

Case Report

Spectrophotometric analysis of Icon[®] treatment outcome in two celiac siblings with developmental defects of enamel, a case report

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ABSTRACT

Developmental defects of enamel (DDE) are common oral manifestation of celiac disease whose onset can overlap to teeth calcification in permanent dentition. The defects of the enamel symmetrically and chronologically occur in all the four quadrants, particularly in maxillary and mandibular incisors and molars. Icon[®] infiltration technique is a minimally invasive procedure for DDE treatment. This paper reports two cases of treatment of celiac siblings with aesthetic purpose. The aesthetic evaluation was made by means of spectrophotometry as a standardized method. International Commission on Illumination (CIE) $L^*a^*b^*$, ΔE variations, contrast ratio (CR), and opalescence, measured against black and white backgrounds before and after the treatment, provide all the quantitative information about the outcome of the Icon[®] infiltration technique. Icon[®] infiltration technique has been showed to be an effective procedure for DDE treatment.

Keywords: Aesthetic outcome, celiac disease, developmental defects of enamel (DDE), Icon[®] infiltrative technique, spectrophotometry

INTRODUCTION

Celiac disease is a common, chronic, multisystem disorder that can start at any age with gluten diet. The villous atrophy damage to the small intestinal mucosa generated by an autoimmune mechanism causes malabsorption of macro- and micronutrients. Celiac disease can be treated by a strict lifelong gluten-free diet.

Developmental defects of enamel (DDE) and aphthous ulcers are the most common and well-documented oral

manifestations among both children and adults with celiac disease; these have been proposed as a possible diagnostic sign of "silent" celiac disease.^[1] Enamel hypoplasia and hypomineralization or a combination of the two can occur. Scanning electron microscopy (SEM) analysis of hypoplastic teeth of celiac children evidenced less mineralization and more irregular enamel organization.^[2]

DDE symmetrically occur in permanent dentition, particularly in maxillary and mandibular incisors and molars.^[1] The chronology of teeth calcification in permanent and temporary dentition can indicate the onset of celiac disease. According to Evans, the most critical period for developing DDE in the permanent central incisors is 15-24 months for males and 21-30 months for females.^[3]

This case report describes the usage of a quantitative spectrophotometric method to evaluate the clinical outcome

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Quick Response Code:



Website:
www.jresdent.org

DOI:
10.4103/2321-4619.168729

of a minimally invasive treatment of DDE in celiac patients performed with Icon® (DMG, Hamburg, Germany).

Spectrophotometric measurements are International Commission on Illumination (CIE) $L^*a^*b^*$, ΔE variations, contrast ratio (CR), and opalescence, measured before and after the treatment.

CIE $L^*a^*b^*$: The L^* value (y -axis) measures the lightness ranging from 0 (black) to 100 (white), the a^* value measures redness ($a^* > 0$) or greenness ($a^* < 0$), and the b^* value measures yellowness ($b^* > 0$) or blueness ($b^* < 0$). Color shade variation (ΔE) is calculated upon CIE $L^*a^*b^*$ variables, according to Ardu's formula.^[4] CR measures transparency (i.e., opacity). Opalescence is the reflectance of blue wavelength when white light strikes the object perpendicularly.^[4]

CASE REPORT

The cases of two celiac female siblings with DDE have been described.

Intraoral photographs (Nikon D90, 105mm Macro lens, R1C1 Macro flash, Nikon Europe) were taken that represent the visual clinical assessment, before and after the DDE treatment, to be compared to spectrophotometric measurements against black ($L^* = 1.6$, $a^* = 1.2$, $b^* = -1.0$) and white ($L^* = 92.8$, $a^* = -1.5$, $b^* = 0.9$) backgrounds.^[5,6]

A calibrated reflectance spectrophotometer (SpectroShade, MICRO, Serial N HDL1407, MHT, Arbizzano di Negrar, Verona, Italy) was used for quantitative assessment, the device being perpendicular to the clinical crown labial surface in order to obtain reproducible measurement conditions.

Trained operators performed Icon® infiltration and SpectroShade assessments, and digital photographs were taken.

Consent for the treatment was obtained. The teeth were cleaned, rubber dam was placed, and resin infiltration was performed according to the manufacturer indication (etching up to three times, followed by the drying agent). The Icon® infiltrant was applied and allowed to penetrate for 3 min. The excess material was removed and the teeth were flossed and light-cured for 40 s. The infiltrant was reapplied and light-cured for 40 s [Figure 1]. Then the teeth were polished. Measurements were noted again at a week's follow-up.

To define the effectiveness of this treatment, the MHT software divides the vestibular tooth area into three equal zones (gingival, central, and incisal) along the median axis. Comparison with photographic images

taken before the treatment was done to identify the sound and the DDE areas of the tooth. ΔE was calculated before and after the treatment in each of the three dental areas to assess the colorimetric variation. ΔE variation quantitatively assesses the amount of shade difference before and after the Icon treatment and correlates it to human eye perception. $\Delta E > 3.3$ indicates a detectable

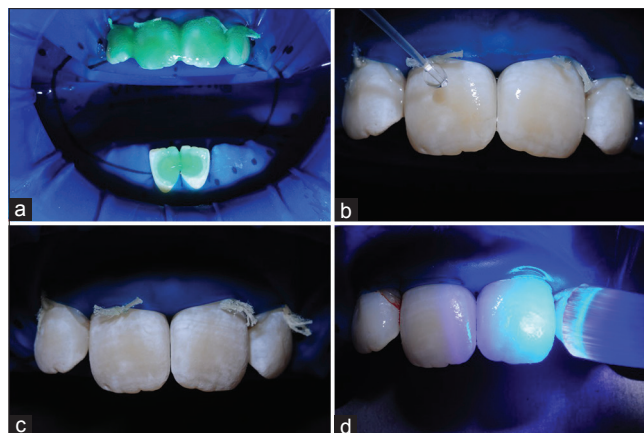


Figure 1: Icon® procedure



Figure 2: (a and b) pt 1 before Icon® treatment (c and d) pt 1 after Icon® treatment



Figure 3: (a and b) pt 2 before Icon® treatment (c and d) pt 2 after Icon® treatment

color difference, ΔE between 3.3 and 1.1 indicates no important difference to human eye evaluation, while $\Delta E < 1.1$ indicates no visible difference.

Patient 1

C. M., aged 14 years, presented with celiac diagnosis in 2008. Yellow, brown, and white multiple diffuse opacities on the clinical crown of the four upper incisors and a patchy yellow defect on the vestibular surface of both the lower central incisors were detected. According to Aine *et al.*,^[7] all the defects were scored as Grade 1. The etching procedure was repeated thrice [Figure 2].

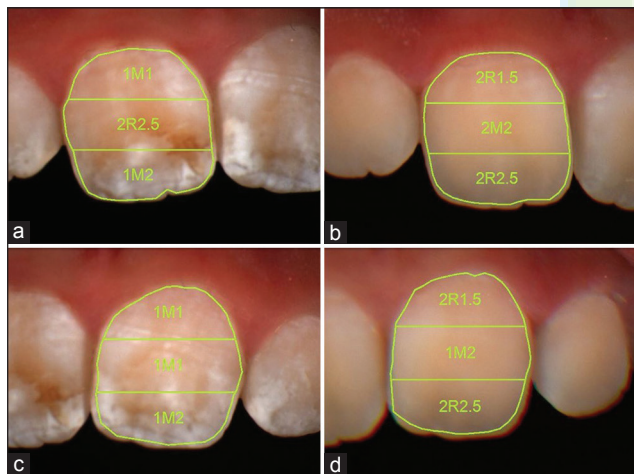
Patient 2

C. G., aged 18 years, presented with celiac diagnosis in 2008. At that time, the girl presented osteoporosis with vitamin D3 and calcium deficiency. Increased calcium and vitamin D3 intake, sun exposure, and weight training did not lead to satisfactory results; so oral administration of bisphosphonate (Actonel) was prescribed. Grade 1 white and yellow diffused DDE with confluent yellow and brown strié were detected on all the upper teeth. The etching procedure was repeated twice [Figure 3].

DISCUSSION

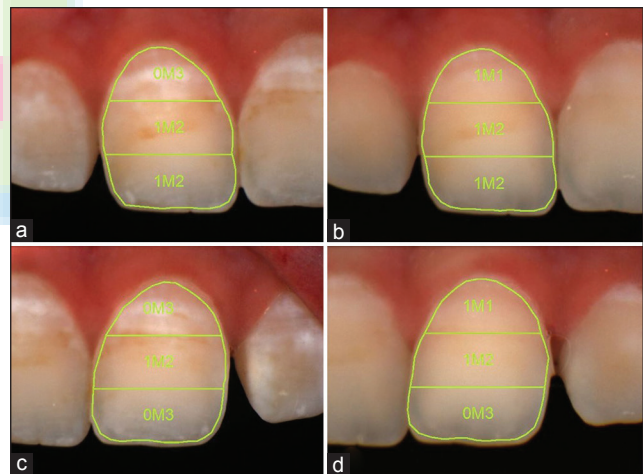
According to Um *et al.*,^[8] we analyzed ΔE of each zone before and after Icon® treatment. The ΔE , opalescence, and CR (transparency) results of the two cases are reported in Tables 1 and 2. Consistent with the finding of Paris *et al.*,^[9] in these cases the infiltrated lesions “took the appearance of the surrounding sound enamel,” while the sound areas (as per photographs) scored < 1.1 . ΔE values ranged 0.90-6.32. Every zone presenting a defect showed $\Delta E > 3.3$. Values < 1.1 refer to sound enamel as shown in the clinical photographic documentation [Figures 2 and 3]. Due to diffuse DDE distribution, it was impossible to identify the specific demarcated affected/sound areas. Thus, we evaluated the whole area (incisal, central, and gingival) shade variation. The goal of our treatment is to show a visible change (i.e., higher ΔE between the measurements) in color matching in the affected areas and low ΔE scores in the unaffected areas [Figures 4 and 5].

Overall opalescence in the incisal zone was higher after treatment, much higher in the central zone, and was equal or lower than before in the gingival zone. CR in all the zones decreased after the treatment.



(a) 1.1 before Icon® treatment
 Incisal: $L^* = 72.25$ $a^* = 2.19$ $b^* = 13.05$
 Central: $L^* = 73.92$ $a^* = 4.40$ $b^* = 21.80$
 Gingival: $L^* = 75.88$ $a^* = 4.07$ $b^* = 15.22$
 (b) 1.1 after Icon® treatment
 Incisal: $L^* = 69.60$ $a^* = 1.17$ $b^* = 17.61$
 Central: $L^* = 76.05$ $a^* = 2.51$ $b^* = 20.29$
 Gingival: $L^* = 74.33$ $a^* = 5.70$ $b^* = 16.84$
 (c) 2.1 before Icon® treatment
 Incisal: $L^* = 73.90$ $a^* = 1.85$ $b^* = 12.69$
 Central: $L^* = 78.71$ $a^* = 3.24$ $b^* = 14.30$
 Gingival: $L^* = 76.13$ $a^* = 5.69$ $b^* = 13.09$
 (d) 2.1 after Icon® treatment
 Incisal: $L^* = 70.35$ $a^* = 1.35$ $b^* = 17.53$
 Central: $L^* = 76.87$ $a^* = 2.54$ $b^* = 17.14$
 Gingival: $L^* = 72.92$ $a^* = 5.99$ $b^* = 17.45$

Figure 4: Pt 1 spectrophotometric analysis



(a) 1.1 before Icon® treatment
 Incisal: $L^* = 74.01$ $a^* = 0.58$ $b^* = 12.33$
 Central: $L^* = 78.56$ $a^* = 2.43$ $b^* = 20.74$
 Gingival: $L^* = 79.93$ $a^* = 4.10$ $b^* = 11.44$
 (b) 1.1 after Icon® treatment
 Incisal: $L^* = 72.61$ $a^* = 0.01$ $b^* = 13.10$
 Central: $L^* = 78.31$ $a^* = 1.64$ $b^* = 20.40$
 Gingival: $L^* = 77.65$ $a^* = 4.37$ $b^* = 15.73$
 (c) 2.1 before Icon® treatment
 Incisal: $L^* = 74.46$ $a^* = 0.34$ $b^* = 10.37$
 Central: $L^* = 79.21$ $a^* = 2.11$ $b^* = 17.26$
 Gingival: $L^* = 79.07$ $a^* = 4.14$ $b^* = 11.28$
 (d) 2.1 after Icon® treatment
 Incisal: $L^* = 74.46$ $a^* = -0.32$ $b^* = 12.11$
 Central: $L^* = 80.00$ $a^* = 1.40$ $b^* = 17.40$
 Gingival: $L^* = 77.35$ $a^* = 4.50$ $b^* = 16.12$

Figure 5: Pt 2 spectrophotometric analysis

Table 1: Patient 1 upper incisors ΔE , CR, and opalescence before and after Icon® treatment

Tooth	Opalescence			CR %			ΔE black		
	Incisal	Central	Gingival	Incisal	Central	Gingival	Incisal	Central	Gingival
Pt. 1									
1.1 before	3.80	3.95	2.31	84.25	94.60	95.93	5.37	3.22	2.77
1.1 after	5.21	21.95	2.10	73.39	93.73	100.13			
1.2 before	5.53	10.14	2.07	79.74	89.47	92.80	5.65	4.45	4.67
1.2 after	5.40	19.03	2.93	76.10	88.91	91.00			
2.1 before	5.23	1.95	1.43	86.56	97.91	107.02	6.02	3.46	5.42
2.1 after	5.11	19.60	0.45	80.36	100.65	101.33			
2.2 before	1.96	3.08	2.26	85.00	93.20	95.83	5.99	5.62	4.18
2.2 after	3.40	16.92	1.81	81.51	95.43	98.95			

Table 2: Patient 2 upper incisors ΔE , CR and opalescence before and after Icon® treatment

Tooth	Opalescence			CR%			ΔE Black		
	Incisal	Central	Gingival	Incisal	Central	Gingival	Incisal	Central	Gingival
Pt. 2									
1.1 before	2.69	1.92	2.57	85.46	95.90	100.31	1.70	0,90	4.87
1.1 after	6.46	22.10	2.50	73.13	88.88	94.12			
1.2 before	4.19	5.94	1.76	78.72	90.72	94.43	5.65	5.19	5.60
1.2 after	6.31	18.95	3.08	72.81	87.65	92.21			
2.1 before	3.42	1.93	2.95	86.75	95.03	99.0	1.86	1.07	5.15
2.1 after	5.07	18.69	2.19	77.60	91.04	93.46			
2.2 before	1.85	12.08	3.30	72.44	92.73	100,43	3.43	4.43	5.44
2.2 after	5.19	17.08	3.10	77.21	89.70	96.82			

Although manufacturer indication does not define brown discoloration as a good candidate for resin infiltration, our results show substantial improvement in the clinical appearance, independent of the initial DDE color. DDE management is challenging both for clinical procedure and for aesthetic subjective perception. The clinical outcome and consistent spectrophotometric analysis in the reported cases were overall satisfactory, especially considering the young age of the patients, when minimally invasive approach is desired.^[10]

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How to cite this article: Guerra F, Mazur M, Rinaldo F, Ottolenghi L. Spectrophotometric analysis of Icon® treatment outcome in two celiac siblings with developmental defects of enamel, a case report. *J Res Dent* 2015;3:88-91.

Source of Support: Nil, **Conflict of Interest:** None declared.