DENTAL PHOTOGRAPHY AND SCIENTIFIC RESEARCH IN ORTHODONTICS – A LITERATURE REVIEW

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Abstract

Photography is increasingly used in communication with patients at dental clinics. Photographs are useful as communication tool to be used not only with patients but also with dental technicians and other physicians; in addition, it is an excellent tool to be used in the assessment of practical skills of every dentist. However, these are not the only applications of photographs in dentistry. Properly used, photography may prove an ideal tool in research studies. The authors reviewed the available literature in search for studies in which dental photography was the study tool used to assess the outcomes of various therapeutic management strategies. The "dental photography" keyword was used to identify articles that met the criterion of photography being used as a research tool in human clinical studies in orthodontics. As shown by this literature review, dental photography has found its place as a tool of scientific research. In the future, dental photography may become even more widespread as a result of constant development in technology and equipment.

Keywords: dental photography, humans, orthodontics.

Photo cameras become increasingly common as part of professional equipment available at dental clinics. Thanks to the technological development, tools allowing to obtain clear pictures of patients have become available to every dentist. Numerous camera kits dedicated to dental photography are available on the market. High-quality pictures may make a difference in dental practice so that it may be taken to a higher level.

Dental photography may prove useful in many aspects of dental practice. Firstly, it may significantly improve communication with patients, allowing the dentist to better explain to their patients the treatment plans, the consequences of inappropriate hygiene, or the stages of dental rehabilitation. The Digital Smile Design (DSD) concept consists in several repeatable photographs of the patient being taken for easy design and visualization of patient's smile and its overall impact on the look of the patient's face following the treatment. Photographs are also a tool in the constantly developing area of telemedicine, allowing for easier consultations with other dentists/specialists. Medical documentation featuring photographs taken before and after the treatment may be useful as a proof of proper rehabilitation in potential court cases. In the era of social media, photographs may also be used to showcase the dentists and replace

traditional advertisement. In addition, photographs may also be used for evaluation of one's own practical skills. Comparing photographs taken for similar procedures performed at different time points, dentists may verify whether the quality of their work is continuously improving. Photograph has also found widespread use in science and education, as it is quite difficult to imagine an article or a textbook without photographs. It is much easier e.g. to demonstrate symptoms of a disorder to students or other dentists using a photograph than to rely on verbal descriptions alone.

Photographs may not only document patients' conditions; they may also be used as research tools. Among others, photographs may be used to study patient's perception of the location, shape, and size of a debrided cavity, [1] to assess the atraumatic restorative treatment (ART) outcomes [2], to assess the outcomes of fluorosis treatment [3], to precisely assess the quantity of dental plaque [4], to assess changes in the occlusal contacts of all-ceramic implant crowns [5] and to many other purposes.

For many years, both extra- and intraoral photography has been widely used in orthodontics, where standard management involves a full set of photographs being taken before, during, and after the completed treatment. The objective of this study was to describe the possible use of dental photography as a research tool in orthodontic studies.

Dental photography may be helpful in the assessment of the outcomes of the selected therapeutic method. Hodge *et al.* [6] used dental photography to determine the accuracy of the direct and indirect method for the placement of orthodontic brackets. Photographs of bracketed teeth models were taken at two-thirds magnification using a YashicaTM Dental Eye III camera. The occlusal surface of each model was placed on a cross on an acetate plate so the contact point of the central incisors lied over the intersection of the cross. Alginate impressions were taken over the brackets in situ and die stone models were cast. Thanks to this acetate plate design, models before and after the bracket placement could be ideally aligned. In addition, as the camera was fixed in a constant position, photographs could be taken in a reproducible manner for subsequent analysis of overlaid images in an image processing software.

Pooja *et al.* [7] used dental photographs to assess the impact of the Biobloc appliance on the soft tissue growth. Standardized side view photographs of 79 children were taken and divided into 3 groups: before treatment, after treatment, and without treatment (control group). A total of 14 points were marked on each photograph and subsequently assessed by finite-element scaling analysis (FESA) to evaluate the therapeutic effects of the device.

Cerruto *et al.* [8] used photographs to assess changes in head posture and scapular position following rapid palatal expansion (RPE) treatment. Intraoral photographs and postural photographs were taken at three-time points: T0 – the day of orthodontic measurements; T1 – completion of active RPE treatment; and T2 – the day of Hyrax RPE device removal (photographs were also taken in control group subjects). Frontal, lateral, and dorsal photographs were used to localize and mark the following anatomic landmarks on both body sides: superior and inferior scapular angles, acromium, manubrium, ear lobe, and coracoid processes. Subjects were asked to take an upright,

quiet-standing position, with their feet placed at 30 degrees using a template as a reference. Each patient was then instructed to look straight ahead at the mirror in the lateral view and at the scoliosometer in the dorsal view. All the photographs were taken with the same settings using a Nikon D80 camera. Photographs were used for measurement and assessment of scapular abduction/adduction (dorsal view), abducted and/or winged scapula (lateral view), as well as shoulder height and asymmetry (frontal view).

Dalstra *et al.* [9] used intraoral photographs of the upper arch and acrylic resin plates (as calibration tools) to assess the impact of the temperature (27 and 40 degrees) in the properties of Cu-NiTi wires. The wires were used in the upper arch in the alignment phase. A digital camera was used to take intraoral photographs in orthodontic patients and the images were analyzed using the SigmaScan Pro 4.0 image processing software on a Pentium II PC system.

Photographs of models were used in another study by the other authors. Damstra *et al.* [10] studied the antero-posterior and transverse changes in the positions of palatal rugae following rapid maxillary expansion (RME) treatment. In this study, photographs of specially prepared models were taken using a Fuji FinePix S5100 with maximum aperture setting for high field depth.

Van der Veen *et al.* [11] studied whether lingual brackets would reduce the development of caries as compared to brackets bonded to buccal surfaces. The study was conducted in 28 patients. All of these patients had participated in the German individual prevention program (oral hygiene monitoring, oral health checkups, fluoridation twice a year, fissure sealing in all permanent molars). Patients were divided into two groups: buccal maxillary brackets and lingual mandibular brackets in the first group, and lingual maxillary brackets and buccal mandibular brackets in the other. Intraoral photographs were taken in each patient after the removal of brackets. Photographs were used to determine the presence or absence of white caries spots. Photographs were taken using a Nikon D 200 digital camera featuring Nikkor 105 mm lens and Nikon Macro SB-29S flashlight. Photographs were taken in frontal, right-sided, and left-sided views; occlusal surfaces of the maxilla and the mandible were also imaged. Distances were standardized for all patients and amounted to 35 cm for the frontal view, 30 cm for the lateral views, and 42 cm for the occlusal/lingual surfaces.

The development of white caries lesions in the course and after completion of orthodontic treatments using fixed appliances is a significant problem. Dental photographs appear to be a good tool for the assessment of the progression of such lesions or of the outcomes of their management. Benham *et al.* [12] studied the impact of fissure sealants on the reduction of white spots in the course of orthodontic treatment. Photographs were taken before bracket placement and then after the application of UltraSeal XT Plus sealant (the sealant was applied from 2 weeks to 3 months after bracket placement). Study equipment consisted of a Canon EOS Digital Rebel XT camera, 105 mm macro lens and macro flashlight; photographs were taken from a fixed distance of 18 inches. Left and right profile photographs were taken to assess the presence of white spots. Subsequent photographic documentation was

collected after from 15 to 18 months following sealant removal; at that time point, photographs were also subjected to final assessment in order to document tooth demineralization processes in both the study and the control groups.

Another study also pertained to the use of resin-based sealants in the prevention of demineralization in the course of orthodontic treatment. Leizer *et al.* [13], just like the authors they cited, acquired photographic images before the procedure and during the subsequent follow-up examinations held after 12 months and 18 months. Pro Seal and Transbond MIP were used on all facial surfaces between both canine teeth (inclusive) in both arches. Photographs were taken using a Stylus 710 digital camera (Olympus, Center Valley, Pa) in the super macro mode (no flash). After removal of brackets and acquisition of pictures, brackets were reattached and patients continued their treatment. The photographs were independently assessed by 12 orthodontists using the following 3-point scale:

0 – no decalcification;
1 – slight decalcification;
2 – significant decalcification [14-16].

Vivaldi-Rodrigues *et al.* [17] also decided to evaluate the effects of fluoride varnish on the development of white spots. Series of intraoral photographs were acquired in all subjects including all facial and buccal surfaces between the second premolar and the contralateral second premolar within the maxilla and the mandible. Photographs were acquired using a Nixon Coolpix 4500 camera. Enamel surface was dried and illuminated. Fluoride varnish was applied every 3 months for 1 year, with a series of photographs being acquired after each application. Next, comparisons were made between photographs acquired before the orthodontic treatment and after 12 months of treatment and fluoride varnish use.

Bock *et al.* [18] used dental photography to study changes in white spot lesions following application of 1.25% fluoride gel. Photographs of upper frontal teeth were acquired using a Nikon D300 camera in a dark room devoid of natural lighting using head support and retractors. To obtain image reproducibility, the camera was mounted on a Manfrotto 055XPRO B tripod with 410 Junior Geared head with lens positioned at a fixed distance relative to teeth. Nikon AF-S (105/2.8G VR IF-ED Micro) lens and Nikon SB-29S TTL ring flashlight were used. After the files had been transferred onto a computer system using Nikon Capture NX2 software, image brightness, color intensity and contrast were adjusted and the files were saved in the TIFF format. Changes in the luminance of white spot lesions were evaluated using Adobe Photoshop CS5 Extended software (version 12.0×64), licensed for medical use.

Some as the authors of previous studies, Senestraro *et al.* [19] also focused on the problem of white spot lesions (WSL) in patients who had completed their orthodontic treatment. Infiltration method was used by the study authors as the WSL treatment modality. The treatment outcomes were assessed on the basis of photographs using visual analog scales and surface area measurements (in square millimeters). Photographs were acquired using a Nikon D60 digital camera (Nikon, Tokyo) featuring a 100-mm Minolta Macro Rokkor-X lens. The teeth were dried immediately before

image acquisition to minimize the impact of moisture on the final photographic outcome. The photos were cropped and combined in a presentation to be evaluated by investigators. Photographs obtained in the study group and the control group were intermixed to minimize the research error.

Willmot [20] examined the impact of low fluoride concentrations on white spot lesions developed following orthodontic treatment. Some study subjects used low-fluoride mouthwash/toothpaste while others (i.e. the control group) used fluoride-free mouthwash/toothpaste. Computer analysis of polarized light photographs was used to measure the white spot lesions. Photographs were acquired using polarized flashlight and polarizing filters after bracket removal and subsequently at 1-month intervals, for as long as 26 weeks (in some cases).

Stecksén-Blicks *et al.* [21] also examined the efficacy of fluoride varnish in the prevention of white spot lesions. Fluoride varnish or placebo were used in study patients after bracket placement and at every follow-up visit (approximately every 6 weeks). All patients were carefully examined before the treatment after their teeth were polished in a fluoride-free manner using rubber and pumice. All white spots or hypomineralized enamel lesions on facial surfaces were photographed. Photographs were acquired using a Nikon Coolpix camera with flash light. After the removal of brackets and very careful removal of cement, the enamel was polished using rubber and pumice. After the teeth were dried, new series of frontal and lateral photographs were acquired using the previous camera settings. The presence and stage of demineralization were assessed by two experienced dentists using the WSL index as developed by Gorelick *et al.* [22].

In another study, Bowen *et al.* [23] assessed the efficacy of text message reminders (with patients in the study group receiving text reminders 2-3 times a week for 4 weeks and then for another 8 weeks after a follow-up visit [23]. Subjects in both the study and the control group were trained to brush their teeth using a manual brushing technique according to Bass – an audiovisual presentation had been used for educational purposes. Photographs were taken at the first visit as well as at follow-up visits at weeks 4 and 12 using a Canon Power Shot G5 camera with 58-mm macro lens and ring flashlight. Photographs of the discolored enamel were taken from the shortest possible distance so that every tooth could be evaluated. Photographs were analyzed using the Digimizer software. The program facilitates determination of the percentage of the entire tooth area covered by particular color (discolored enamel).

Aesthetic assessments are another application of photography in orthodontics. Bongaarts *et al.* [24] assessed the aesthetics of the nasolabial region in children with unilateral cleft lip and palate (UCLP) . The study was conducted in 54 patients; one half of the group was treated with infant orthopedics – passive plates of soft and hard acrylic resin – until surgical closure of the soft palate whereas the other half of the group received no intervention. Facial appearance at 4 and 6 years of age was assessed using photographs. Photographs were scanned and saved in a dual manner: the first series of images were left as they were with the exception of images showing right-sided clefts being flipped so that the cleft was on the left. The second series of images were cropped

so as to show nose and mouth region only. Images were inserted into a PowerPoint presentation to be assessed by 16 specialists and 10 laypersons using VAS scales and numerical scales when the reference photograph was assigned the value of 100.

Taylor *et al.* [25] examined the relationship between the presence and treatment of occlusal defects and the quality of life (QoL). The study was carried out in 293 subjects aged from 11 to 14 and divided into three groups: patients requiring orthodontic treatment who had hitherto not undergone any treatment, patients having completed orthodontic treatment, and control subjects requiring no orthodontic treatment. The appearance of teeth and occlusal defects were assessed using the Index of Complexity, Outcome and Need (ICON) and three Youth Quality of Life questionnaires to assess general QoL, Children's Oral Health-Related Quality of Life to assess oral health QoL, and Treatment Expectations questionnaire to assess subjects' expectations related to changes in specific areas of their lives. During the study, photographs were taken from control subjects undergoing no orthodontic treatment and having no plans to undergo such a treatment. Intraoral photographs were used to assess the appearance of teeth/smile. In the control subjects, ICON assessments were limited to the aesthetic component alone. Photographs were assessed independently by three observers.

Parkin *et al.* [26] used patient photographs in their study on the aesthetic assessment of palatally displaced canine teeth three months after their surgical exposure using closed or open techniques. Photographs taken 3 months after the procedure were used in a PowerPoint presentation. Each slide consisted of intraoral buccal images of the operated as well as of the contralateral side – the reviewers were to assess the canine teeth shown in the pictures.

Sajjadi *et al.* [27] carried out a study to determine the influence of three types of digital camera sensors and three specialties of dental medicine on the subjective assessment of smile appearance. In the first stage, 40 photographs with female patients' smiles were assessed by three prosthetic surgeons, six orthodontics, and three conservative dentistry specialists; all of the reviewers were to identify the smiles they considered most aesthetic. In the second stage, smiles of 20 students were recaptured in standard conditions using three different digital sensors, including a full frame (Canon EOS 5D Mark II), an APS-C (Canon EOS 550D) and a compact camera (Canon PowerShot G12). The same panel of experts assessed the aesthetics of smiles using an 11-point visual analog scale (VAS) scale: 0 – definitely not pleasing, 10 – extremely beautiful. All photographs were coded and the reviewers were unaware of the sensor type used to acquire the image. Photographs were acquired in standardized conditions (no make-up, natural head posture, focal length 100 mm, distance from model 60 mm, aperture f/8, no flash, white background). Photographs acquired using the full frame received the highest notes from all reviewers.

Thanks to the possibility of repeatable acquisition of photographs for subsequent analysis by a number of experts or by means of computer software, dental photography offers now opportunities to assess different treatment modalities or changes occurring within the oral cavity during or following orthodontic treatment. Photo cameras

become increasingly common as part of professional equipment available at dental surgeries, and thus no additional costs are associated with this research method. For these reasons, wider use of dental photography in research studies is warranted and justified.

References

1. Isoya K, Sasaki Y, Mataki S. Patient's perception of location, form and size in case of cavity preparation. *J Med Dent Sci*. 2004;51:139-45.
2. Farag A, van der Sanden WJM, Abdelwahab H, et al. 5-Year survival of ART restorations with and without cavity disinfection. *J Dent*. 2009;37(6):468-74.
3. Castro KS, de Araújo Ferreira AC, Duarte RM, et al. Acceptability, efficacy and safety of two treatment protocols for dental fluorosis: A randomized clinical trial. *J Dent*. 2014; 42(8):938-44.
4. Al-Otaibi M, Al-Harthy M, Soder B, et al. Comparative effect of chewing sticks and toothbrushing on plaque removal and gingival health. *Oral Health Prev Dent*. 2003;1:301-7.
5. Esquivel-Upshaw JF, Mehler A, Clark AE, et al. Fracture analysis of randomized implant-supported fixed dental prostheses. *J Dent*. 2014;42(10):1335-42.
6. Hodge TM, Dhopatkar AA, Rock WP, Spary DJ. A randomized clinical trial comparing the accuracy of direct versus indirect bracket placement. *J Orthod*. 2004;31(2):132-7.
7. Pooja K, Harpreet S, Jagvinder S M. Orthodontic photography: Know your camera. *Res Med Eng Sci*. 2018;5(2). RMES.000610.2018. DOI: 10.31031/RMES.2018.05.000610
8. Cerruto C, Di Vece L, Doldo T, et al. A computerized photographic method to evaluate changes in head posture and scapular position following rapid palatal expansion: A pilot study. *J Clin Pediatr Dent*. 2012;37(2):213-8.
9. Dalstra M, Melsen B. Does the transition temperature of Cu-NiTi archwires affect the amount of tooth movement during alignment? *Orthod Craniofac Res*. 2004;7(1):21-5.
10. Damstra J, Mistry D, Cruz C, Ren Y. Antero-posterior and transverse changes in the positions of palatal rugae after rapid maxillary expansion. *Eur J Orthod*. 2009;31(3): 327-32.
11. Van der Veen MH, Attin R, Schwestka-Polly R, Wiechmann D. Caries outcomes after orthodontic treatment with fixed appliances: do lingual brackets make a difference?: Lingual brackets and caries prevention. *Eur J Oral Sci*. 2010;118(3):298-303.
12. Benham AW, Campbell PM, Buschang PH. Effectiveness of pit and fissure sealants in reducing white spot lesions during orthodontic treatment: A pilot study. *Angle Orthod*. 2009;79(2):338-45.
13. Leizer C, Weinstein M, Borislow AJ, Braitman LE. Efficacy of a filled-resin sealant in preventing decalcification during orthodontic treatment. *Am J Orthod Dentofacial Orthop*. 2010;137(6):796-800.
14. Wenderoth CJ, Weinstein M, Borislow AJ. Effectiveness of a fluoride-releasing sealant in reducing decalcification during orthodontic treatment. *Am J Orthod Dentofacial Orthop*. 1999;116(6):629-34.

15. Gaworski M, Weinstein M, Borislow AJ, Braitman LE. Decalcification and bond failure: A comparison of a glass ionomer and a composite resin bonding system in vivo. *Am J Orthod Dentofacial Orthop*. 1999;116(5):518-21.
16. Le PT, Weinstein M, Borislow AJ, Braitman LE. Bond failure and decalcification: a comparison of a cyanoacrylate and a composite resin bonding system *in vivo*. *Am J Orthod Dentofacial Orthop*. 2003;123(6):624-7.
17. Vivaldi-Rodrigues G, Demito CF, Bowman SJ, Ramos AL. The effectiveness of a fluoride varnish in preventing the development of white spot lesions. *World J Orthod*. 2006;7:138-44.
18. Bock NC, Seibold L, Heumann C, et al. Changes in white spot lesions following post-orthodontic weekly application of 1.25 per cent fluoride gel over 6 months – a randomized placebo-controlled clinical trial. Part I: Photographic data evaluation. *Eur J Orthod*. 2017;39:134-43.
19. Senestraro SV, Crowe JJ, Wang M, et al. Minimally invasive resin infiltration of arrested white-spot lesions. *J Am Dent Assoc.* 2013;144(9):997-1005.
20. Willmot DR. White lesions after orthodontic treatment: does low fluoride make a difference? *J Orthod*. 2004;31(3):235-42.
21. Stecksén-Blicks C, Renfors G, Oscarson ND, et al. Caries-preventive effectiveness of a fluoride varnish: A randomized controlled trial in adolescents with fixed orthodontic appliances. *Caries Res*. 2007;41(6):455-9.
22. Gorelick L, Geiger A M, Gwinnett A J. Incidence of white spot formation after bonding and banding. *Am J Orthod.* 1982;81(2):93-8.
23. Bowen TB, Rinchuse DJ, Zullo T, DeMaria ME. The influence of text messaging on oral hygiene effectiveness. *Angle Orthod*. 2015;85(4):543-8.
24. Bongaarts CAM, Prahl-Andersen B, Bronkhorst EM, et al. Effect of infant orthopedics on facial appearance of toddlers with complete unilateral cleft lip and palate (Dutchcleft). *Cleft Palate Craniofac J*. 2008;45(4):407-13.
25. Taylor KR, Kiyak A, Huang GJ, et al. Effects of malocclusion and its treatment on the quality of life of adolescents. *Am J Orthod Dentofacial Orthop*. 2009;136(3):382-92.
26. Parkin NA, Freeman JV, Deery C, Benson PE. Esthetic judgments of palatally displaced canines 3 months postdebond after surgical exposure with either a closed or an open technique. *Am J Orthod Dentofacial Orthop*. 2015;147(2):173-81.
27. Sajjadi SH, Khosravanifard B, Moazzami F, et al. Effects of three types of digital camera sensors on dental specialists' perception of smile esthetics: A preliminary double-blind clinical trial: Perception of digital smile beauty. *J Prosthodont*. 2016;25(8):675-81.

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