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On the permanence of tooth bleaching

Yacoub Al-Tarakemah[a,*], Brian W. Darvell[b]

[a] Dept. of Restorative Sciences, Faculty of Dentistry, Kuwait University, P.O. Box 24923, Safat 13110, Kuwait
[b] School of Dentistry, University of Birmingham, UK

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ABSTRACT

Objective. Bleaching (*alias* whitening) is increasingly the chosen means of modifying the appearance of teeth for cosmetic reasons. Behbehani et al. (2012) acquired the largest known data set for the effects of bleaching over time (300 patients for ~1 year), but the analysis then was rather superficial and did not exploit the full depth of information available in it.
Methods. Data collected by Behbehani et al. (2012) were re-analysed to explore in detail the variation in outcome between patients and over time.
Results. There is a distinct regression in shade scale value with time, taking something over 1 year to approach stability. There appears to be an intrinsic shade that cannot be altered, at around 1 unit (0.5M1 on the Vita 3D bleached shade guide). Some patients (11/300 at 1 year) appear to be worse-off after treatment, especially those with lighter starting shades, while many get no real benefit, with a change ≤2 units.
Significance. The effects of bleaching are often transient, but the reversion to a darker shade than the original may be due to the cumulative damage done to the organic matrix of enamel. The ethics of the treatment are questioned, as are over-the-counter products and whitening toothpastes. It might be appropriate to suggest to a patient that there is no point unless the shade is darker than some (Vita) shade value, say ~1M2, but in any case informed consent is in need of improvement. All observations of the effects of bleaching ought to be made on timescales longer than 1 year to be meaningful.

1. Introduction

Tooth-whitening is an increasingly popular cosmetic process that broadly is considered desirable by the public and accepted by the dental profession as a safe and reasonable treatment [1]. This is despite the acknowledged non-normal appearance of 'white' teeth and the "Hollywood" smile [2,3]. There are, however, aspects that receive, in our view, insufficient attention, despite the presence in the literature of adequate documentation.

One factor of concern in the treatment is the occurrence of sensitivity [4]. That is, the treatment has irritated the pulp (*sensu latu*). This can only have occurred because of the existence of a path of communication for the active material, *i.e.*, hydrogen peroxide, through the enamel. This may be for two reasons. The enamel is itself necessarily permeable [5–9]. It is essentially a composite structure, with crystallites of HAp embedded in a hydrous protein matrix, albeit to the extent of about 95% by volume. Were it not permeable, other than superficial discoloration from ingested materials could not occur, and thus bleaching of such subsurface color could not occur; bleaching would be no more effective than toothbrushing with abrasive. Secondly, the enamel is frequently (and

* *Corresponding author.*
E-mail addresses: yacoub@hsc.edu.kw (Y. Al-Tarakemah), b.w.darvell@gmail.com (B.W. Darvell).
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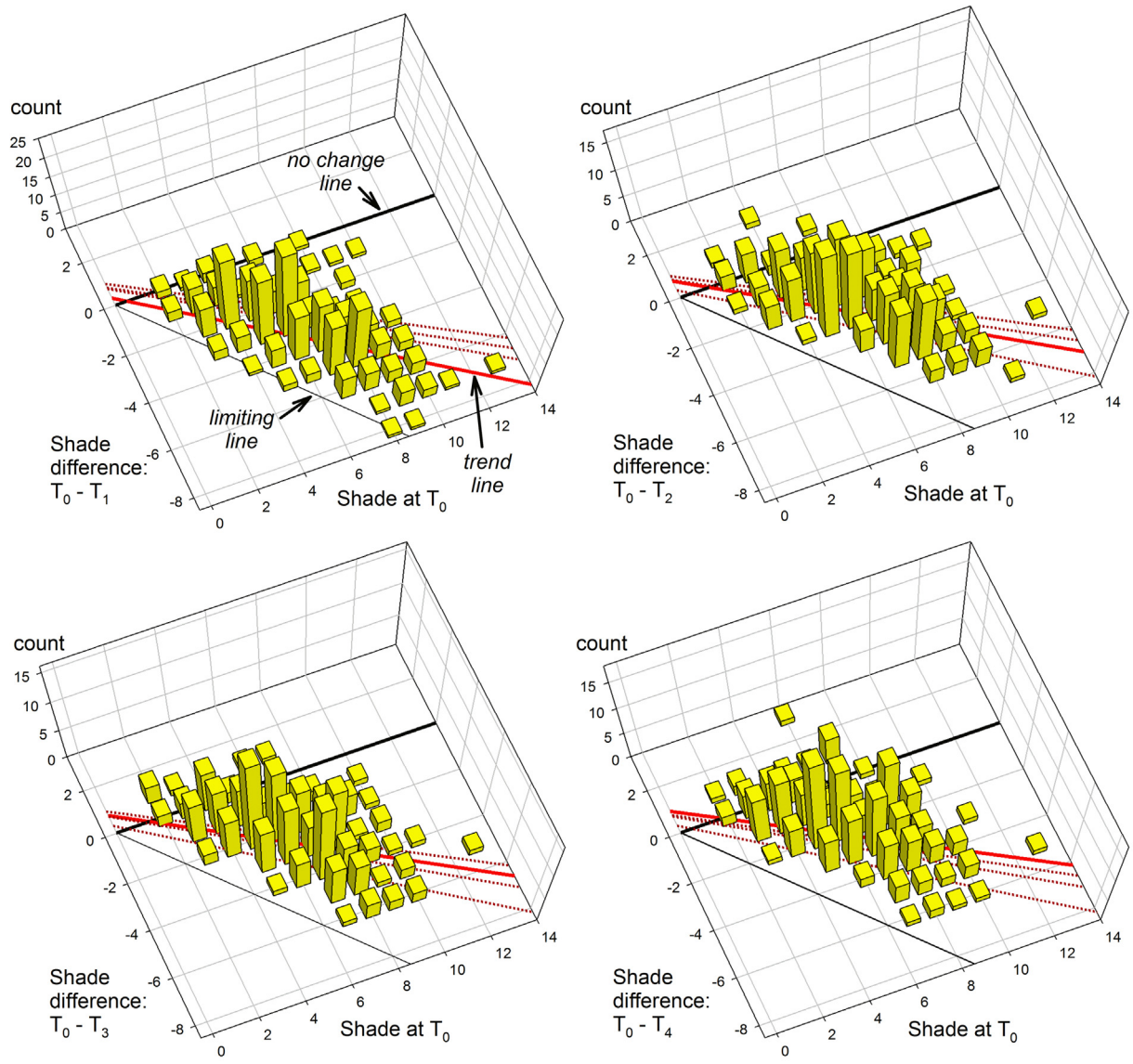

Fig. 1 – Shade scale value difference plots. Abscissa: T_0, shade scale value before treatment. Ordinate: $T_0 - T_x$, shade scale value difference at time *x* after treatment. z-axis (depth of figure): count of cases with indicated before and after values. Limiting line: corresponds to reduction to shade value zero (cannot be made lower). Trend line: fitted regression. Broken lines: trend lines from the other plots. No change line: where treatment has not altered the shade scale value from the initial condition. (For interpretation of the references to color in the text, the reader is referred to the web version of this article.)

increasingly with age) cracked [10]. This leaves a more rapidly permeable pathway deep into the substance, to at least as far as the amelo-dentinal junction [4,11]. Of course, the pulp is in direct communication at this layer through the odontoblastic processes and *via* the dentinal tubules themselves for diffusible materials [12,13]. Further evidence lies in the observation that fully-dried enamel is less translucent than fully-imbibed material because of the light scattering that occurs at air spaces, where the change of refractive index is marked.

The existence of this permeability is well understood in dentistry. It is known to provide a reservoir for the peroxide that can subsequently interfere with the polymerization of bonding agents [14].

Thus, were it a matter simply of the natural permeability of the enamel, then control to limit the extent of permeation is in principle straightforward. Indeed, this is implemented implicitly through the restriction of the concentration of peroxide in 'overnight' at-home treatment kits, and the duration of 'in-office' treatments at higher concentrations [15]. Thus, for one product range, the treatments with carbamide peroxide are: 8–10 h/day with 10%, 4–6 h/day with 15%, 2–4 h/day with 20%, 30 min/day with 35% [16]. (Curiously, assuming a first-order dependence on concentration, the exposure,