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METHOD ARTICLE

Clinical protocol for the registration of individual translucent zones of frontal teeth [version 1; peer review: 1 approved, 1 approved with reservations]

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Abstract

In contemporary dentistry, a successful restoration should not only restore the shape and function of the impaired dentition, but also contribute to the overall aesthetic appearance. In order to achieve this goal, the dental team should possess complete information about the different optical dimensions of the tooth structure. Besides the standard properties of the color, it is important to define, register and interpret the shape and position of the individual translucent zone. With the help of a device and software developed by the authors, a five step clinical protocol has been developed by the authors for individual translucent zone registration, with the help of trans-illumination. The translucent areas are then shown in a digital photograph of the teeth, analyzed and interpreted. The translucent zone is finally visualized as a 'translucent map', which is clearly defined, and is easily interpreted and used by the dental team.

Keywords

trans-illumination, translucent zone, frontal teeth

Open Peer Review

Approval Status

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Marta Mazur, Sapienza University of Rome, Rome, Italy
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Any reports and responses or comments on the article can be found at the end of the article.

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Introduction

The term trans-illumination depicts tissue diagnostics with a high intensity light beam projected through an object. The object that is studied is positioned between the light source and the observer. The method is quick, accurate, precise, and can determine the current state of the tissues, which makes it a valuable tool¹⁻³.

Trans-illumination is a well-known diagnostic concept used in dentistry. The index of light transmission of healthy tooth tissues is higher than those with caries, and differs from dental calculus. If a tooth is illuminated with sufficient intensity, those clinical findings would appear as dark spots surrounded by light, healthy tooth substance^{3,4}. Using this method fractures lines and orifices of molars, and premolars can be visualized^{5,6}. These are among the reasons why trans-illumination is most frequently applied in operative dentistry. The two devices commonly used are FOTI (fiber-optical trans-illumination) and DIFOTI (digital fiber-optic trans-illumination)^{7,8}.

Currently for trans-illumination, white LED light that is transmitted to the surveyed field through a fiber-optical handpiece is used. This ensures direct contact, without the risk of overheating the structures or causing discomfort to the patient^{8,9}. The small dimensions of the hand-piece allows direct access to all surfaces of the teeth – lingual, vestibular, occlusal - and the ability to assess hard to reach areas, for example the distal parts of the dentition³.

In comparison to X-ray imaging, the teeth can be lit from different angles, which enables the operator to assess more viewpoints. Another advantage of the method is the absence of distortion, which occurs in X-ray images because of the translation of three dimensional objects to two dimensions¹⁰. In addition, trans-illumination has better acceptance among patients because of its noninvasive nature¹¹.

In prosthetic dentistry, trans-illumination is used as a proof tool for diagnosis of cracks in ceramic masses after sintering. In cases of full ceramic crowns, the light beam is projected from the intaglio surface of the construction, whereas in cases of metal-ceramic restorations, a tangential direction is used^{3,6}.

In dentistry, translucency is defined as the gradient between transparent and opaque¹². Furthermore, the translucent zones, especially in the upper frontal teeth, play a major role in the aesthetic perception and have an impact on the vital appearance of artificial prosthetic constructions. Therefore, their correct in-office registration and recreation by the dental technician are important prerequisites for successful treatment outcome. In standard clinical conditions these areas cannot be assessed. The only commercially available device for individual translucent zone registration currently is the MHT SpectroShade (Verona, Italy), which is based on spectrophotometry. The device presents the individual translucent zone as a scale, which was developed by the manufacturers¹³.

Therefore, the objective of this article is to propose a clinical protocol for obtaining the individual localization of the translucent zone of frontal teeth with the use of trans-illumination.

Methods

All experimental work associated with the current project was approved by the Ethical Committee of Plovdiv Medical University (protocol number P-1546; approved on 13th March 2014). Written informed consent was obtained from all individuals participating in this method, which has been used in clinical practice as part of routine care.

Trans-illumination device

In order to utilize trans-illumination for individual transparent zone registration, a device called 'Apparatus for registration of translucent individual zone' (ARTIZ; shown in Figure 1) was developed by the authors. The main components of the apparatus are a power module and emitting module. The main component of the emitting module is a 10W, LZ4-00MA10 emitter (type RGBA LED, Led Engine, USA). The power module is constructed with separate drivers for each LED, based on ZXLD1360 (ZETEX) controller.

Protocol

The proposed protocol for clinical registration of the individual translucent zone is separated into five steps:

1. Ensuring access to the structures undergoing translucent zone diagnosis
 - Intraoral examination and removal of calculus/tartar, debris and food leftovers;
 - Choice of appropriate lip and cheek retractor.
2. Powering and tuning of the apparatus
3. Positioning of the hand-piece
4. Registration of the observed translucent zone with a digital photograph
5. Creation of a 'translucent map' with the use of custom-made software developed by the authors – ARTIZ-soft.

Figure 1. Armamentarium needed for clinical registration of the individual translucent zone proposed in this study.

The steps of the clinical protocol are visualized in [Figure 1–Figure 5](#). Step 2, as well as different technical peculiarities are further mentioned in the next sections.

Step 1 ([Figure 1](#))

The teeth undergoing translucent zone registration should be polished with a soft silicone brush and pumice prior to the procedure. If calculus, food leftovers or debris are present, a cleaning procedure is advised. The lip and cheek retractor should enable the operator to position the hand piece in the desired orientation and ensure direct visibility of the surveyed teeth.

Steps 2 and 3 ([Figure 2](#))

The optimal settings of the ARTIZ apparatus are white light with intensity 1 for all potentiometers. The orientation of the hand-piece depends on the position of the tooth undergoing translucent zone registration, and is up to 50° tangential to the long axis. The optimal angle is between 30–45° tangential to the lingual surface of the tooth, pointed apically.

Step 4 ([Figure 3–Figure 5](#))

The camera is fixed to the reflector of the dental unit with a standard super-clamp at an angle approximately perpendicular to the vestibular surface. This will minimize the dimensional distortion caused by the transition of a 3D object to 2D. A remote shooter is used to negate vibration and movement during the image acquisition phase. We found out that the optimal camera settings for the Canon camera are as follows:

- Exposition time: 1/260 to 1/500 s.;
- ISO: 200;
- Focal length: 6–7 cm from the vestibular surface of the diagnosed tooth.

Step 5 ([Figure 6](#))

The image is then transported into ARTIZ-soft. After some in-software image manipulation, e.g. cropping, a template representing the tooth and the shape of the translucent zone is chosen (ARTIZ-soft includes digitized templates of the different types of translucent zones according to the classification of Ralin Ralev¹⁴) in order to create a ‘translucent map’ of the tooth.

Figure 2. Lips and cheek retractor placed to ensure access to the surveyed field.

Figure 3. Optimal orientation of the hand-piece, and light intensity and color correction for ARTIZ.

Figure 4. Clinical setting for image registration and camera position.

Figure 5. Different cases with registered translucent zones.

Figure 6. Obtained image of the translucent zone (right) and translucent map (left) of a lateral incisor.

The use of ARTIZ-soft is optional, since there are image manipulation tools freely available in common open-source graphical software, e.g. [Inkscape](#), [Gimp](#), [ImageMagick](#), and using a free-draw tool the translucent zone can be recreated from Ralev's classification, as depicted in [Figure 5](#).

Discussion

The translucent zone visualized with the help of the proposed method is clearly defined and easily visible. The registration itself is fast, straightforward and takes 5 to 10 minutes. As a result, a digital image of the individual translucent zone of the tooth is created. With the help of the custom developed software ARTIZ-soft, it is possible to transform the photograph into a 'translucent map', which can be used as a guideline for different restorative procedures.

In addition to the established concept of horizontal distribution of the translucent zone, parallel to the incisal edge, with the help of trans-illumination a vertical translucent zone is visualized. This

finding complements the overall color registration procedure and gives the practitioner a more detailed information, making restorative procedures predictable.

Software availability

ARTIZ-soft is currently still in development, with a release date of early 2018. However, the method can be performed with other freely available manipulation tools, as detailed above.

Competing interests

No competing interests were disclosed.

Grant information

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The funders had no role in study design, data collection and analysis, decision to publish, or preparation of the manuscript.

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This paper tries to provide clinical protocols for the registration translucent zone of teeth. Study design is good and paper preparation was accurate.

I am wondering whether you have some idea on the opalescence of teeth correlated with translucency of teeth. In Figs 5 and 6, you might have found opalescence property of teeth. If that is possible, we can map the translucency and opalescence of teeth simultaneously.

Is the rationale for developing the new method (or application) clearly explained?

Yes

Is the description of the method technically sound?

Yes

Are sufficient details provided to allow replication of the method development and its use by others?

Yes

If any results are presented, are all the source data underlying the results available to ensure full reproducibility?

Yes

Are the conclusions about the method and its performance adequately supported by the findings presented in the article?

Yes

Competing Interests: No competing interests were disclosed.

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.

Reviewer Report 25 January 2018

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Question 3

The presented method is not really reproducible by others, as the “apparatus” described by the Authors is not yet on the market.

Question 4

The results should be presented differently, as there is a lack of standardization.

Please present the results in a more effective way, because they are unclear and difficult to be followed.

Is the rationale for developing the new method (or application) clearly explained?

Yes

Is the description of the method technically sound?

Yes

Are sufficient details provided to allow replication of the method development and its use by others?

Partly

If any results are presented, are all the source data underlying the results available to ensure full reproducibility?

Partly

Are the conclusions about the method and its performance adequately supported by the findings presented in the article?

Yes

Competing Interests: No competing interests were disclosed.

Reviewer Expertise: Preventive and community dentistry, cariology, minimally invasive procedures, technology-aided caries diagnosis, spectrophotometry applied to colourimetric evaluation of sound enamel, caries and developmental defects of enamel.

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, however we have significant reservations, as outlined above.

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