Case Report: In-office bleaching, microabrasion, and resin infiltration for the correction of hypomineralized esthetic defects
[version 1; peer review: 1 approved, 1 approved with reservations]

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Abstract
Enamel hypomineralization is a condition that affects the quality of enamel, resulting in a change in its translucency and color. In this case report, a patient with a chief complaint of discolored front teeth, represented a very interesting case as he had combined opaque white, brown discoloration, and pitted enamel well distributed over the entire facial surfaces of enamel, especially his anterior teeth. It was also found that tooth #10 was protruded in relation to the adjacent teeth. The patient’s main concern was to improve his aesthetic appearance. Despite being a typical clinical picture of fluorotic lesion, fluoride was excluded as the cause of his lesions as the patient’s history indicated a lack of exposure to fluoride. A combined minimally invasive treatment, consisted of teeth bleaching, microabrasion, and resin infiltration were performed to address these esthetic problems. Minimum tooth reduction plus resin composite placement was done to solve the problem of the protruded tooth. All materials used was placed according to the manufacturer's instructions. Intraoral photographs were taken directly after each treatment to document any change in the appearance of the case. Six months follow up of the case was documented. The result was acceptable for the patient, and he was satisfied as more aggressive treatments were avoided.

Keywords
Hypomineralization, resin infiltration, microabrasion, bleaching
Introduction
Hypomineralization defects are considered one of the most common reasons patients seek esthetic dental treatment. However, management of such defects is always challenging as they imply proper identification of the cause, nature, severity of the defect, and proper understanding of all available treatment modalities that suit various degrees of the defect, thus achieving satisfactory results.

The probable etiological factors for enamel hypomineralization defects in permanent teeth can be broadly divided into two main categories, according to whether those defects have a localized or generalized distribution. Localized hypomineralization defects could be caused by trauma, localized infection, and irradiation. While generalized (diffuse) hypomineralization may be caused by a wide range of factors. Genetic disorders resulting from a single gene defect, as an X-linked, autosomal dominant or autosomal recessive trait are considered one of the factors. Fluoride intoxication is one of the most common types of intoxications that causes enamel hypomineralization. Fluorotic lesions are characterized by opaque white spots or discolorations ranging from yellow to dark brown. The severity of those lesions depends on the duration and amount of fluoride intake during tooth development. Perinatal and postnatal illnesses that may occur in premature and low birth weight neonates could be also responsible for the occurrence of enamel hypomineralization. Infectious diseases and fever during early childhood such as chickenpox, measles, and mumps have also been linked to the occurrence of hypomineralization defects.

Case presentation
A 27-year-old single Egyptian male, working as a clothes vendor, visited the outpatient clinic of Operative Dentistry Department, Faculty of Dentistry, Cairo University in March 2017 requesting to remove the discoloration from his front teeth. The patient was not satisfied with his smile because of the discolored teeth. He was healthy, with no systemic diseases. The patient’s dental history showed an irregular attendance to dental care with history of fillings, root canal fillings, and extraction.

Clinical examination showed a diffuse opaque white spots and streaks, together with subsurface brown discolorations and pitted enamel representing severe hypomineralization. Figure 1 illustrates the pre-operative photos of the case. This clinical appearance was very confusing concerning its cause, as it has long been considered a typical clinical picture of enamel fluorosis. Nevertheless, developmental defects of enamel with similar appearances are not necessarily caused by similar aetiologic factors.

Conversely, the same aetiologic factors can produce different defects at different stages of tooth development. Consequently, not all white or brown hypomineralized enamel are caused by fluorosis. In addition, the medical history of this patient was noncontributory regarding his exposure to fluoride, as this patient did not report that he had lived in an area where water is fluoridated during his childhood, nor had he taken any fluoride supplements. Thus, based on the patient’s history, fluoride was excluded to be the cause of hypomineralization.

The patient had calculus deposits on the upper left canine and premolar teeth, and bleeding on probing, thus full mouth debridement was performed together with instructions about maintenance of good oral hygiene. Besides, the clinical and diagnostic cast examination revealed a protrusion (malalignment) of tooth #10 relative to the adjacent teeth. In addition, teeth #21 and #32 were badly decayed. Tooth #21 was restored with a root canal treatment, ready-made post, resin composite core, and a definitive full coverage restoration. As for teeth #32, root canal treatment, and a definitive composite restoration was made.

Periapical radiographs (Figure 2) showed that teeth #19 and #30 had periapical radiolucencies related to their defective root canal fillings. Tooth #19 was extracted as it was unrepairable. While tooth #30 was subjected to a re-treatment of its root canals, and a definitive composite restoration.

The initial treatment plan for the hypomineralization defects was presented to the patient, this included in-office bleaching with 35% hydrogen peroxide (polooffice in-office Tooth Whitening System, SDI Australia, 7700031) to target the brown discolorations, followed by resin infiltration to mask the white spot areas with Icon (DMG Germany, 220343). The patient was informed that the correction of the protruded tooth #10 would have to be delayed until after completion of the whitening and resin infiltration procedures.

One session of 3 applications of an in-office whitener (polooffice in-office Tooth Whitening System, SDI Australia, 7700031) was performed for the patient, each of 8 minutes duration. The patient mentioned no post-treatment sensitivity, and no inflammation in his soft tissue was observed. The patient was informed that a period of 3 weeks was necessary between the bleaching sessions and the resin infiltration procedures. Figure 3 illustrates the clinical picture after the in-office bleaching, it was noticed that a residual light brown color still remains on the anterior teeth especially tooth #8. It was decided at this moment that a change in the initial treatment plan would have to occur, and that teeth microabrasion (Opalustre, Ultradent USA, 555) was going to be carried out before resin infiltration to selectively target those resistant stains.

The disappearance of those resistant stains was evident immediately after the microabrasion session (Figure 4). The patient returned to the clinic one week later for the resin infiltration procedures (Figure 5 & Figure 6). The patient was now told at this stage of the treatment plan that he would have the correction of his protruded #10 done two weeks after completion of the resin infiltration. All the materials used in this case were applied according to the manufacturer’s instructions. Table 1 illustrates the materials used in this clinical case, their composition, and catalogue number. Table 2 illustrates the timeline of the esthetic rehabilitation of the case.
Figure 1. Pre-operative photographs of the case. (a) Smile view. (b) Frontal retracted view. (c) Right side retracted view. (d) Left side retracted view. (e) Maxillary occlusal view. (f) Mandibular occlusal view.

Figure 2. Periapical radiograph of tooth #19 and #30. (a) Periapical radiograph of tooth #19. (b) Periapical radiograph of tooth #30. (c) Periapical radiograph of tooth #30 after endodontic re-treatment and a definitive restoration.
Figure 3. After in-office bleaching. (a) Frontal retracted view. (b) Right side retracted view. (c) Left side retracted view.

Figure 4. Microabrasion procedure. (a) Application of Opalustre microabrasion gel. (b) After microabrasion, frontal view. Notice the brightening of the brown stain that was present on tooth #8. (c) After microabrasion, right sided view. (d) After microabrasion, left sided view.
Figure 5. Resin infiltration procedure. (a) Icon-Etch gel (DMG Germany) was applied to the surface and left undisturbed for two minutes. The gel was thoroughly rinsed with water for 30 seconds. The teeth were then air dried with water- and oil-free air for 15 seconds. (b) Icon-dry (DMG Germany) was applied to the surface and left undisturbed for 30 seconds. The teeth were then air-dried with water- and oil-free air for 15 seconds. (c) Icon-Infiltrant (DMG Germany) was applied and left undisturbed for three minutes. Excess material was gently air-blown to prevent pooling around the incisal edge. (d) Excess resin was removed with dental floss. The resin was then light cured for 40 seconds in each tooth. Notice the difference between the resin infiltrated lateral, canine, and the other teeth.

Figure 6. Clinical aspect of the teeth after resin infiltration. (a) Frontal view. (b) Right sided lateral view. (c) Left sided lateral view.
Table 1. The materials used in this clinical case and their composition.

<table>
<thead>
<tr>
<th>Material (Manufacturer)</th>
<th>Composition</th>
<th>Catalogue number</th>
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| polaoffice in-office Tooth Whitening System (SDI, Australia) | Pola Office Liquid 35% Hydrogen peroxide 65% Water  
 Pola Office Powder 73.26% Thickeners 26.2% Catalysts 0.04% Dye 0.5% Desensitizing agents  
 Gengival Barrier 83.95% Methacrylic ester 16% Silica 0.04% Pigment 0.01% Butylated hydroxy toluene | 7700031 |
| Opalustre (Ultradent, USA) | 6.6% hydrochloric acid plus silicon carbide microparticles. | 555 |
| Icon (DMG Germany) | Icon Etch: 15% hydrochloric acid  
 Icon Dry: 100% ethyl alcohol  
 Icon Infiltrant: TEGDMA, additives, and initiators | 220343 |
| OptiBond All In-One (Kerr, Italia), single step self-etch adhesive system | Acetone, ethyl alcohol, uncured methacrylate ester monomers, inert mineral fillers, ytterbium fluoride, photoinitiators, accelerators, stabilizers, water | 29670 |
| Herculite XRV Ultra (Kerr, Italia) | Organic part: Bis-GMA1, TEGDMA2, Bis-EMA3  
 Inorganic part: Barium glass (0.4 lm; silica, 20–50 nm); pre-polymerized filler barium glass and silica  
 Filler load 78% wt (57% vol) | 34002, 34019 |

Abbreviations: Bis-GMA, Bisphenol A diglycidylmethacrylate; TEGDMA, Triethyleneglycoldimethacrylate; BIS-EMA, Bisphenol A polyethylene glycol diether dimethacrylate

Table 2. Timeline of the esthetic rehabilitation of the case.

<table>
<thead>
<tr>
<th>Time</th>
<th>Event</th>
</tr>
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<tbody>
<tr>
<td>0</td>
<td>Patient visited clinic, history, clinical and radiographic examination</td>
</tr>
<tr>
<td>0</td>
<td>Full mouth debridement, and oral hygiene instructions</td>
</tr>
<tr>
<td>+ 3 weeks</td>
<td>In-office bleaching</td>
</tr>
<tr>
<td>+ 6 weeks</td>
<td>Microabrasion</td>
</tr>
<tr>
<td>+ 7 weeks</td>
<td>Resin infiltration.</td>
</tr>
<tr>
<td>+ 9 weeks</td>
<td>Re-alignment of protruded #10 with resin composite</td>
</tr>
</tbody>
</table>

A waxed up model (Figure 7) was fabricated and shown to the patient to express his opinion. The model included the following: a slight reduction (0.5 mm) of the mesio-incisal aspect of the labial surface of tooth #10, increase of the length of the clinical crown of tooth #10 with white wax, labial realignment of tooth #10 with resin composite, with a similar realignment for tooth #7 to preserve symmetry of the frontal aspect of the teeth.

The steps that was done on the model to realign tooth #10 was duplicated inside the patient’s mouth using a putty consistency guide (zetaplus, Zhermack, C 100600) fabricated from the waxed-up model. After the resin composite shade was selected and minimal tooth reduction (0.5 mm) of the mesio-incisal aspect was carried out as previously mentioned, enamel was then etched with 37.5% phosphoric acid gel (Kerr, Italia, 31297) for 15 seconds, rinsed with water for 10 seconds, and dried with air. OptiBond All In One adhesive (Kerr, Italia, 29670) was then applied for 15 seconds in a rubbing motion, and gently air dried followed by light curing (Elipar LED curing light, 3M ESPE) at an intensity of 1200 mw/cm² for 10 seconds from the facial and palatal aspects. Resin composite was then applied in layers starting with A1 enamel shade (Herculite XRV Ultra, Kerr Italia, 34002) from the palatal aspect, followed by A2 dentin shade (Herculite XRV Ultra, Kerr Italia, 34019) to replace missing dentin and finally A1 enamel shade on the labial aspect. Each layer was light cured for 40 seconds from the both facial and palatal aspects. Finishing was carried out using a tapered flat end finishing carbide bur #7713 (MIDWEST, DENTSPLY 388529), and polishing was performed using fine, extra-fine discs (OptiDisc, Kerr 4182, 4183) and rubber cups (HiLuster Gloss PLUS Polisher, KerrHawe 2653 ). Figure 8 shows the procedure of realignment of tooth #10, and enhancing the final esthetic
outcome using resin composite restorations. Figure 9 and Figure 10 show the final photographs of the case.

Discussion

The aim of the esthetic rehabilitation in this case was to restore the patient esthetics and self-confidence in the most conservative way. The success of different treatment plans proposed for treating enamel hypomineralization cases depends on the severity of the defect. Most clinical reports aimed at conservative management of those defects have incorporated different interventions such as teeth bleaching, enamel macroabrasion, microabrasion, and resin infiltration in their treatment plans. The main difference between these reports is the sequence with which these interventions were used.

A recent clinical report has recommended masking enamel fluorosis stains using at home bleaching with 10% carbamide peroxide in an overnight tray as a first phase of treatment, followed by resin infiltration to mask the residual white spots. They did not recommend the use of in-office bleaching as it would cause post-treatment sensitivity. On the contrary, in-office bleaching was used in our case because the patient compliance

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**Figure 7.** Waxed up model. (a) Frontal view. (b) Palatal view.

**Figure 8.** Re-alignment of tooth #10 using resin composite. (a) All prepared enamel was etched with 37.5% phosphoric acid gel for 15 seconds. (b) OptiBond All In One adhesive was applied for 15 seconds in a rubbing motion, air dried and then light cured. (c) Trimmed putty consistency index containing A1 enamel shade composite to be adapted on the palatal surface of tooth #10. (d) Tooth #10 having a palatal wall of A1 enamel. (e) Sectional matrix placement. (f) Tooth #10 after re-alignment, finishing and polishing.
to wear a tray was doubtful, additionally no sensitivity was reported after the treatment.

The second phase of the treatment in our clinical case included enamel microabrasion. This was opposite to a previous report, who recommended resin infiltration as a second phase rather than microabrasion. They stated that resin infiltration would be more conservative as it removes only 40 µm of surface enamel, while microabrasion removes up to 200 µm of enamel corresponding to 10 applications. In our case, only 2 applications of microabrasion, which contains 6.6% HCl and silicon carbide, was carried out, which removed 50 µm of the enamel surface which is nearly equivalent to the amount removed during resin infiltration, and was sufficient in our case to remove those residual brown stains. In addition, the procedure of resin infiltration blocks the enamel from the labial
surface because of the thin layer of resin coating the surface, and this would preclude the use of any further intervention from the labial surface (the most important surface). It is for this reason that the previous case report had to apply the bleaching gel from the lingual surface to target a residual yellow color after bleaching was carried out. Microabrasion also harmonized the color of the tooth after bleaching, and prepares the surface for resin infiltration.

A previous case report has recommended microabrasion as a first stage in treating hypomineralization defects. They used an ultrafine diamond bur (macroabrasion) followed by eight applications of the microabrasion gel. After one week, the microabrasion procedure was repeated, and finally three sessions of in-office whitening (35% hydrogen peroxide) were carried out. This approach was considered to be aggressive because of the enamel removal by macroabrasion.

In another case report, two sessions of an in-office bleaching, three applications in each session was the starting protocol for such case. This was followed by 12 applications of the microabrasion material. This was consistent with the strategy adopted in our case, except that the number of applications of the bleaching material and that of the microabrasion material was quite big, so it may be considered also an aggressive treatment.

Realignment of tooth #10 and #7 was carried out in our current case using minimum reduction (0.5 mm) of the mesio-incisal surface, increase in its clinical length, and re-shaping using resin composite. This was considered a perfect alternative for patients unwilling to undergo orthodontic treatment, or when ceramic restorations are not feasible. Resin composite was used to create an optical illusion that the protruded teeth were realigned, conforming to the shape of the arch, and the result was quite acceptable for our patient. Figure 10 illustrates six months postoperative evaluation of the patient and he was satisfied with the result.

Patient perspective
The patient was pleased with the provided conservative treatments, he preferred the use of as few clinical procedures as possible. He was satisfied with the outcome and his self-esteem was improved.

Conclusion
The proper management of hypomineralization defects depends on the evaluation of the severity of the defect, and proper evaluation of the outcome after each single step of intervention rather than predetermined interventions based on anticipated outcomes. Thus, we consider in-office teeth bleaching, followed by microabrasion, and resin infiltration an acceptable method in treating hypomineralization discolorations.

Consent
Written informed consent for publication of the clinical details and images was obtained from the patient.

Data availability

Underlying data
All data underlying the results are available as part of the article and no additional source data are required.

Author contributions
Ahmed Zakaria Aboelenein: Data Curation, Investigation, Writing – Original Draft Preparation.
Mona Ismail Riad: Supervision, Writing – Review & Editing.
Mohammed Fouad Haridy: Project Administration, Writing – Review & Editing.

Grant information
The author(s) declared that no grants were involved in supporting this work.

References

tooth bleaching, enamel microabrasion, and direct adhesive restorations. Gen
PubMed Abstract

12. Sammarco G: Combined minimally invasive treatment of white and brown
PubMed Abstract
Open Peer Review

Current Peer Review Status: ✓ ❓

Version 1

Reviewer Report 23 August 2019

https://doi.org/10.5256/f1000research.21603.r52646

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Michael J Wicht
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The authors submitted a clinical case report about a full mouth rehabilitation of a young male patient exhibiting moderate to severe enamel defects and staining resulting in an unfavorable aesthetic appearance. The patient’s chief complaint was to enhance anterior teeth aesthetics and overall appearance. The hidden message was a negative self-image and restricted self-confidence mainly due to discoloration.

The treatment plan consisted of a hygiene phase, in-office tooth whitening, micro-abrasion, resin infiltration and minor aesthetic corrections using composite restorations. On a different note, an endodontic re-treatment as well as the extraction of a so called un-restorable molar were performed.

The manuscript is well organized and the case is really worth to be reported because it shows, in an outstanding manner, that minimal interventions can result in excellent clinical results even from an aesthetic point of view and concomitantly enhance oral health and self-esteem.

Unfortunately, the manuscript also contains numerous errors and suffers from shortcomings that are worth being addressed and revised accordingly. In the following, I’d like to itemize my suggestions for improvement:

- I would like to read more about the patient’s expectations. What exactly did he want to achieve, what would he be able to invest, were there any no-goes?

- Are there any anomalies regarding his anamnesis or family history? I have the feeling that there was something overlooked.

- Does the patient smoke or regularly consume any discoloring foods or beverages?

- Why is it important to mention that the patient is single? Please explain in detail or just leave it. To me it sounds slightly discriminating.
Figure 2 A and B are inverted which is quite confusing.

I would love to read more about the decision-making process. What alternatives were presented, why did the patient go for this option? Was he informed about risks and side-effects, if yes, which ones? Was the decision-making participatory or was it just a recommendation.

To me, one, if not the, major success was the absence of gingivitis after treatment. Apparently, the full mouth debridement has been beneficial. However, and this should be taken into consideration as well, the patient was seemingly motivated to intensify his oral hygiene substantially. Was this effect stable over the observation period? The resolution was not high enough to comment on this from my side.

In the discussion part compliance should be replaced by willingness (second paragraph).

The literature falls short of the actual state of art. Please see Schoppmeier et al. 2018, da Cunha Coelho et al. 2019, di Giovanni et al. 2018 for more recent citations.1,2,3

The discussion is mostly oriented towards materials and methods used for operative care. This is fine; however, as I mentioned before the most precious aspect of this case to me is the cost-benefit analysis relative to Oral Health related Quality of Life. I would appreciate to see a focus also on that patient-centered outcome as well.

I like the patient’s perspective part a bit more detailed.

Finally, the manuscript needs linguistic revisions, it contains too many errors.

In summary, I encourage the authors to consider my thoughts in order to make this good case an excellent one depicting that modern dentistry can affect a great deal without sacrificing too much time, money and, first and foremost, tooth substance.

References

Is the background of the case’s history and progression described in sufficient detail?
Partly

Are enough details provided of any physical examination and diagnostic tests, treatment given and outcomes?
Partly

Is sufficient discussion included of the importance of the findings and their relevance to future understanding of disease processes, diagnosis or treatment?
Partly

Is the case presented with sufficient detail to be useful for other practitioners?
Yes

Competing Interests: I regularly collaborate with DMG, Germany in terms of clinical studies, key-opinion leader meetings, global presentations and scientific symposia for which I receive remuneration.

Reviewer Expertise: Cariology, doctor-patient interaction, decision-making process, aesthetic rehabilitation, bleaching, resin-infiltration

I confirm that I have read this submission and believe that I have an appropriate level of expertise to confirm that it is of an acceptable scientific standard, however I have significant reservations, as outlined above.

Reviewer Report 26 July 2019
https://doi.org/10.5256/f1000research.21603.r50917

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Marco Storari
University of Cagliari, Cagliari, Italy

We reviewed the article sent to us. In our evaluation, the organization is well-defined with a brief but complete introduction, interesting comparisons in the discussion and a precise presentation of the case. In this very last part however, we found a paragraph that we consider not appropriate at all in the context of the case discussion and is also somehow repetitive; thus, probably, it would sound better in the introduction.
It would be necessary to insert some more recent citations.
Lastly, a little grammatical mistake about the verb “to be” is present in the introduction.

Is the background of the case’s history and progression described in sufficient detail?
Yes

Are enough details provided of any physical examination and diagnostic tests, treatment given and outcomes?
Yes

Is sufficient discussion included of the importance of the findings and their relevance to future understanding of disease processes, diagnosis or treatment?
Yes
Is the case presented with sufficient detail to be useful for other practitioners?
Yes

Competing Interests: No competing interests were disclosed.

Reviewer Expertise: Dental Traumatology, Prosthetic Dentistry, Paediatric Dentistry, Orthodontics, Conservative Dentistry

We confirm that we have read this submission and believe that we have an appropriate level of expertise to confirm that it is of an acceptable scientific standard.

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