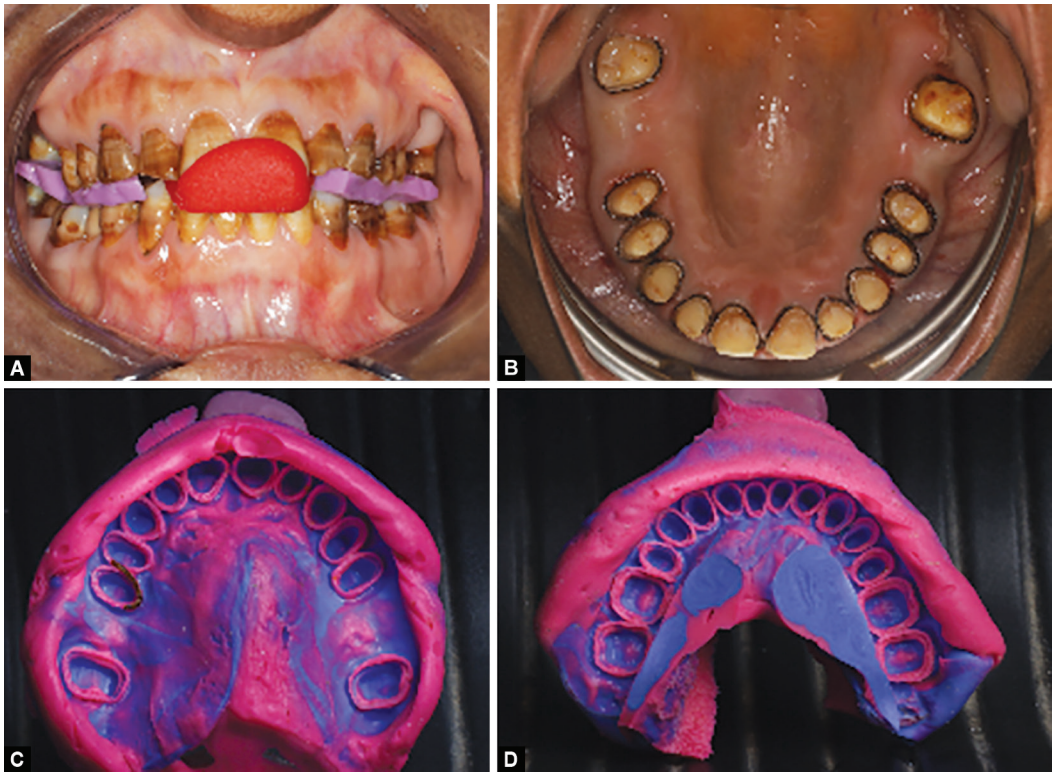
Figs 1A to D: Preoperative views. (A) Frontal extraoral; (B) Intraoral frontal; (C) Maxillary teeth; (D) Mandibular teeth

with a TFI score 7. She was born and raised in Al-Majardah, an area known to contain high fluoride levels (ranging from 0.5 to 2.3 ppm) in the groundwater. She had visited government dental clinic at 15 years of age, where they had advised her to delay the treatment of discolored teeth, which was due to fluorosis. Patient was medically fit, past dental treatment consists of multiple extraction, restorations, and RCTs. She brushes her teeth twice daily with soft toothbrush and fluoridated toothpaste.

The extraoral examination showed an asymmetrical face with competent lips and improper ratio of the lower face to the middle third heights (Fig. 1A). Temporomandibular joints were asymptomatic with no signs of clicking, crepitus, or tenderness to palpation, and the mandibular range of motions was within normal limits. Intraoral soft-tissue examination was without obvious pathology and ovoid arch form. Enamel surfaces of the teeth were affected with progressive occlusal wear from anterior to posterior and marked general form of discrete pitting, and widespread brown stains, and teeth presented a corroded-like appearance. All of the teeth were present except extracted bilateral maxillary first molars (Fig. 1A). Molar's relationship was not applicable on both sides (Fig. 1B). There was class II residual ridge deformation in the area of missing teeth # 16, 17, 26 (Figs 1C and D). The patient showed high risk for caries, severe DF with score 7 (TI index), and teeth wear with score 2. Symptomatic irreversible pulpits with symptomatic apical periodontitis of teeth #28, 37, 48 and generalized excessive wear with loss of occlusal vertical dimension seen (Figs 1B to D).

The treatment objectives were developed using information obtained from review of medical, dental histories, and clinical findings. The case was diagnosed as moderate-to-severe DF with a bilateral edentulous first maxillary molar. The patient was informed about the possible benefits of pre-prosthetic orthodontic treatment to align the lower anterior teeth, but she declined this option. All teeth diagnosed with different grades of DF were planned to be treated with crowns to establish bilateral esthetic. Missing teeth were to be replaced by bridges. These treatment options were proposed and discussed with the patient. Following a review of all treatment options, objectives and limitations, a full mouth rehabilitation with indirect restorations (crowns and bridges) was approved by the patient. The treatment plan by phases suggested by Riahi et al. was followed after agreement from the patient.[15] It consisted of the following phases:

Phase I: The patient was educated about the treatment plan and was motivated during the 7 months treatment period. Preliminary impressions were made using irreversible hydrocolloid and poured in type IV stone. On assessment of occlusal vertical dimension (OVD) loss utilizing physiological rest position, phonetic evaluation, assessment of facial diminution, and esthetic appearance, VD at rest was 77, at occlusion was 71 (6 mm of freeway space), and the speaking space was 1 mm apart. Using Denar Slidematic facebow, centric relation record was made using bimanual manipulation technique. With the help of 3 mm height Lucia jig and polyvinylsiloxane occlusal registration material, lateral and protrusive records were obtained (Fig. 2A). Diagnostic casts were made and mounted on a semi-adjustable articulator (Denar mark II). The existing OVD was increased by 2 mm using the incisal guidance pin of the articulator, another centric relation record was obtained which was then used to remount the casts, followed by diagnostic wax. Fabrication of silicon index was done and loaded with tooth-colored resin composite material and repositioned in the patient's mouth for mock-up. The occlusion was stabilized with removable stabilization appliance in the maxillary arch at the estimated VD for 6–8 weeks using CAD/CAM technology for the fabrication of splint. A weekly schedule was drawn for the adjustment of the splint, and



Figs 2A to D: (A) During centric relation record; (B) Prepared maxillary teeth; (C and D) Maxillary and mandibular final impressions

the patient was instructed about the proper insertion and removal of the appliance.

P*hase II:* Root canal retreatment for teeth # 46 and 37 followed by post-core buildup, and extraction of nonrestorable teeth 28, 38, 48 was done. After 8 weeks, the patient had adapted to the new OVD. Therefore, further treatment was proceeded with preparation and temporization with CAD/CAM prostheses. An adequate amount of overjet and overbite was achieved to allow disocclusion of the posterior teeth through correct incisal and canine guidance.

Phase III: Final teeth preparation was done following the principles and guidelines for tooth preparation of full coverage ceramic restoration (Fig. 2B), then one step-double mixed maxillary and mandibular final impression with additional silicon (Virtual, Ivoclar Vivadent, Lichtenstein) with two-chord technique were done (Figs 2C and D). Fabrication of the prostheses by CAD/CAM and following the manufacturer's instructions were carried out. Full coverage crowns were given for maxillary teeth (from tooth #14 to #24) and all mandibular teeth with monolithic lithium disilicate IPS e.max Press (HT ingot and MO ingot, Germany). The maxillary bilateral bridges replacing missing 1st molars were replaced with IPS e.max Ceram bridges #15–17 and #25–27 over zirconia cores. The following steps were followed during cementation for the prostheses. The intaglio surfaces of the restorations were treated with 9.5% hydrofluoric acid (IPS Ceramic Etching Gel, Ivoclar Vivadent) rinsed and dried, then a silane coupling agent (Silane, Ultradent, South Jordan, Utah) was applied to this surface for 60 seconds and air-dried. After that, the preparations were treated with total-etch technique 35% phosphoric acid for 90 s, rinsed and dried, then bonding agent system, Adper Prompt L-Pop (3M ESPE, St. Paul, Minnesota, USA) self-etching adhesive system was applied to the preparations for 20 seconds and air-thinned. A dual-cure resin cement, Unicem AppliCap Resin Cement (3M ESPE, Germany), was then applied to the intaglio surface of each restoration. The overall excess of resin cement was separated, and the restorations were entirely light-cured on each accessible side. Lastly, removal of excess cement was achieved with scalers. Cementation for bridges were done after air particle abrasion of the inner surfaces of abutments (Figs 3A to D).

Phase IV: The patient was followed up after 3 and 6 months, and bitewing radiographs were taken at these intervals.

Case #2

A 35-year-old Saudi female patient arrived in December 2021 with a complaint of white color lines on her teeth, presented since she was a child after the eruption of all her permanent teeth. She was born and raised in Al-Majardah, and complained of a mild grade of DF due to high fluoride levels (0.5–2.3 ppm) in the groundwater. The patient was medically fit; the last dental visit was 3 months ago for periodontal follow-up and dental treatment such as extractions, restorations, and RCT.

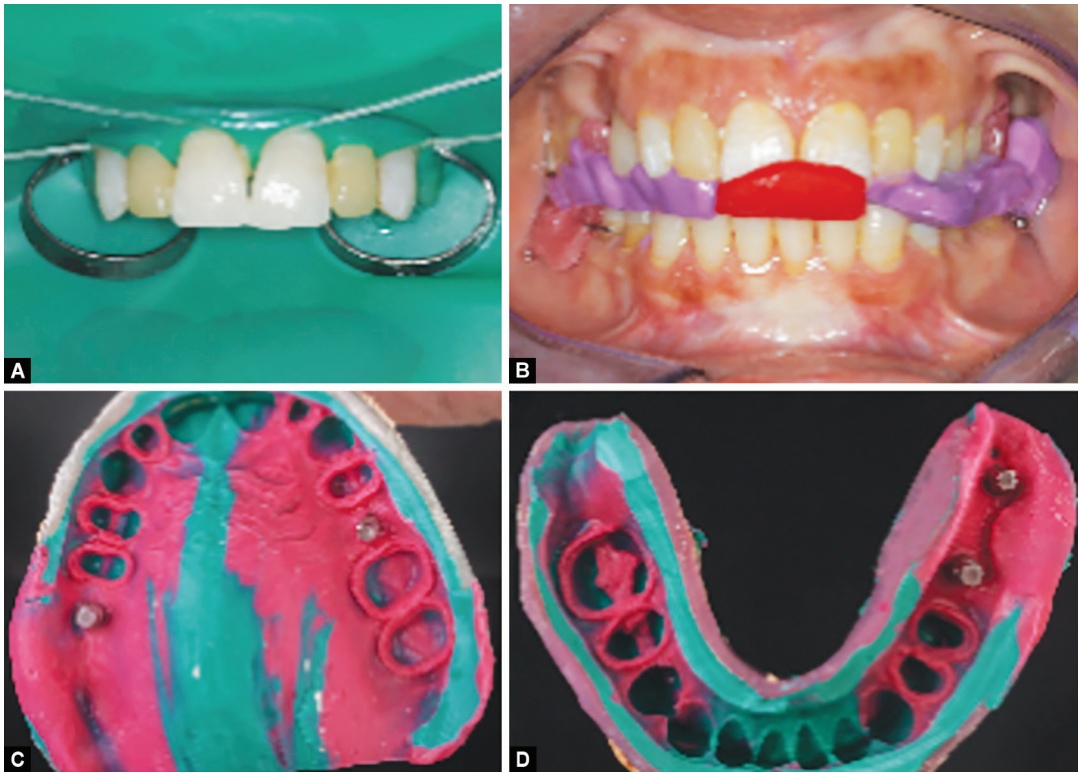
On extraoral examination, the patient showed normal lip movement between right and left side during smile. The incisal plane followed the curvature of the lower lip in normal convex curve. Intraoral findings, all soft-tissues examinations showed no obvious pathology. Her intra-oral investigation revealed irregular chalky white lines and cloudy areas of opacity spread in relation to maxillary incisors teeth and canines had paper white opacities on the entire surface (Figs 4A to E). Clinical assessment revealed mild-to-moderate dental fluorosis (TF = 3 – 4), discrepancy in plane of occlusion, and dentoalveolar extrusion related to teeth #16, 17 teeth by 2 mm. Symptomatic irreversible pulpits with symptomatic apical periodontitis for teeth #16, 25, 44 was present. Necrotic pulp in relation to previously RCT teeth with symptomatic apical periodontitis for teeth #14, 22, 45 and #15, 12, 27, 37 was present.

Figs 3A to D: Cemented maxillary and mandibular crowns and bridges

Figs 4A to E: Preoperative intraoral of right, frontal, and left views

The treatment objectives were proposed and discussed with the patient. A full-mouth rehabilitation based on minimal intervention for anterior teeth, avoiding treatments with more predictable results that would require greater tooth structure reduction, was planned. In-office bleaching and home bleaching followed by resin infiltration for objectionably fluorosed teeth. The teeth which did not respond to minimal invasive methods would be treated first with microabrasion, then by indirect restorations (crowns) for RCT teeth and dental implants supported crowns for missing teeth. The treatment planned were bleaching, microabrasion of maxillary teeth (13–23), crowning of teeth (15, 14, 12, 21, 23, 24, 26, 27, 34, 35, 45, 46), and dental implant supported with all-ceramic crown for replacement of missing teeth (16, 25, 36, 37).

Phase I: The patient was motivated about the treatment plan steps and duration (11 months). *Phase II*: Bleaching for moderate DF was done as a pre-treatment regimen for achieving better



Figs 5A to D: (A) During bleaching and resin infiltration; (B) Bite registration; (C and D) Teeth preparation and final maxillary and mandibular final impressions

esthetic results with resin infiltration. The rubber dam was utilized to shield neighboring teeth and soft tissues. The patient was advised to dress through protective eyewear up until the technique was accomplished. About 35% of hydrogen peroxide gel was applied to teeth in the sextant number 2 (13, 12, 11, 21, 22, 23) of maxillary arch. The bleaching gel was "photo" activated using a power bleaching unit for 15 minutes. Etching gel was detached with gauze, and the technique was replicated for one more time. In-office bleaching and home bleaching followed by resin infiltration for objectionably dental fluorosed teeth (Fig. 5A). Rubber dam was placed, and the procedure was started first for the maxillary teeth, where the affected teeth were etched with an icon-etch gel. The teeth were completely dried with icon-dry, infiltrated with icon-infiltrant, and cured. Teeth numbers 12, 21 did not respond to RI, so the treatment plan was modified for indirect restorations.

Face bow record was taken, and centric relation records were made with aid of 2 mm height Lucia jig and polyvinylsiloxane occlusal registration material (Fig. 5B). A complete diagnostic wax-up was performed, and after that, we proceeded with preparation and provisional restoration. RC retreatment for teeth #15, 12, 27, 37, RCT for teeth #17, 16, 25, 44, 22, 45, then post and core for all RCT teeth, then extraction of tooth # 27, 37. Dental implants for placement of missing teeth #15, 26, 46, 47 was carried out using an immediate nonfunctional loading of implant augmented with freeze-dried cancellous bone grafts through healing period of 3–4 months.

Phase III: During this phase, lithium disilicate glass-ceramic crowns for maxillary teeth #15, 14, 12, 21, 24, 26, 27 and mandibular teeth 37, 36, 44, 45 were constructed and cemented. Also, implant supported crowns for teeth 16, 25, 46, 47 was fabricated, try-in, and cemented, then occlusal splint was made-up to be used at night by the patient for 3 months. Final tooth preparation was done for teeth following the principles of tooth preparation and guidelines for tooth preparation of full coverage ceramic restoration. Then, final impressions (Figs 5C and D) were done. Full coverage crowns were constructed from IPS e.max Press by CAD/CAM following manufacturer's instructions, while the remaining teeth as well as implant supported teeth were replaced with IPS e.max CAD with zirconia cores. Cementation for anterior, posterior, and implant supported crowns were done as discussed in the previous case (Figs 6A to F).

Phase IV: Follow-up as mentioned in the previous case.

Both patients were able to function well and were pleased with the esthetics and comfort of their treatment. The occlusion was evaluated and adjusted as necessary. They were reminded that follow-up was necessary every 3–4 months. Bite-wings X-rays were taken every 6–18 months. The patients were extremely pleased with the outcome of the treatment. This along with their philosophical attitude to the given treatment insured long-term good prognosis.[16]

Discussion

The esthetic changes due to DF is one of the major concerns nowadays. The best preventive measure to avoid fluorosis is to control the intake of fluoride. Fluoride constitutes to 0.08% of the Earth's crust, and in the human body, it is stored in the skeletal tissues. In a healthy adult, the stable plasma level is supposed to be 1.5 ml/L, above which is called as fluorosis. In the community water supplies, the amount of fluoride that is used is in the concentration of 0.7–1.2 parts per million (ppm).[17] This paper described and illustrated a case series, the treatment of moderate-to-severe grade of DF to improve the esthetic appearance of the teeth.

The diagnosis of DF is very challenging in the clinical practice since the enamel defects could be confusing. Thorough knowledge

Figs 6A to F: Views of cemented maxillary and mandibular crowns

of various enamel defects is important for the diagnosis of dental fluorosis and its treatment. The patient must be educated about the associated factors of DF and also the preventive measures. It is necessary for the practitioner to be aware of all the treatment options provided and its choice would depend on the particularities of the case.

In this area of SA, the level of high fluoride is mainly due to water. The treatment of dental fluorosis is mainly dependent upon the severity, location, and age of the case and patient. It included many choices started by conservative dentistry such as microabrasion bleaching, labial veneers by composite or ceramic materials, and crowning of teeth. In these cases, we selected all ceramic full crown to create esthetic harmony for all teeth.

The dental caries in the permanent teeth reduces by 50–60% with the required level of concentration of fluoride. The bacterial enzymes get inhibited at these lower concentration levels of fluoride, and mineralization of the enamel takes place. When the concentration of fluoride goes above 3 ppm or more, it leads to fluorosis.[17] The toxicity of fluoride is first exhibited as clinical sign in the form of DF in children. The clinical signs seen due to longer intake of fluoride are flecks which are white and minute, brown or yellow scattered areas, or streaks, or dead paper white color of the entire tooth surface.[18]

Due to dental caries, dental fluorosis or dental calculus, studies have shown that these factors affect the oral health related quality of life.[19] According to recent studies, the loss of vertical dimension due to severe fluorosis could be treated with full ceramic crowns rather than labial veneers.[16,20] Also, Alaajam et al., found that acceptable bond strength was recorded after aging and thermocycling of composite with teeth with deep fluorosis.[21]

The etching of the enamel has to be done properly to achieve good bonding, and in the patients with fluorosis, the etching time needs to be comparatively longer since the hydroxyapatite crystal, which gets replaced with fluorapatite are more resistant to etching. Hence, in cases with moderate-to-severe fluorosis, the etching time should be doubled with 37% phosphoric acid.[15]

The conservative approach of treating the low grade of DF without causing excessive wear of sound enamel is by bleaching and microabrasion. They may be used in the cases with TF index TF 1–4.[22–24] Microabrasion is carried out first, followed by bleaching of the fluorosed tooth surface. Sensitivity of the teeth and irritation of gingiva are the most common complaints revealed by the patients after the microabrasion.[25,26] This might be because of reduced enamel structure. Recent literature recommended the use of TF index classification because it guided us in the proper selection of the proper treatment type of each case and individual.[23–25]

In both cases and due to grade of DF, all ceramic E.max CAD crowns were chosen since the residual discolored image of the tooth could be masked. It was also necessary to cover the post and core.

Only e.max CAD/CAM ceramic materials would provide the required opacity and reflect the natural appearances of prostheses. Same e.max CADs were used in all the teeth, and discrepancy in the color matching was avoided. E.max CAD is strongly recommended for teeth with moderate-to-severe grade of dental fluorosis.[27]

The clinical and histological aspects were correlated, and careful classification of the affected teeth are done by TF index.[28,29] As seen in the cases, the defects of enamel which were uneven suggested that the ameloblasts must have been affected during a particular stage of development leading to opaque areas in the enamel, having characteristics of mineral deficiency.[30]

The clinical significance of the treatment of this case is the masking off the deep fluorosis stain, creating an excellent relationship of teeth in relation to overjet and overbite with durable and biocompatible restorations in harmony after restoring the lost VDO. This resulted in a boosted self-esteem of the patient with better social interaction. This type of treatment was selected in relation to the grade of DF.

Conclusion

The treatment approach depends on the severity of the dental fluorosis. In mild-to-moderate DF, resin infiltration with increased infiltration time, followed by bleaching will provide better esthetics. The treatment options suggested for mild-to-moderate DF can be microabrasion, bleaching, and their combinations. The fluorosis index in the patients should be well analyzed before planning the treatment of them. The other options such as crowns and laminate veneers should also be considered. Most importantly the education of the community is important to prevent the DF.

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