

CIELAB Tooth Colour Measurements Comparing Contact and Non-Contact Clinical Methods

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ABSTRACT

Objectives: This research evaluated in vivo tooth colour measurement reproducibility of two spectrophotometers relative to a standardised digital imaging system.

Methods: The research evaluated clinical tooth colour measurements obtained with two contact spectrophotometers compared to a standard, non-contact digital image analysis method that has been used in numerous whitening clinical trials. Repeated tooth colour measures of 1 mandibular and 3 maxillary anterior teeth (6 per method) were obtained from 8 adults over a 2-day period. The two contact spectrophotometers, VITA EasyShade® (ES) and Shofu® ShadeEye-NCC® (SE) measured colour from approximately a 3-mm spot in the middle of each tooth, while digital imaging measured average colour of the entire tooth surface. Intra-class correlations (ICC) were calculated, and residual variability determined using standard methods.

Results: The three methods yielded different raw L*a*b* values. Mean L*a*b* spot measurements were 81.2, -1.0 and 19.6 with ES and 74.4, -1.2 and 9.3 with SE, with these systems differing significantly ($p < 0.01$) with respect to mean L*a*b* values. Using imaging to measure the whole tooth yielded L*a*b* means of 75.1, 6.1 and 16.4. Each method exhibited measurement reproducibility for L*a*b*, with ICCs exceeding 0.895. Residual measurement variability for the two contact spectrophotometers ranged from 18-23% for L*, 24-25% for a*, and 15-17% for b*. Imaging yielded lower residual variability, not exceeding 15% for any colour parameter.

Conclusions: Clinical measurements of tooth colour with two spot contact spectrophotometers were generally reproducible across visits, yielding different CIELAB values and higher variability compared to overall tooth colour measurements obtained using non-contact digital image analysis.

INTRODUCTION

Reliable objective tooth colour measurement is desirable for both research purposes and in-office demonstration of tooth colour changes offered by whitening treatments. Many objective methods of comparing tooth colour are available. This research compares two commercially available systems to a proprietary, but very well characterised and published Digital Image Analysis system.

PURPOSE

There is a considerable body of tooth colour publication which has used Digital Image Analysis (DIA) as an objective measurement method. Data is reported in CIE L*a*b*. This research investigates how DIA compares to two commercially available contact spectrophotometers in terms of absolute L*a*b* and measurement variability.

MATERIALS AND METHODS

Measurement method

- 2 popular commercially available tooth colour contact spectrophotometers were selected:
 - VITA EasyShade® (ES) (L*a*b* mode)
 - Shofu® ShadeEye-NCC® (SE) (L*a*b* mode)
- Both instruments are contact spectrophotometers, which measure a 3mm spot on the tooth.
- 8 subjects had the midpoint of 4 teeth (upper right central/lateral incisor, canine and lower right central incisor) measured 6 times over 2 days.
- All subjects also had 6 digital images captured, and L*a*b* data was generated the same 4 teeth.

Analysis method

- Average L*a*b* scores for all 3 instruments were generated, to compare the raw L*a*b* numbers.
- Additionally, residual measurement variability was calculated, to establish which instrument demonstrated the best consistency of colour measurement. Lower percentage residual variability indicates a more consistent instrument.

RESULTS

All three instruments show markedly different raw L*a*b* values for measurement of the same teeth on the same subjects. This is to be expected, given the different instrument characteristics.

	L*	a*	b*
Vita	81.2	-1.0	19.6
Shofu	74.4	-1.2	9.3
DIA	75.1	6.1	16.4



Vita EasyShade®



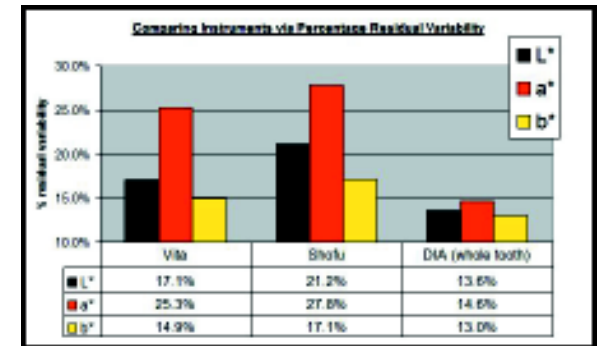
Shofu ShadeEye®



Digital Image Analysis System

RESULTS (Cont.)

- The percentage residual variability is a measure of data variability. For research purposes, a **lower residual variability is advantageous** as it allows smaller base sized tests and smaller differences between treatments to be established at a significant level.
- For all 3 colour parameters (L*, a* and b*) **the DIA system shows the lowest percentage residual variability.**
- The ES instrument shows slightly lower residual variability than the SE.



CONCLUSION

- Digital Image Analysis demonstrates **consistently lower variability** that the two commercially available tooth colour measurement systems. This system is ideally suited to tooth colour research.
- Both the commercially available systems demonstrate reasonably good reproducibility. Further work in a larger population is required to establish with confidence if one system offers a significant advantage over the other.

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