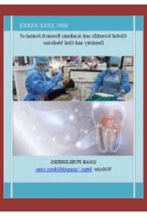

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Esthetic rehabilitation of two different levels of dental fluorosis with CAD-CAM generated yttria-stabilized zirconia and glass-ceramic laminate veneers

BY

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Abstract

Dental fluorosis is a growing public health problem.

Its manifestation could compromise esthetics and function.

Several treatment modalities have been proposed to manage mild to severe dental fluorosis.

Treatment options varied from bleaching to full coverage crowns.

This clinical report demonstrates the use of two different ceramic biomaterials for the treatment of two different levels of fluorosis.

Keywords: *Dental fluorosis, veneer, zirconia, lithium disilicate, CAD-CAM*

Introduction.

Dental fluorosis is a chronic condition in which the excess of fluoride intake leads to irreversible biochemical changes within the tooth structure.

High levels of fluoride anion could be responsable for disrupting the enamel formation.[1]

The widespread use of fluoride based caries preventive strategies helped to decline dental caries prevalence and incidence in developed countries over the last two decades.

However, it has been recognized that fluoride ingestion in excess amounts could be responsable for the hypomineralization of the enamel.

A conducted study in 2017, showed that approximately 25% of the Tunisisan population presented a potential dental fluorosis risk. [2]

Dental fluorosis may undergo a continuum of post eruptive changes among the enamel surface.

It may manifest with white spots, or fine opaque striations as much as it could present discrete or confluent pitting aspect of the enamel.[3][1]

Thylstrup–Fejerskov index classifies theses histopathological changes, in an ordinal scale extending from 0 to 9, in order to simplify diagnostic criteria.

At a grade of 0, the enamel stands on its normal translucency.

Scores ranging from 1 to 4 demonstrate several shades of opacities with no loss of the outerlayer of the enamel surface. Scores of 5 or more indicate increasing degrees of loss within the enamel structure.[4][5][6]

Treatment modalities for fluorosis depend on its severity. They vary from bleaching, micro/macro abrasion, resin infiltration to veneers and full coverage crowns.[7]

Contemporary dental rehabilitation relies on finding the balance between the patients' expectations and the most conservative means of treatments.

Although the fact that achieving ideal esthetics may be facilitated by the use of all-ceramic restorations, it still challenging to choose the appropriate restorative material to reach esthetics as well as proper biomechanics.[6]

Improvements in restorative dental materials have made glass ceramic a desirable option for indirect esthetic restorations.[8]

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In the last decade, zirconia gained an enormous interest for its exceptional mechanical and biological properties.

However, 3Y-TZP zirconia is an opaque material.

Therefore, research have turned to developing a more translucent zirconia.

Zirconia fifth generation 5Y-TZP associates, nowadays, high levels of translucency while keeping an intersting flexural strenght.
Zirconia restorations offer long-term stability thanks to the inertness of its surface. [9]

However, unlike silica-based ceramic, this chemical inertness makes the bond strength with resin composite cement challenging even more so with fluorotic enamel.[10]

Owing to the need to improve compromised esthetics and under the light of scientific evidence of the successful use of 5Y-PSZ zirconia, this manuscript reports a serial cases describing the treatment of two different levels of dental fluorosis of maxillary incisors using lithium disilicate–reinforced ceramic and zirconia veneers.

First case report :

A 42-year-old healthy Tunisisan woman was referred to the departement of fixed prosthodontics in the dental clinic of Monastir for an esthetic restorative consultation.

Her chief complaint was about her discolored brown teeth.

She complained of severe dental fluorosis with a TF score 5. She was born and raised in Kairouan, an area known to contain high fluoride levels in the groundwater.

The extraoral examination showed a symetrical face with competent lips and proper ratio of the lower face to the middle third heights.

The comprehensive oral examination and sectional radiographic series revealed the absence of active dental caries and signs of periodontal disease.

Medical history manifested no contraindication for elective dental treatment.

The treatment options were discussed with the patient.

She decided to include whitening and micro-abrasion therapy while restoring her maxillary anterior teeth with lithium disilicate veneers.

The whitening and micro-abrasion of the teeth allows to lighten the dental stumps' shade to better control the final color.

At the first appointment, the polishing of all teeth was done.

Initial diagnostic impressions were taken with alginate for the treatment planning.

After achieving an acceptable shade, we waited two weeks for oxygen free-radical dissipation and color stabilisation.

A mock-up was completed to enhance the predictability of the final esthetic result.

Once validated, mini-invasive preparation started, threw the mock-up.

It included a butt-joint margin, 1.5mm reduction of the incisal edges and 0.7mm on facial surfaces using a round-ended diamond burs.

The preparations were then rounded and polished with fine diamond burs.

Digital impressions were taken with a 3 shape TRIOS 4 digital scan after color selection.

The provisional veneers were temporarily cemented using the acid-etch point technique and bonded with flowable resin composite.

After receiving the final ceramic restorations, we verfied the marginal adaptation, interproximal contacts and occlusion, individually and then collectively using a translucent try-in paste (VARIOLINK®N).

After the final approval of the patient, the internal surfaces of the laminate veneers were etched with a 10% hydrofluoric acid for 20 seconds and silanated.

As for teeth surfaces ; they were etched with 35% phosphoric acid for 20 seconds, rinsed and thoroughly dried to then, be treated with an adhesive system.

The final restorations were cemented using a translucent dual-cured resin cement (VARIOLINK®N).

After curing, the excess of the cement was removed with a scalpel blade.

Figure 1 :
Pre-operative view

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Pre-operative view

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(a)

(b)

Figure 3 (a) Silicone index for mock-up, wax model and (b) diagnostic mock-up with self-cured temporary composite material.

(c)

(d)

Figure 4 : (c) *Horizontal and vertical depth grooves marcked on the teeth with a pencil.*

(d) Clinical aspect after final preparations of the anterior teeth.

Figure 5 : Lithium Disilicate restorations

Figure 6:
Dual-cure resin cement (Variolink®)

Figure 7 : *Completion of cementing of the ceramic veneers.*

Figure 8: Final smile view

Second case report :

A 21 year-old female patient, reporting small, discolored upper front teeth as her main complaint.

The clinical findings revealed the absence of an obvious pathology among soft-tissues.

Irregular chalky white lines manifested along the facial surfaces of all maxillary and mandibular teeth.

Clinical assessment revealed severe dental fluorosis (TF = 7) with a slight discrepancy in the anterior plane of occlusion.

The treatment objectives were discussed with the patient that prefered to restore her smile with ceramic veneers.

Diagnostic impression were taken and sent to laboratory to fabricate stone models.

After mock-up validation, minimally invasive preparations were performed along the maxillary anterior teeth.

A medium round-ended diamond instrument was used on the buccal surface of the teeth to remove a uniform thickness of 0.4 mm.

All angles were rounded before final polishing and color selection.

Impressions were taken with an addition silicone and sent to laboratory for final conception.

Monolithic ceramic veneers were fabricated with translucent zirconia.

At the insertion appointment, we checked the marginal fit and interproximal contacts before selecting the shade of the final resin cement.

Teeth surfaces were etched with 35% phosphoric acid for 20 seconds, rinsed in running water, dried and treated with a universal adhesive system.

The internal bonding surfaces of the veneers were abraded with particles of aluminum and treated with a zirconia primer.

A dual-cure resin cement PANAVIA V5 was inserted into the ceramic veneers, which were placed on their respective abutements.

The additional excess cement was removed with a scalpel blade.

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Figure 1 :

Pre-operative view of the teeth

Figure 2 : Pre-operative view of the patient's smile

Figure 3: Stone casts and silicone index for mock-up

Figure 4:

Aspect of the teeth with diagnostic mock

Figure 5: Clinical aspect of the teeth after preparation

Figure 6:

Zirconia primer and dual-cure resin cement (PANAVIA V5®)

Figure 7: Final cementation of zirconia veneers

Discussion :

Dental fluorosis is a specific growth-related abnormality that could have deleterious effects on permament tooth structure.

High levels of fluoride ingestion, frequency and timing of exposure define the extent and the severity of damages.[11]

The different features of hypomineralized enamel are considered to be the main concern for patients with dental fluorosis expecting to correct their smile.[1]

Severe fluorosis was reported to have negative impact on the individuals' oral health related quality of life.[12]

Microscopically, incorporated fluoride anions increase the width of the intercrystalline space within the enamel apatite, causing pores.[3][13]

The depth of the enamel involvement increases with the severity of fluorosis.[1][14]

Various treatment approaches have been proposed for the treatment of moderate to severe flurorosis such as bleaching, abrasion, composite restorations, veneering and crowning.[15]

Among these alternatives, nonmetallic veneers are preferred for patients with oral disorders due to their lower risk of allergic reactions compared with metal alloys.

Ceramics exhibit many desirable material properties such as compressive strength, abrasion resistance, surface smoothness, diminished thermal conductivity, biocompatibility, esthetics, low plaque accumulation and color stability.[16][17]

Porcelain veneers are considered to be viable restorations with only 0% to 5% of failure rates over 1 to 5 years.[18][19]

This restoration design is highly esthetic and very effective to wear conditions. [17][19][20]

However, porcelain veneers have much higher debonding related failure rates when bonded to fluorotic teeth.[21][22]

The adhesion to enamel tissue produces more predictable results than bonding to dentin. It is, for this reason, recommanded to indicate ceramic veneers when only 30% of the enamel tissue is lost.[23]

Physical and morphological changes induced by dental fuorosis makes bonding to this substrate a clinical challenge because of the resistance of fluorapatites to acid etching.[24][25]

High fluoride concentration is usually located along the outersurface of the enamel on a 200 µm thikness.[26][27]

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The mechanical removal of this layer exposes the subsurface enamel that contains lower fluoride concentration which promotes chemical adhesion.

Furthermore, the removal of the outerlayer of flurotic enamel conserves the microtensile bond strength of laminate veneers.[27][28]

Al-Sugair and Akapta investigated the depths of etching on different levels of dental fluorosis and concluded that the etching patterns of TF=1-3 was similar to that in non fluorosed teeth.

In contrast, the typical etching pattern on teeth with TFI = 4 was obtained after 75 to 90 seconds.

Consequently, Akapta et al suggested to double etch severely damaged teeth.[27][29]

Studies suggested that etch and rinse bonding systems present higher bond strength with fluorosed teeth than that with self etch adhesives.[27][30]

With the increasing implementation of computer-aided design/computer-aided manufacturing technologies, e.max CAD crowns have shown to be resistant to fracture and suitable for posterior and monolithic restorations.[19][31]

They exibit superior fatigue resistance compared to veneered zirconia that is more prone to shipping while fracture values of monolithic zirconia are higher than those of lithium disilicate particle filled glass material.[19][32][33]

Due to its mechanical properties and shearbond strength to resin cement, lithium disilicate veneers can be considered as shield restorations in the presence of unfavorable biomechanical oral enviroment.[19][34][35]

Moreover, lithium disilicate (LS2) is 30% more transluscent than conventional zirconia which makes it exceptional regarding esthetics.[19][36]

However, theses ceramic systems have lower fracture toughness and low tensile strength.[37]

The success of veneer restorations relies on the bond durability of composite cement to the internal surface of the restauration.

Unlike zirconia, LS2 contains an etchable glass ceramic phase that is hyper sensitive to 5% concentrated hydrofluoric acid.

The acid etching promotes the micromechanical interlocking between resin cement and the intaglio surface of the restoration.

Yttria-stabilized tetragonal zirconia polycrystals (Y-TZPs) outperform lithium disilicate ceramics in terms of mechanical properties.

3Y -TZP possesses the highest strength and fracture resistance thanks to high tetragonal particles that lead to transformation toughening preventing crack propagation.[38]

Nevertheless, theses mechanical properties decrease with veneering and may lead to chipping.[39][40][41][42]

Over time, monolithic full contour designs of zirconia hve gained popularity over porcelain-veneered zirconia as they preserve more dental tissue allowing reduced prosthetic space.[43][44]

The increasing of the yttria content (up to 5 mol%) and the replacement of certain tetragonal zirconia grains with cubic ones has led to diminish the light scattering and the birefringence at grain boundaries.[38]

The 5 mol% cubic phase zirconia is found to be more resistant to aging behavior than 3 mol% yttria-stabilized tetragonal zirconia (3Y-TZP).[44][45]

5Y-PSZ can offers ultrtranslucency that is similar or even higher than that of (LS2) ceramic.[44][46][47]

Other studies have reported that lithium disilicate has higher levels of translucency than that of cubic-phase zirconia.[44]

Unfortunately, 5Y-PSZ lost a part of its toughening mechanism when acquiring translucency.[44][48]

A recently developed method combines two generations of zirconia onto a unique blank to benefit from their mechanical and esthetic properties.[38][49}

Althougth considred as resistant to compression, ceramic material behaves differently from metal alloys when putted under oral functional stress.

They are brittle and cannot undergo plastic deformation.

Excessive masticatory forces may cause irreversible surface damages.

Therefore, the type of the permanent luting agent have a significant influence on the clinical success of theses restorations.[50]

Consequently, adhesive bonding with composite resin are mainly used to improve retention of ceramic restorations, increase fracture resistance and reduce microleakage.[51][52]

Hydrofluoric-acid etching, followed by the application of a silane coupling agent, is recommended for silicate ceramics.[50]

Studies have reported unsustainable results about the bond strength of resin cement to metal-oxide-based ceramics such as Y-TZP and Y-PSZ.[42][53][54]

Other studies suggest to improve the microchemical interlocking, surface wettability and chemical bonding with a suitable surface conditioning such as air abrasion with silica-coated alumina particles [42], tribochemical silica followed by silane coupling agent application or the use of universal adhesives containing functional phosphate monomers.[55]

A recent review have demonstrated the effect of resin bonding on long term success of high-strength ceramics and suggested to use self-adhesive resin cements for zirconia restorations that do not require bonding.[56]

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The APC zirconia-bonding approach includes three practical steps: (A) airparticle abrasion with 50 to 60 µm alumina particle at a low speed (below 2 bar), (P) specefic zirconia primer containig phosphate monomers, and (C) dual or self-cured adhesive composite resin.

Conclusion :

Dental fluorosis is a disease that affects esthetics and function.

Thanks to the development of biomaterials and processing technologies, translucent zirconia ultrathin veneers provide strength and satisfactory esthetics.

However, further clinical investigations are needed to recommand this type of restauration material, especially, in cases of dental flurosis.

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