The performance of ICDAS-II using low-powered magnification with light-emitting diode headlight and alternating current impedance spectroscopy device for detection of occlusal caries on primary molars

Research Article

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It is well established that caries levels in industrialized nations have decreased over the last few decades with the greatest reductions occurring on the smooth and approximal surfaces. Because of the complex occlusal anatomy, more sensitive and reproducible diagnostic tools for precise caries detection in children are needed. Visual examination still is the most commonly used method for detecting dental caries, but various studies showed problems for sensitivity and reproducibility problems. A standardized scoring system, International Caries Detection and Assessment System (ICDAS-II), has been developed for clinical practice and research to overcome these problems. A complimentary approach to visual examination is to use visual aids such as low-powered magnification (dental loupes) and special headlights mounted on them. These visual aids became popular among dentists to improve precision of visual examination and for ergonomic reasons. Advances in caries research led novel technologies to help dentists in the diagnosis of early lesions. ACIS device (Cariscope PRO, Dundee, Scotland) is one of the recent examples of the novel technologies. This device relies on the application of a small alternating electrical signal (undetectable by the patient) through the tooth while monitoring the response at the sensor. By changing frequency of the applied signal, a spectrum is captured which provides valuable insights into the physical and chemical properties of the tooth. The result is displayed on the LCD screen and the color LED display that enables dental professionals to evaluate the depth of the carious lesion. Pediatric dentistry, with its small operating field and its demands for manual skills and precision, is particularly suited to the use of novel technologies and visual aids.

Therefore the aim of this study was to compare in vitro the diagnostic performance of low-powered magnification (LPMLED) with mounted LED headlight illumination using ICDAS-II criteria and AC Impedance Spectroscopy device, on occlusal surfaces of primary molars.

Materials and Methods

Prior to undertaking the study, ethical approval was granted by Western Sydney University Research Ethics Board for Health Sciences Research (File no. H13930). Eighteen recently extracted second primary molars (n = 18) selected for this in vitro study. Extracted teeth were kept in 0.5% neutral buffered formalin immediately following extraction. Only teeth with sound to incipient lesions were selected, teeth with occlusal restorations, occlusal fissure sealants, and hypoplastic pits were excluded from this study. Prior to examinations, each tooth surface was cleaned with pumice and water slurry to remove all debris and rinsed thoroughly in sterile water. The teeth were mounted to impression putty (VP Mix Putty, Henry Schein Inc., USA) in order to mimic intraoral anatomical position for mixed dentition.

The details of each score for ICDAS-II examination and ACIS device instructions were discussed. Examiners were calibrated by a training exercise on both techniques followed by discussion to consensus of any uncertainties.

In order to assess intra- and interexaminer reproducibility, 15 primary molars (7 primary 1st molars and 8 primary 2nd molars) that were not included in the present study were examined on two separate occasions with two weeks interval by both examiners. All examinations were conducted under standard conditions in dental surgery, with conventional dental light (a-dec300, USA) and a syringe. The teeth were positioned 40 cm from examiners' eyes and kept dark during the examinations unless when dried for ICDAS-II examination. One site on each tooth was selected on the occlusal surface, and examiners were guided by black and white photographs printed on draft quality paper containing a dot on the test site to allow the precise assessment of the same area. The examinations were first carried out with custom made dental loupes (2.5X magnification) mounted on LED headlight (Univet Optical Technologies, Italy) and then AC Impedance Spectroscopy device (Cariscope PRO, Dundee, Scotland) on separate occasions.

After all examinations were completed, the roots of the teeth were rejected just apical to the cementum-enamel junction prior to histological examination. A marker was placed on the mesial cervical area of each tooth, and nail varnish was applied to this mesial groove to aid identification of tooth surfaces and therefore orientation after sectioning. To obtain the histological sections, each tooth was immersed in orthodontic resin (Caulk Orthodontic Resin, Dentsply, Dentsply, USA) and allowed to set into blocks (18 individual blocks), with approximately 1 cm to one side. Each mounted block was then serially sectioned in a longitudinal buccolingual direction with a water-cooled diamond disc on a micromotor with a water-cooled diamond disc on a thin sectioning machine (Galgano Hanse, NY, USA). Each section was approximately 50 micron thick, and based on visible caries location the cuts were done approximately every 200 microns. The sections were separated from the block and numbered for examination. After sectioning the grooves and artifacts left by the diamond disc were polished with a fine-grained paper per coated with 600, 1200, and 2400 grade aluminium oxide (Al2O3). In
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For each examiner, the relationships between both histological and ICDAS-II scores were used. The Spearman rank correlation coefficient (Downer) was assessed using the Spearman rank correlation coefficient. Data from these measurements were used to calculate sensitivity and specificity at the D1 diagnostic threshold using gold standard. The use of a gold standard is a prerequisite in assessing the reproducibility of visual aids on caries detection. Even when using a detailed system (ICDAS-II), there might be a significant correlation between histology and ICDAS-II scores, indicating both primary and permanent teeth in children. Although occlusal surfaces are the most visited sites during clinical examination, occlusal complex enamel and dentine, histopathology of the disease makes difficult to move from restorative to a preventive and therapeutic based approach, early caries detection and quantification of lesions to improve oral or age progression over the time is essential. One of the purposes of the ICDAS-II system is to assist the examiner to overachieve this fact, and the earliest visible changes on all tooth surfaces. Clinical results of the ICDAS-II system provide an acceptable level of sensitivity and specificity for the diagnostic ability. The degree of intrinsic interexaminer reproducibility for ACIS device was good. The weight-ed kappa values for intra- and interexaminer reproducibility for ICDAS-II using LPMLED were good to excellent (Table 2).

Area under curve (AUC) values, sensitivity, and specificity of the examination method based on D1 diagnostic threshold are presented in Table 3 for each examination. The overall AUC performance was 0.61 to 0.84 for ACIS device and 0.68 to 0.83 for ICDAS-II using LPMLED. The Spearman-Koepcke statistics for intra- and interexaminer reproducibility was statistically significant higher AUC performance than ACIS device readings. Spearman’s correlation coefficients in relation to both histological classification systems (Downer) were presented in Table 4. It is generally accepted that a correlation coefficient of 0.70 or above represents a strong relationship between two variables. There was a statistically significant correlation between histology and ICDAS-II scores using LPMLED.

Discussion
Occlusal surfaces account for the majority of new carious lesions, effecting both primary and permanent teeth. Even when using a detailed system (ICDAS-II), there might be a significant correlation between histology and ICDAS-II scores, indicating both primary and permanent teeth in children. Although occlusal surfaces are the most visited sites during clinical examination, occlusal complex enamel and dentine, histopathology of the disease makes difficult to move from restorative to a preventive and therapeutic based approach, early caries detection and quantification of lesions to improve oral progress over the time is essential. One of the purposes of the ICDAS-II system is to assist the examiner to overachieve this fact, and the earliest visible changes on all tooth surfaces. Clinical results of the ICDAS-II system provide an acceptable level of sensitivity and specificity for the diagnostic ability. The degree of intrinsic interexaminer reproducibility for ACIS device was good. The weight-ed kappa values for intra- and interexaminer reproducibility for ICDAS-II using LPMLED were good to excellent (Table 2).

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