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Digital scan to enhance patient education

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Digital Scan to Enhance Patient Education:

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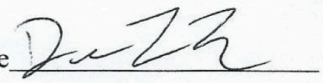
Signature 

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Human Subjects Approvals

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SUBJECT: Digital Scan to Enhance Patient Education (HS-5647)

With the amendments provided on November 30, 2018, human subjects protocol HS-5647 entitled "Digital Scan to Enhance Patient Education" has been approved as an exemption from federal regulations under CFR Title 45, Part 46.101(b) (1-6).

Before you begin, however, please identify yourself on all your communications as being a student of Eastern Washington University (i.e., script, email, and consent form) and amend your consent form as follows:

- In the procedures section, please provide couple of example questions from the surveys so that participants have some understanding of the nature of the questions that they are going to be asked; and
- On the second page of the form under Other Information, please change "anonymous" to "confidential" since this is not an anonymous study.

Please send a final revised consent form to rgalm@ewu.edu that can be included in your IRB file.

Student research qualifying for an exempt IRB review is valid for a period of one year. If subsequent to initial approval, the research protocol requires minor changes, the Office of Grant and Research Development should be notified of those changes. Any major departure from the original proposal must be reviewed through a Change of Protocol application submitted to the IRB before the protocol may be altered. Please refer to HS-5647 on future correspondence as appropriate as we file everything under this number.

Cc: HS-5647 file
Prof. Lisa Bilich, RPI
Prof. Ann O'Kelley Wetmore, Dept. Chair
Graduate Office

Abstract

Purpose: The purpose of this study was to evaluate if the use of a 3D intraoral scan as a visual aid improves a patient's communication self-efficacy and risk-literacy concerning their periodontal disease status.

Methods: This study used a parallel experimental research design and collected quantitative data through a pre-test and two post-tests for both groups. The Ask, Understand, Remember Assessment (AURA) survey was used to collect quantitative data pertaining to patient communication self-efficacy and the Protection Motivation Survey (PMS) was used to evaluate each patient's risk-literacy of their periodontal disease. The addition of four Likert-scale questions concerning experience with the periodontal chart was added to the control group. An additional eight questions were added to the experimental group's post-test concerning experience and understandability with the periodontal chart and 3D digital intraoral scan.

Results: Participant communication self-efficacy (AURA survey) in the 3D intraoral scan experimental group did not statistically improve compared to the control group. Change in risk-literacy (PMS questionnaire) between the control and experimental groups found no statistical significance between the pre- and post-tests and individual questions. Although there was no significant difference found in AURA and PMS scores, anecdotal discussion found communication between provider and patient was enhanced. Questions regarding periodontal disease during the educational portion were asked showing a deeper level of critical thinking by both the control and experimental groups. A high correlation ($p < 0.03$; $N=21$) was found between an elevated PMS post-

test #1 score and elevated experience Post-test score for the whole group indicating that a high risk-literacy score is correlated to a high level of comprehension.

Conclusion: Statistical significance was difficult to achieve due to a small sample size and the high education level of participants, and therefore results had no significant results as to whether or not a 3D digital scan, when used as a visual aid, can improve patient communication self-efficacy and risk-literacy concerning periodontal disease.

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I would like to thank Lisa Bilich RDH, BS, MSEd, for inspiring me to push myself beyond what I thought I could achieve. It is your example that I hope to mirror in my future career. Thank you for your friendship, mentorship, and inspiration. I would also like to thank my second and third chair committee members, Merri Jones RDH, MSDH and Dr. Pam Nagasawa. I am grateful for your insight and encouragement. You both have shown me what professionalism is, and I am forever thankful for you both. I wish to thank Dr. Dean Kois DMD, MSD for allowing me to conduct my study at his practice and for imparting your love for science and research into my daily practice. Lastly, I would like to thank my family and roommate for your unwavering support, encouragement, laughter when I needed it and the daily prayers said on my behalf. I love you all with my full heart.

Table of Contents

List of Figures

Figures

List of Tables

Tables

Introduction/Literature Review

Introduction to the Research Question

New and emerging technologies are consistently pushing the dental hygiene profession and changing how treatment is planned and presented to patients (American Dental Hygienists Association [ADHA], 2016). Utilizing new technology to present individual treatment plans may enhance treatment acceptance and increase a patient's understanding of their oral health (Jönsson, Öhrn, Oscarson, & Lindberg, 2009). One technology used is the intraoral digital scan. The use of digital scan technology provides accurate gingival recession measurements and produces presentable visual images of periodontal data acquired (Corraini, Baelum, & Lopez, 2013). Images acquired through a digital scan of the gingival tissue are used as visual aids to enhance the explanation of each patient's periodontal status, periodontal treatment plan, and promote patient involvement (Stenman, Wennström, & Abrahamsson, 2010) This study examined differences in patient self-confidence regarding the understanding and comprehension of periodontal disease when presented with a traditional periodontal chart and periodontal disease education compared to a digitally enhanced treatment plan presentation with periodontal disease education.

Statement of the Problem

A major role of a dental hygienist (DH) is to educate patients on periodontal disease. The DH synthesizes clinical data and patient assessments in order to present an accurate picture of each patient's oral health and periodontal status (ADHA, n.d.). Most DHs use visual aids, such as the analogue periodontal chart and digital radiographs, to

illustrate individual patient probe depths and bone loss. While these methods are effective, they may be unfamiliar to patients, and difficult to synthesize into understandable facts (Hughes, Heo, & Levin, 2018). Using a digital scan to present gingival data that is visually recognizable to a patient may enhance a patient's understanding of their recession, and disease progression (Garcia-Retamero & Dhami, 2011). Currently there is a lack of research addressing the effectiveness of digital scan technology on patient education, and how the technology affects a patient's self-perceived ability to comprehend and remember their clinical diagnosis in order to make informed decisions regarding care.

The research questions for this study were:

- Can the use of digital scan technology improve patient self-efficacy in relationship to communication?
- Does the use of digital scan technology increase a patient's risk literacy?
- Does the use of a digital scan technology increase a patient's self-reported confidence and ability to ask, understand and remember information in a dental office?

Overview of Research

Periodontal disease. Periodontitis is a chronic inflammatory disease that presents itself in over 45% (141.0 million) of the American adult population. (AAP, p. 5). The American Academy of Periodontology (AAP) (2018) defines periodontitis as, "inflammation within the supporting tissues of the teeth [which leads to] progressive attachment and bone loss . . . characterized by pocket formation and/or recession of the gingiva" (Periodontitis section, para 2). Within the gingival (gum) tissues, small collagen

fibers are responsible for attaching the gingival tissue to the root layer of the tooth, creating a natural sulcus or pocket. During the periodontal disease process, the body's inflammatory response is initiated by the presence of bacteria in the pocket, and a wide variety of immune cells destroy the pathogenic bacteria. The inability of the immune system to destroy the periodontal bacteria, combined with other risk factors, creates an overabundance of inflammatory cells (Darby & Walsh, 2015). Chronic inflammation caused by the overproduction of inflammatory cells results in the destruction and detachment of the collagen fibers, resulting in attachment loss and increased pocket depths (Savage, 2009). The resulting alveolar bone loss and recession from periodontal disease are irreversible. Periodontal disease not only affects the gingival tissues, but effects overall health. Research shows a high correlation between periodontal disease and other diseases such as, diabetes, cardiovascular disease, and low preterm birth weight (U.S. Department of Health and Human Services [USDHHS], 2000).

Eke et al. (2015) used the 2009-2012 National Health and Nutrition Examination Survey (NHANES) to conduct a stratified multistage probability sample of the U.S. adult population (*N*=7,066) concerning the prevalence and severity of periodontal disease. Inclusion criteria was restricted to adults 30 years of age and older with one or more natural teeth and no premedication requirements. Participant (*N*= 7,066) data collected was further classified into subgroups based on sex, history of smoking, socioeconomic status, education level, marital status, and ethnicity. All periodontal examinations were collected by registered and calibrated dental hygienists and dentists from the years 2009 – 2012 (Eke et al., 2015). In order to determine the severity and prevalence of periodontal disease among the population surveyed (*N*=7,066) the examiners used the 2012 AAP

periodontal case type definitions of periodontal disease (see Table 1), and for comparison applied the European Federation of Periodontology (EFP) definitions of periodontal disease case types (see Table 2) (Eke et al., 2015).

Table 1

2012 AAP Periodontal Case Types

Periodontal Case Type	CAL		PPD
Severe Periodontitis	Two or more interproximal sites with ≥ 6mm (not on the same tooth)	AND	one or more interproximal sites with ≥ 5mm
Moderate Periodontitis	Two or more interproximal sites with ≥ 4mm CAL (not on the same tooth)	OR	two or more interproximal sites with ≥ 5mm
Mild Periodontitis	≥ 2 interproximal sites with ≥ 3mm	AND	≥ 2 interproximal sites with ≥ 4mm or one site with ≥ 5mm

(Eke et al., 2015)

Table 2

2005 European Federation of Periodontology Case Types

Periodontal Case Type	Criteria
Incipient Periodontitis	Presence of proximal attachment loss of ≥3mm in ≥2 non-adjacent teeth.
Severe Periodontitis	Presence of proximal attachment loss of ≥5mm in ≥30% of teeth present.

(Tonetti et al., 2005)

Based on the AAP guidelines Eke et al. (2015) found 45.9% (*n* =3,243.3) of the U.S. adult population (30 years and older) sampled had periodontitis. Within the population surveyed (*N*= 7,066) 8.9% (*n*=628.9) were found to have severe periodontal disease while 37.1% (*n*=2,621.5) were classified as having either slight or moderate periodontal disease. When data was compared to the EFP guidelines, similar results were obtained, with 12% (*n*=847.9) categorized as having severe periodontal disease and 65.8% (*n*=5,356.0) with incipient periodontal disease (Eke et al., 2015).

Comparing data through two separate disease classification methods, Eke et al. (2015) showed periodontal disease is prevalent with nearly half of the U.S. adult population. Eke et al (2015) concluded that efforts to prevent and decrease the prevalence of periodontal disease are needed in order to increase the oral health status of the U.S. population.

Due to the high prevalence of periodontal disease, and its effects on overall health, the Centers for Disease Control and Prevention (CDC) along with the Healthy People 2020 initiative has set clear objectives to decrease the number of American adults effected by periodontitis (CDC, 2014). Improving practitioner to patient communication on periodontal disease and increasing patient health literacy is a vital step in the betterment of the American adult oral health status (USDHHS, 2016).

Intraoral scan technology. Intraoral scan (IOS) technology was introduced to the dental community in the 1990s and used in the field of orthodontics to replace traditional alginate cast models with 3D digital models (Jacob, Wyatt, & Buschang, 2015). Since its inception in the 1990s IOS has been employed in many clinical applications within the field of dentistry. Common applications in dentistry are in general dentistry for crown

and bridge fabrication, prosthodontics and oral maxillofacial surgery for accurate measurement and placement of dental implants, and orthodontics for digital Invisalign® impressions (Mangano, Gandolfi, Luongo & Logozzo, 2017). Currently scanners used in IOS use a laser, white light, or mechanical probe in order to capture thousands of images. Images captured by the scanner are then transmitted to software that renders and combines individual images into accurate digital 3D models of the teeth and gingiva (Jacob et al, 2015). Rendered models can be instantly viewed on a monitor or sent to a 3D printer to create a physical plastic model presentation (see *Figure 1* and *Figure 2*). To date there is no research on the use of IOS as an educational visual aid, nor has there been documentation of studies on the use of IOS within the field of dental hygiene concerning periodontal disease education.

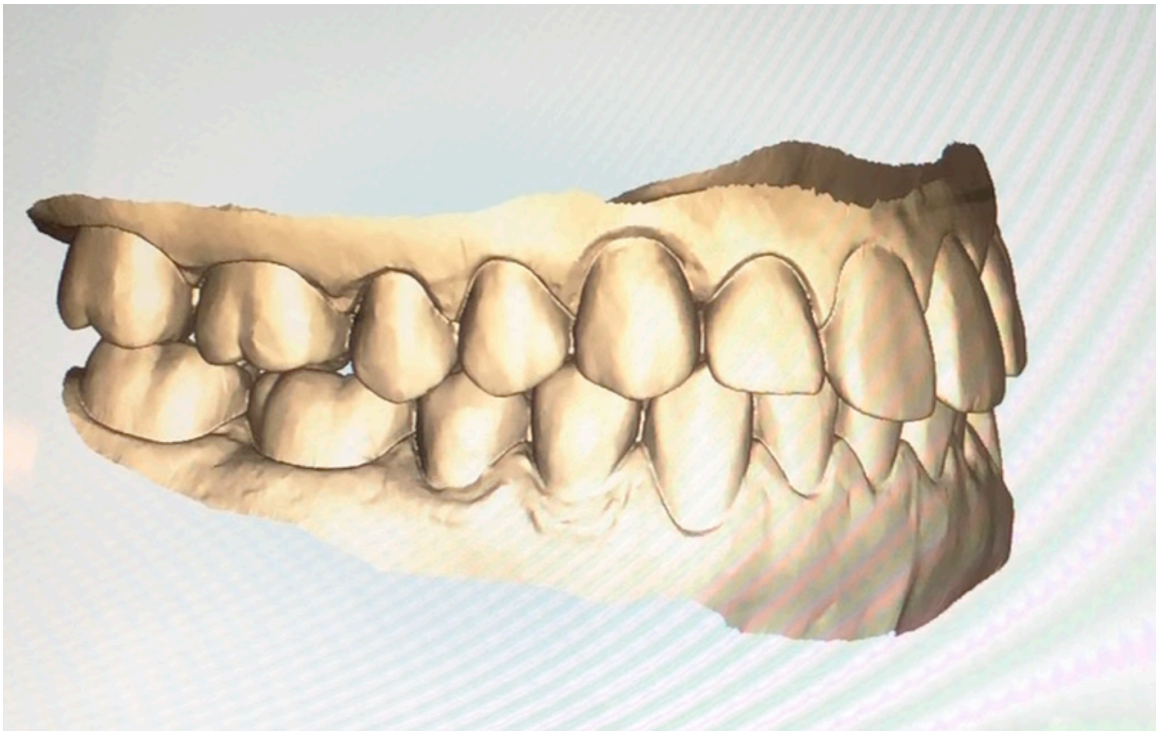

Figure 1. iTero® Element Rendered Scan.

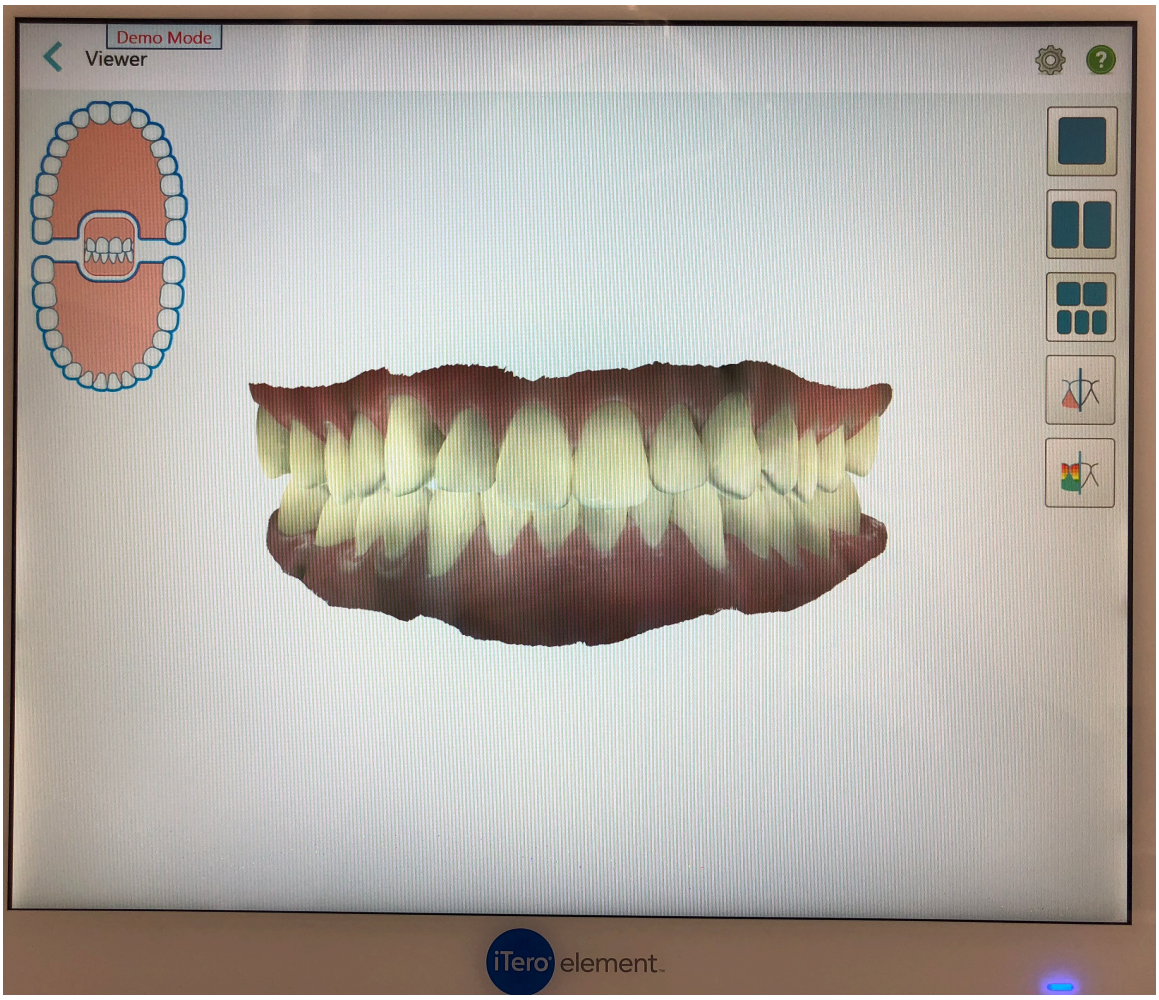

Figure 2. iTero® Element Rendered Scan with Gingival Tissue.

The periodontal probe for measuring gingival recession is the main tool DHs use to collect gingival data. Discrepancies in measurement among practitioners exist, leaving slight inaccuracies between periodontal charts (Schneider et al., 2014). The use of 3D scan technology for the measurement of gingival recession has been shown to be more accurate and linearly more reliable (Schneider et al., 2014). Schneider et al. (2014) conducted a randomized study assessing the accuracy of human examiner probe measurements of recession and papilla height compared to the accuracy of using 3D scan technology. Six (*N*=6) participants were randomly selected and received four methods of

measurements by five randomized examiners. The four measurement methods used were: direct calibrated periodontal probe measurements, direct measurements utilizing a cast model of each participant, digital measurements from optical impression of each participant, and finally digital measurements taken from participants' cast models. Schneider et al. (2014) used a mixed model regression analysis and Bland-Altman analysis to evaluate the study's findings. It was found that the direct periodontal probe measurement method was the least accurate, and that both digital methods were found to be the most accurate.

Increasing the accuracy of recession measurements can give a more precise picture of a patient's periodontal status. Acquiring accurate measurements with digital scan technology and overlying the analogue measurements onto a 3D image can provide patients with visual data of their history of recession**.**

Obtaining accurate and consistent gingival recession measurements with the periodontal probe depends on many variables, including practitioner digit preference (Holtfreter, Alte, Schwahn, Desvarieux, & Kocher, 2012). Digit preference occurs when "…the observer reads to a preferred digit more commonly than the other digits, most often to zero" (Ayodele et al., 2013, p. 73). Digit preference is an over or under estimation of a number leading to improper diagnosis, especially when a disease, such as periodontal disease, is dependent upon periodontal chart readings. Within dentistry digit preference can occur when using a periodontal probe. Holtfreter et al. (2012) conducted an in vivo crossover study that examined measurements of gingival height (GH), periodontal pocket depth (PD), and clinical attachment level (CAL) between three different periodontal probes (PCP11, PCP2, PCPUNC15). Measurements on participants

($N = 6$) were taken by six examiners, and four sites per tooth (excluding third molars) were recorded. The study took place over three days, with each examiner conducting six complete periodontal charts per day. Random selection for participants to be examined and probe type to be used was implemented. Overall sites recorded with all three probes totaled 11160. Holtfreter et al. (2012) found that digit preference was highest when measuring PD, and still observable when examiners measured GH and CAL. GH measurements were affected by probe selection ($p < 0.001$) and examiner ($p < 0.001$). Using digital scan technology to measure gingival recession can decrease digital preference among clinicians and give a more accurate and reliable reading.

Health numeracy. Within health care many concepts and outcomes of a disease are presented in a numerical format, such as a data chart or graph (Reyna, Nelson, Han, & Dieckmann, 2009). The ability for an individual to comprehend numerical information and make an educated decision regarding their health is known as health numeracy (Reyna et al., 2009). Golbeck, Ahlers-Schmidt, Paschal, & Dismuke (2005) define health numeracy as, "the degree to which individuals have the capacity to access, process, interpret, communicate, and act on numerical, quantitative, graphical, biostatistical, and probabilistic health information needed to make effective health decisions" (p. 375). Reyna et al (2009) conducted a review of literature and research on numeracy with the goal of exploring how numeracy effects a patient's decision making and their understanding of risk of a disease. Reyna et al (2009) found several studies that concluded individuals with low numeracy ". . . can be helped by presenting information in a logically ordered format and displaying only the important information, presumably decreasing cognitive burden" (p. 959). Reyna et al (2009) concluded more research needs

to be conducted concerning health numeracy and how to effectively present numerical information to patients.

In dentistry, patients can have difficulty understanding numerical data from the periodontal chart (Bress, 2013). A lack of patient comprehension of periodontal chart information can lead to ill-informed decision making regarding their oral health. The periodontal chart (PC) is a numeric table that organizes data collected during the periodontal exam (PD, CAL, mobility, and recession). Dental Hygienists use the PC as a periodontal map of the gingiva and as a diagnostic tool for the presence and severity of periodontal disease, as well as a visual aid for patient presentation. After gingival measurements are recorded, the PC is presented to patients through a 2-D format (See *Figure 3*). The current format and presentation of numerical information within the PC can be overwhelming, and difficult for patients to understand (Bress, 2013).

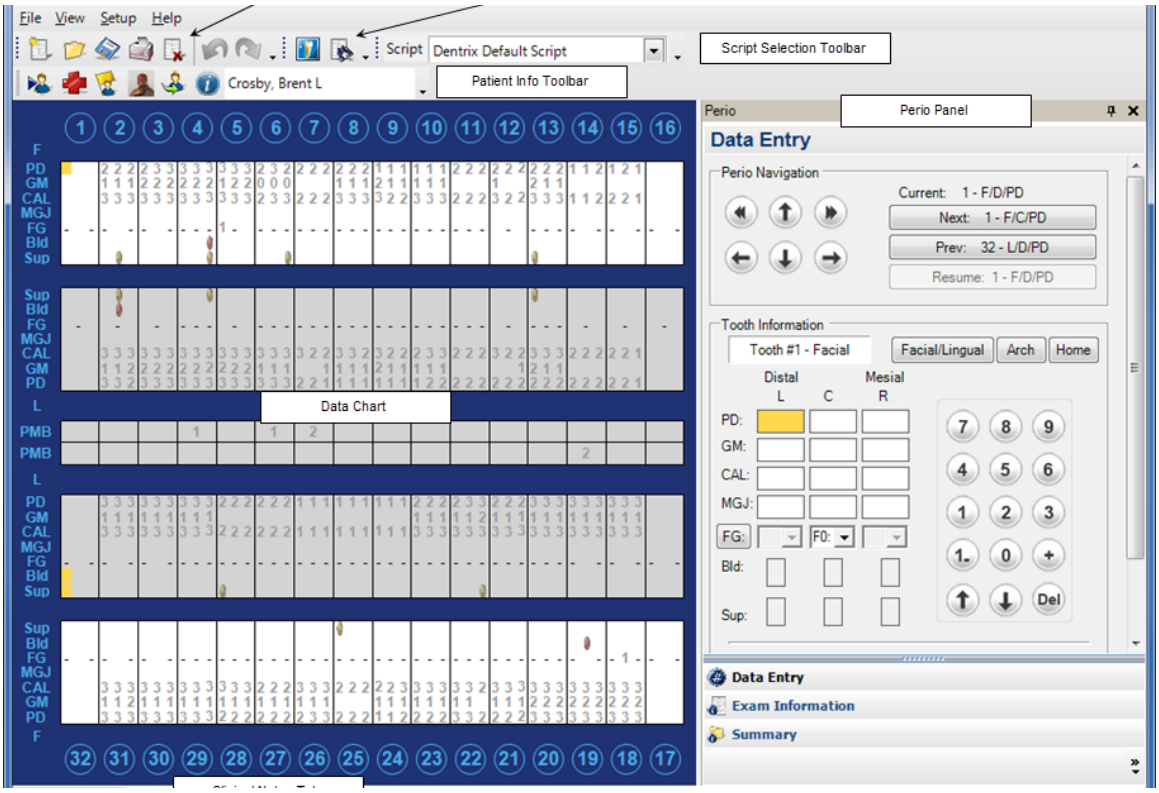

Figure 3. A 2-D patient periodontal chart depicting full mouth numerical measurements of PD: Pocket Depth, Rec: Recession, AL: Attachment Loss, Mob: Mobility of teeth. Adapted from Dentrix.com (2018).

Patients find numeric information difficult to comprehend due to numbers having abstract meaning (Peters, Dieckmann, Vastfjall, Mertz, Slovic, & Hibbard, 2009). Presenting a patient with a 2-D numerical chart without ascribing meaning or visual context for the data can leave the patient confused (Peters et al, 2009). Using a 3D scan as a visual aid to represent a patient's gingival recession in concordance with a 2-D periodontal chart may increase a patient's understanding of numeric data presented on a PC and therefore provide each patient with understandable information that aids in making informed decisions regarding their oral health.

Risk literacy. In order to make an informed decision a patient must understand the risks and outcomes of a disease or diagnosis. The ability to synthesize information

regarding a health diagnosis and evaluate its risks is known as risk literacy (Garcia-Retamero & Cokely, 2017). Many patients make misinformed decisions regarding their oral health and treatment plan options. These misinformed decisions can occur due to poor patient education of risk of a disease, and lead to non-compliance of treatment options presented. In order to see if individualized patient disease risk education influences a patient's understanding of periodontal disease and their adherence to oral care suggestions, Asimakopoulou, Newton, Daly, Kutzer, & Ide (2015) conducted a controlled randomized study on adults (N=82) with moderate to severe periodontal disease. A control group (n=43) was presented with a routine periodontal consultation with general questions on oral health, while the experimental group (n=38) was presented with a routine periodontal consultation, and the addition of an individualized risk communication session that included a risk calculation of their periodontal disease using PreViser Risk Calculator® software. Three measures were used in order to evaluate both control and experimental groups (N=82) psychological reactions. Asimakopoulou et al. (2015) employed the Positive Affect Negative Affects Scale (PANAS) to measure participant emotional response to their periodontal assessment, A Protection Motivation Theory (PMS) questionnaire to measure participants beliefs about periodontal disease, self-efficacy to adhere to treatment suggestions, and susceptibility to the disease, and lastly the Hospital Anxiety and Depression Scale (HADS-A/D) was used to screen for anxiety and depression. Participants of both groups (N=82) took all three measures at the beginning of the study, and only two measures (PANAS and PMS) after the study concluded. Asimakopoulou et al. (2015) found that the experimental group perceived their periodontal disease status as significantly more serious compared to the control

groups perceptions (p<0.04). Increase in risk perception was not the only difference seen between groups. Asimakopoulou et al. (2015) found that the experimental group showed more confidence/self-efficacy in their ability to adhere to periodontal treatment suggestions and routine care compared to the control group ($p < 0.05$). Asimakopoulou et al. (2015) concluded individualized intervention strategies should be implemented to increase a patient's understanding of risk of their periodontal disease as well as increase their confidence/self-efficacy for compliance to treatment and homecare. Using IOS to present disease markers such as periodontal recession, may increase a patient's self-efficacy and understanding of their periodontal disease risk.

Self-efficacy. A DH is tasked with presenting patient information with the aim of patient compliance and adherence to treatment suggestions. As stated by the social cognitive theory, knowledge alone does not equal patient behavioral change, nor does it equal patient adherence to treatment suggestions (Bandura, 1977). Patients who feel comfortable stating opinions and asking more questions regarding treatment options have better overall health outcomes (Kaplan, Greenfield, Gandek, Rogers, & Ware, 1996). In order to effectively educate and motivate patients, a DH must understand their patient's self-efficacy in regard to treatment suggestions. Self-efficacy is the internal perception/confidence of one's ability to perform a task or change a behavior (Bandura, 1977). Communication self-efficacy is a patient's perceived confidence in their ability to communicate with their provider (Clayman et al., 2010). In order to create a reliable and quick tool to measure patient communication self-efficacy in a clinical setting, Clayman et al (2010) conducted a study on patients (N=330) with hypertension at their routine medical appointments. Clayman et al. (2010) adapted the 12 question Communication

and Attitudinal Self-Efficacy (CASE) Cancer questionnaire to measure participant communication self-efficacy. Clayman et al (2010) used six questions from the CASE questionnaire, focusing on items pertaining to patient comprehension and seeking of health information. The new adaptation of the CASE questionnaire by Clayman et al (2010) was named the Ask, Understand, Remember Assessment (AURA). In addition to the AURA, each participant took the S-TOFHLA to measure health literacy and completed a 15-item questionnaire testing their knowledge of hypertension. The General Self-Efficacy/Manage Disease in General Subscale was used to measure participant self-efficacy concerning chronic disease. Clayman et al (2010) found construct validity for the AURA assessment was strongly correlated with chronic disease efficacy (SD=9.6; r=0.31) and moderately with disease knowledge (SD=2.3; r=0.11). Finally, Clayman et al. (2010) found participants (n=100) with low health literacy scores, scored low on the AURA assessment (p<0.05). Clayman et al. (2010) concluded that AURA is an effective instrument when measuring a patient's confidence in their ability to ask, understand, and remember relevant health information. Further suggestions for the use of AURA by Clayman et al. (2010) include, "[…] testing the effect of interventions designed to improve patient participation, communication, or other enhancements to the patient-provider relationship" (p. 4). Effective communication between provider and patient leads to better patient comprehension of given health information, and the ability of a patient to ask pertinent questions regarding care and diagnosis (Clayman et al., 2010). The use of digital scan technology may increase a patient's self-reported confidence and ability to ask, understand and remember information regarding their periodontal disease status.

Visual aids in patient education. Providing health education is an important stage in the process of patient disease comprehension and acceptance. The World Health Organization (WHO) (2018) defines health education as, ". . . any combination of learning experiences designed to help individuals and communities improve their health, by increasing their knowledge or influencing their attitudes" (Health education section, para 1). In order for patients to understand complex oral disease concepts and eventually accept treatment plan options, patient oral health education must be provided (Cleeren et al., 2014). Patient education and experience can be enhanced through the use of visual aids (Dhulipalla et al., 2015).

In order to provide quality patient education, DHs synthesize periodontal chart data into lay person terminology in order to facilitate comprehension of the periodontal disease process, and risk factors associated with the disease. Using the periodontal chart as a visual aid is common practice; however, this 2D graphic can be difficult for patients to visually comprehend. Mayer's (2008) Cognitive Theory of Multimedia Learning (CTML) simply states the human brain processes and comprehends better when both words and pictures are used compared to plain text only. The brain processes words and images through two separate limited capacity channels. Due to the limited capacity of each channel it is easy to experience overload of information, causing low comprehension (Mayer, 2008). By utilizing both channels (words and images), compared to one, overload is decreased, and comprehension and memory are increased (Meppelink, Weert, Haven, & Smit, 2015). Recent research has shown that the use of multimedia methods for patient education yields a higher level of patient comprehension (Winter et al., 2016). In a recent study, researchers found that utilizing 3D images to convey patient

periodontal disease information increased the patient's immediate and subsequent comprehension of periodontal disease (Cleeren et al., 2014). Cleeren et al. (2014) performed a randomized controlled parallel trial on two sets of participants (*N*=68). Two sets of videos were made, one with 3D animation (experimental group) of periodontal structures with voiceover, and the second (control group) was hand drawn animations of periodontal structures with the same exact voice over as the 3D video. Each video was 6 minutes and 20 seconds in length. A pre-test and post-test were given to each group and a short questionnaire given at the end. Two weeks following the study, each participant, with the exception of one from the experimental group, participated in a follow up survey. The follow up survey was performed to test comprehension retention of the videos. Results demonstrated participants in the experimental group had significantly higher post-test scores compared to the control group (p=0.003) (see Table-3).

Table 3

Pre-test scores compared to post-test scores

Time point	Median			Mean ± SD		
	3D animation	Control	*p*-value	3D animation	Control	*p*-value
Pre-test	4	4	1	3.73 ± 2.14	3.68 ± 1.89	0.918
Post-test	9	7.5	0.003	8.42 ± 1.09	7.15 ± 1.56	0.000
Follow-up test	8	5	0.000	7.55 ± 1.03	4.94 ± 1.32	0.000

Cleeren et al. (2014)

As illustrated in the above study by Cleeren et al. (2014) 3D imaging used as a visual aid can enhance patient education and comprehension.

Similarly, Austin, Matlack, Dunn, Kesler, & Brown (1995) conducted a study using illustrations in conjunction with written text in order to test patient comprehension.

Austin et al. (1995) created two sets of patient post-op wound care pamphlets. The experimental pamphlet contained written instructions along with illustrations, while the control pamphlet contained text only. Participants (N=101) were randomly selected from an emergency department in a rural hospital. Each participant was contacted and asked 10 questions designed to test comprehension of the pamphlets given. Austin et al (1995) found that 65% of participants who received the experimental pamphlet (n=54) answered more than 5 out of 10 questions correctly compared to 43% of the nonexperimental group participants (n=47). Austin et al's (1995) study results show a significant difference in comprehension between the two groups (p=0.033), proving the importance of using visual aids in patient education.

Increased patient compliance and adherence with visual aids. There are several barriers that prevent patient compliance and adherence concerning treatment. A patient's preconceived beliefs about oral health and incorrect information gathered from outside sources act as barriers to making a well-informed treatment decision (Fagerlin, Wang, & Ubel, 2005). Educating patients in order to increase comprehension and motivation is one of the many goals a DH faces within patient care. Educating patients not only leads to increased patient comprehension but plays a direct role in patient compliance of treatment suggestions (Collins, 2011). One method used to increase patient compliance is the use of visual aids that include the patient in the decision-making process (Hofmann et al., 2012). Using visual aids to increase comprehension and compliance is an important step in patient education and care.

Fagerlin et al. (2005) conducted a randomized cross-sectional study that investigated how anecdotal information compared to visual information influenced a

person's decision-making regarding treatment options for angina. Two options for treatment, balloon angioplasty and bypass surgery (higher survival rate compared to balloon angioplasty), were given to choose from. Fagerlin et al. (2005) randomly distributed four different versions of a questionnaire among participants (*N*=875). All questionnaires had one positive and one negative anecdote regarding each treatment option. The four different versions of the questionnaire randomly distributed among participants were: questionnaire with information only regarding treatment options and outcomes, questionnaire with addition of pictograph, questionnaire with no pictograph but added quiz, and finally questionnaire with both pictograph and quiz. Thirty seven percent (*n*=524) of those who received the version with quiz and pictograph chose the bypass surgery option compared to 27% (*n*=517) of the participants who received the information only version (*p*=0.003). Comparatively, 40% (*n*=524) of the participants who received the questionnaire with pictograph only chose the bypass surgery option compared to the 27% in the no pictograph and no quiz questionnaire group ($p = 0.011$) (Table 4).

Table 4

Pictograph versus no pictograph quiz scores

	No Pictograph[a] (*n* = 517)	**Pictograph[b] (*n* = 524)**
No tradeoff quiz[c] ($n = 520$)	27	40
Tradeoff quiz[d] ($n = 521$)	28	37

Fagerlin et al. (2005)

Fagerlin et al. (2005) concluded that using graphical representation of data can significantly reduce a patient's biased preconceived knowledge of a disease, thus help

them make a more informed decision regarding treatment. Fagerlin et al. (2005) concluded that more research needs to be done to explore how visual information presented to a patient changes risk perception of a disease.

In order to test whether or not patient knowledge of HIV and adherence behavior (behavioral changes initiated by the patient in order to achieve better health) toward HIV improved with the use of video education, Brock and Smith (2007) conducted a quasi-experimental study on HIV patients (*N*=50) in an outpatient facility. Each participant had to have a confirmed HIV diagnosis, be 18 years of age and older, and speak English as their first language. After meeting qualifications and given consent instructions, participants could choose to participate or withdraw from the study. Within one clinical visit Brock and Smith (2007) gave each participant a personal digital assistant (PDA)/ tablet with a pre-test survey concerning HIV knowledge. Each participant was given instruction on how to use each PDA/tablet and the option to have each question audibly given to factor in low health literacy. Immediately after completion of the pre-test survey each PDA device played a 17-minute video concerning HIV knowledge and adherence procedures. At the end of the video each PDA device prompted participants to take a post-test survey. Finally, after completing the post-test survey participants were instructed to take the Rapid Estimate of Adult Literacy in Medicine (REALM) test in order to test health literacy of each participant. Brock and Smith (2007) administered the final survey, which tested recall, comprehension and adherence from facts presented in the video, at each participant's 4-6 week HIV clinical check-up. They reported 60% (*n*=30) of participants held high school diplomas, and 55% (*n*=27.5) scored low on the REALM test, indicating low health literacy (Brock & Smith, 2007). The paired sample *t*-

tests, implemented to evaluate the effectiveness of the video on HIV knowledge and adherence protocols, found a statistically significant increase in HIV knowledge (p<0.005) as well as proper adherence towards medication (p<0.005) (Brock & Smith, 2007). Ninety percent of participant's (n=45) reported feeling the videos increased their understanding of HIV and how to properly take medications (adherence) (Brock & Smith, 2007). Although Brock and Smith (2007) concluded using video increases knowledge and patient adherence to medication protocol, there were some limiting factors to the study such as no control group, nor had the participants taken the REALM in the pre-test phase of the study (Brock & Smith, 2007). The majority of participants (96%; n=48) reported they felt more confident with new medication protocol after watching the videos and would be able to properly self-administer their new HIV medications. The majority of participants, 96% (n=48) also showed understanding of the negative consequences if proper medication protocol was not followed. Brock and Smith (2007) concluded more research should be directed at patient specific use of multimedia technology, in order to understand how patient adherence and knowledge is impacted.

The use of digital scan technology as an individualized visual representation of patient data may help patients understand the status/risk of their periodontal disease and make informed decisions regarding treatment and adherence of oral hygiene suggestions.

Relevance of technology to DH patient education. Within daily practice a DH synthesizes complex patient oral health information and presents it to each patient, establishing a foundation of trust and conveying a message of personalized care. Understanding what DHs value in daily practice can reveal the motivation behind the care they give, and type of communication used. In a recent qualitative study concerning

what DHs value in practice, Stenman, Wennstrom, & Abrahamsson (2010) found DHs value behavioral change and being accurate when presenting patient information. Stenman et al. (2010) performed one-hour interviews with DHs (*N*=17), with ages ranging from 29-66. The DHs were from 17 different clinics. Each participant was interviewed for one hour by the same examiner. An interview guide was used with open-ended questions and designed using the Grounded Theory method of qualitative interviewing. Results of the study revealed the central theme of the interviews as, "to be successful in information and oral health education and in managing desirable behavioral changes" (Stenman et al., 2010, p. 214). Stenman et al. (2010) also found the participants placed value in using methods or tools to enhance patient understanding of periodontal disease. Understanding what DHs value in daily practice with patients is telling of where technology can be utilized to amplify these values. Producing an understandable synthesis of a patient's periodontal data is foundational in DH practice and valued as an important aspect of care among DHs. The DH may use intraoral scan technology as a tool to facilitate personalized patient education, communication and motivational change.

Summary

Digital scan technology has been utilized in orthodontics, cosmetic dentistry, oral maxillofacial surgery and prosthodontics, but has yet to be studied as a method utilized by DHs as a tool for patient education. Patient communication self-efficacy and risk literacy concerning their periodontal disease status may be improved by the use of a digital scan as a visual aid, however further research is needed.

Methodology

Research Method or Design

This research study used a parallel experimental quantitative research design, with pre-tests and post-tests (see Appendix A, Appendix B, and Appendix C) in order to evaluate the effectiveness of the intraoral scan as a visual aid for demonstrating periodontal recession. The aim of this study was to examine if patient communication self-efficacy and risk literacy concerning periodontitis was affected when patients are presented with a personalized 3D scan of their tissue compared to a 2D periodontal chart. Two groups were evaluated for the study. A control group received a periodontal evaluation presentation with 2D periodontal chart, and the experimental group received a periodontal evaluation presentation with 2D periodontal chart with the addition of a 3D scan of their teeth and gingiva showing recession. The experimental group also viewed a time lapse of dentoform (model teeth and gingival tissue) recession using the iTero® Element's TimeLapse demo mode (see *Figure 4*). The TimeLapse demo mode function on the iTero® Element is a preset function created by iTero to demonstrate gingival recession that may occur within a six-month period. Due to the limited time allotted for this study, the iTero® Element demo TimeLapse was used to illustrate progression of recession. Using the preset demo TimeLapse ensured all experimental group participants received the same gingival recession progression demo. The Principal Investigator (PI) presented to both groups to ensure continuity of presentation content, and a script (see Appendix D and Appendix E) was used to ensure each group participant received the same presentation. The methods used for data collection include the use of a pre-test with

the self-efficacy Ask, Understand, Remember Assessment (AURA) Likert-scale instrument (see Appendix A). The AURA survey contains questions regarding communication self-efficacy of periodontitis diagnosis and treatment. The pre-test also contained the Protection Motivation Survey (PMS) which is compiled of seven sliding-scale questions evaluating patient periodontal disease risk literacy (see Appendix A). Two post-tests were given (see Appendix B and Appendix C). The control group post-test contained the same AURA and PMS questionnaires with the addition of four Likert-scale questions regarding participant experience and understandability of the 2D periodontal chart as a visual aid. The experimental group post-test also contained the same AURA and PMS questionnaires with the addition of eight Likert-scale questions regarding understandability and experience with the 2D periodontal chart and 3D intraoral scan. Each Post-test was given directly after periodontal evaluations are complete. A second post-test was given via email one week after the initial presentation with AURA and PMS questionnaires only, to measure comprehension data.

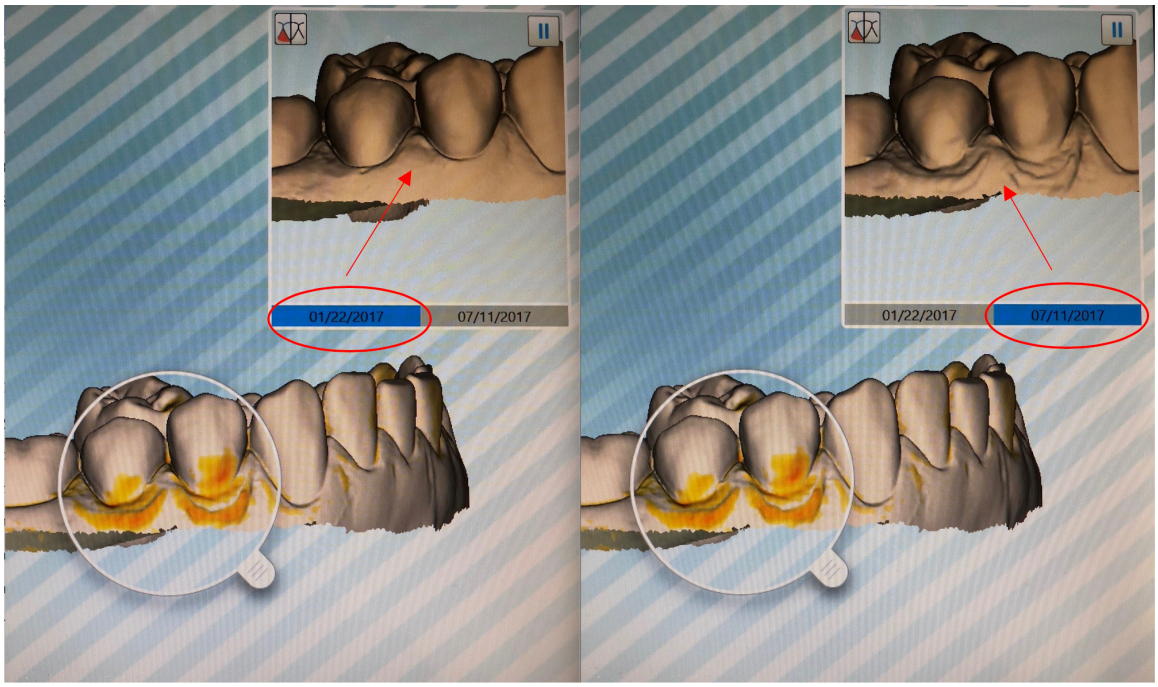

Figure 4. iTero® Element TimeLapse of recession as shown in demo mode.

Procedures

Human subjects protection/informed consent. The PI obtained approval from the Eastern Washington University (EWU) Institutional Review Board (IRB) and informed consent (see Appendix H) from each participant before the study was implemented. Participation in the study was voluntary, and participants had the right to withdraw from the study at any time. In order to ensure confidentiality, data was kept on the PI's personal computer and protected with a secure password. Participant information was deidentified before data was analyzed. To further insure anonymity, participants were informed not to write their names on the pre-test, instead each participant was given a specific identification number that corresponded to the pre-test and post-tests. After each pre-test and post-test was completed, the PI enclosed it in a manila envelope with the corresponding patient identification number. The second post-test, taken one week

after the initial study) was sent through Kois Dentistry's secure email server. The post-test email contained a link to SurveyMonkey® which contains the post-test Likert-scale AURA and PMS questions. All data was kept with the PI on a password protected computer.

Sample source, plan, sample size, description of setting.

Criteria for Sample Selection. Participants for this study were recruited from a convenience sample of existing Kois Dentistry patients. For pragmatic purposes the private practice chosen was Kois Dentistry which is located in the city of Seattle, Washington and is the PI's place of employment. Inclusion criteria for participation in the study were history of periodontal disease with at least 5mm Clinical Attachment Loss (CAL) measurements, at least 2mm of bone loss visible on radiographs, recession of 2-3mm, and at least five 4mm pocket depths or greater. Participants had to be at least 21 years of age and primary language being English, with access to email. Participants had to be existing patients of Kois Dentistry. Exclusion criteria included those who have had previous formal dental education.

Description of the Setting. This study was implemented in a private dental practice setting due to accessibility to the iTero® Element scan technology that was used for the intraoral scan.

Source. The population of the study included persons who were returning patients of Kois Dentistry at the time of the study and met the minimum criteria.

Plan. A randomized controlled method was employed through the use of Kois Dentistry's private practice data base. The population was chosen through the study's inclusion and exclusion criteria, and participants were invited to participate in the study

on a volunteer basis. Patients were asked in person at their regular dental hygiene visit and by phone correspondence. If contacted by phone a script was followed to ensure each potential participant receives the same information (see Appendix J). The PI explained what the study would entail and answer questions each potential participant had regarding the study. The study took place on Thursdays and Fridays at Kois Dentistry due to convenience and availability of the iTero® Element. Random selection using a random number generator determined which group (control or experimental) the participants were placed in and ensured non-bias from the PI. Group selection took place two weeks prior to implementation of the study. Each presentation (control and experimental) was allotted 90 minutes from the start of the pre-test to the completion of the post-test. Participants filled out the paper pre-test in the Kois Dentistry waiting room. Upon completion of the pre-test each participant was shown to the operatory set up for either the control presentation, or the experimental presentation. After the completion of the presentation (control or experimental) participants were allowed to ask questions to the PI regarding their periodontitis status, treatment options, and prevention strategies. Directly after the presentation and question time a paper post-test was completed by each participant. The experimental group post-test was identical to the pre-test with the addition of eight Likert-scale questions regarding experience with the 3D iTero® Element scan and 2D periodontal chart. The control group post-test contained the addition of four Likert-scale questions regarding experience with the 2D periodontal chart as a visual aid. In order to test long term comprehension, one week after the initial study, a post-test SurveyMonkey® link, corresponding to each group, was sent out via a secure email.

Size. Kois Dentistry has approximately 1,000 patients in its data base. To achieve a confidence level of 95% and confidence interval of 21.7 a sample of 21 participants (*N* = 21) is needed.

Variables. The independent variable was the iTero® Element scan used as a periodontal visual aid, and the dependent variables were the communication self-efficacy and risk literacy of each participant regarding their periodontal disease status.

Instruments. Quantitative data on patient communication self-efficacy concerning their ability to "obtain, understand, and remember" (Clayman et al., 2011. p. 4) periodontal information presented was collected using the AURA self-efficacy instrument (Clayman et al., 2011) (see Appendix A). The Protection Motivation Survey (PMS) was used to examine participant risk-literacy concerning their periodontal disease (see Appendix A). The PMS is a seven question Likert-scale survey with items targeting participant periodontal disease beliefs concerning personal susceptibility to the disease, importance of treatment, self-efficacy, disease related fear, barriers to treatment acceptance, and intentions for compliance with homecare instructions (Asimakopoulou et al., 2015). Demographic data included with each pre-test included age, gender, and educational experience. Participants were given a unique identifying code, through the use of a random number generator, that corresponds to their pre-test. This identifying code ensured that no participant wrote their name on the pre-test and ensured anonymity. The same participant code used for the pre-test was used for the post-test taken through a SurveyMonkey® link sent via email.

Equipment. The periodontal assessment presentation used Dentrix dental software to record periodontal charts and present the visual 2D periodontal chart image.

The iTero® Element scan (see *Figure 5*) was used to acquire participant 3D intraoral scan of teeth and gingival tissues. The TimeLapse feature of the iTero® Element scan was used to show six-month recession progression of dentoform gum tissue (see *Figure 4*). The periodontal chart was projected on a Twenty-inch plasma monitor to ensure that all participants can clearly see their probe depths and recession measurements. The 3D image was displayed to each patient on the nineteen-inch iTero® Element scan screen. IBM SPSS® version 2.4 software was used to collect and analyze the data.

Figure 5. iTero® Element Scan Being Performed on a Patient.

Steps to implementation. Upon approval from EWU IRB the PI implemented the following steps (see *Figure 6*).

Step One 1/3/2019	Step Two 1/3/2019-2/4/2019	Step Three 2/4/2019
Meet with Kois Dentistry Patient Coordinator: • Determine days to be blocked on schedule for study • Educate patient coordinator and front desk on study, participation guidelines and expectations for day of study • PI to identify returning patients who qualify for study	PI to recruit participants: • Ask potential participants in person at hygiene visits or over the phone	Meet with Kois Dentistry Patient Coordinator to solidify participants signed up for study • Send email to confirmed participants scheduled and inform them of appointment date and time. • Participant names randomly drawn using a random code generator to determine group assignment (Experimental or Control) and given a unique identifying number
Step Four: Implementation 2/15/2019, 2/22/2019 and 3/1/2019	**Step Five: 2 Weeks After Study**	**Step Six: Evaluation 2 Weeks After Study**
Implementation of study • Pre-test and informed consent completed before study. • Eight, one-hour presentations to be done each study day. • Post-test completed by each corresponding group participant • Participants informed of SurveyMonkey® email to be sent with post-test link.	• Second post-test sent to participants of the study via email link to SurveyMonkey®	Statistical analysis of data by PI of quantitative data • PI to meet with statistician to evaluate results of data

Figure 6. Steps to Implementation.

Step one. After IRB approval**,** the PI met with Kois Dentistry's Patient Care Coordinator to determine and block out days for the study to take place. During this meeting the PI educated the Patient Care Coordinator on the goals of the study as well as expectations for the day of the study. Participant inclusion criteria was explained to the

Patient Care Coordinator as well as informed consent instructions to be given to each participant on the day of the study. During this meeting the PI identified current patients of Kois Dentistry who qualified for the study based on the inclusion criteria.

Step two. One month was devoted to the recruitment process. Recruiting took place in person and through calling participants. The PI explained the study to participants and answered any questions participants had regarding the study. Once participants agreed to be included in the study the PI emailed the consent form twenty-four hours before the appointment and provided a written consent form to each patient and scheduled a ninety-minute time slot for the participant through the Dentrix® scheduler software.

Step three. The PI met with the Kois Dentistry Patient Care Coordinator to solidify the final list of participants. The final list was kept on the PIs personal computer and participant names were entered into an online random number generator. This assigned each participant to the control group or the experimental group by ascribing a unique identifying number. From the random number generator list, a master list with participant name and unique number was made (see Appendix F). Participant email reminders were sent out 2 days prior to the study to participants regarding their participation in the study and their study appointment time. Participants were emailed and called one day before their appointment time as a final reminder.

Step four. Upon arrival to Kois Dentistry for their study appointment time slot, each participant was given a manila envelope with their unique identification number. Blue manila envelopes were given to the control group and green manila envelopes were given to the experimental group. A master list with participant names and corresponding

unique identification codes was kept with the PI for reference and to ensure each participant was in the correct group on the day of the study. Each participant filled out an informed consent, as well as pre-test questionnaire. After completion of the pre-test and informed consent, the PI escorted each participant to an operatory to implement the study. After each periodontal presentation was complete (control and experimental) and periodontal therapy was performed, participants were handed a second manila envelope with the same unique identification code from the first envelope. The second envelope contained the post-test questionnaire for the participants to take. After completing the post-test, the PI informed each participant to expect an email from Kois Dentistry with a SurveyMonkey® link for the one-week follow up post-test (see Appendix G). Participants were thanked for their participation and escorted out to the front desk for check out.

Step five. One week after the study, each participant was sent a SurveyMonkey® link via email (see Appendix G). The SurveyMonkey® link contained the post-test questionnaire that corresponds to either the control group or experimental group. Each SurveyMonkey® link sent corresponded to each participant's unique identification number. This ensured that data from the pre-test and both post-tests corresponded to each participant. Information collected via SurveyMonkey was kept with the PI for data analysis. Upon completion of all three tests (pre-test, post-test, and emailed post-test) participants were added to a drawing for a Fifty-dollar gift card to Amazon®. This encouraged participation and completion of all tests.

Step six. After all post-test surveys were completed, the PI met with a statistician to evaluate and analyze data from the pre-test and post-tests.

Summary. In order to evaluate data, concerning the effectiveness of an intraoral scan on patient risk literacy and communication self-efficacy regarding periodontal disease, data from Likert-scale questionnaires were used. The PI administered each pre-test and post-test on the day of the study followed by a one-week post-test. To ensure anonymity of each participant personal data was coded, and no participant names were included during the pre-test, post-test and data analysis.

Results

Description of Sample

The PI recruited existing patients of Kois Dentistry for participation in this study via in person and telephone conversations. Participants (N = 21) totaled 14 females and 7 males. Comparative research used larger participant samples ranging from 50 to 875 subjects (Brock and Smith, 2007; Fagerlin et al., 2005; Austin et al., 1995; Cleeren et al., 2014; Asimakopoulou et al., 2015). For pragmatic purposes the PI recruited 21 participants (N =21) to meet the minimum confidence level of 95%. Participants were assigned to an experimental group (n =11) and a control group (n =10) through an online random number generator. Age was split into five different ranges (21-25, 26-34, 35-44, 45-54, 55+). Within these age ranges, 9.5% (n = 2) participants were in the 26-34 age range, comprising the lowest age group represented, while 33.3% (n = 7) of participants comprised the 55+ age group, representing the largest participant population in the study. The majority of participants (42.9%; n = 9) indicated they have a college degree while 19% (n = 4) indicated they hold a high school diploma. See Table 5 for full list of participant (N =21) study demographics.

Table 5

Demographic Characteristics of Study Participants

Characteristic	Percentage of Sample (*N*=21)
Gender	
Male	33.3% (*n*=7)
Female	66.7% (*n*=14)
Age	
21-25	14.3% (*n*=3)
26-34	9.5% (*n*=2)
35-44	19% (*n*=4)
45-54	23.8% (*n*=5)
55+	33.3% (*n*=7)
Education	
Highschool	19% (*n*=4)
Some College	23.8% (*n*=5)
College Degree	42.9% (*n*=9)
Graduate Degree	14.3% (*n*=3)

Statistical Analysis

All participants (100%; *N*=21) completed all three surveys (pre-test, post-test, emailed post-test). The additional questions added to the first post-test surveys, which tested for experience/comprehension with the periodontal chart and the 3D intraoral scan, were only completed by 85.7% (*n* =18) of participants.

The 4-item AURA survey was scored using a four-point Likert-scale where 1=Disagree A Lot, 2=Disagree A Little, 3=Agree A Little, and 4=Agree A Lot. The desired answer for all AURA questions is 4=Agree A Lot, which indicates a high degree of perceived communication self-efficacy. An independent samples *t*-test was run in order to evaluate significant change in the total average scores for the AURA survey from the pre-test and post-tests for each group (control and experimental). No statistical significance was found between the control (*n*=10) and experimental (*n*=11) group

AURA score. Table 6 shows the average answer given for all three AURA surveys taken between the control group (*n*=10) and the experimental group (*n*=11).

Table 6

Comparison of Overall Score Change in Experimental and Control Group AURA Pre-test and Post-tests

	Control Group Mean Score (*n*=10)	Experimental Group Mean Score (*n*=11)	Sig.
AURA Pre-test	3.80	3.81	0.91
AURA Post-test #1	3.90	3.95	0.50
AURA Post-test #2	3.95	3.86	0.33

Although Participants in the control (*n*=10) and experimental (*n*=11) groups showed high scores for all three AURA surveys taken, no statistical significance in average score change was found after control intervention or experimental intervention. In order to evaluate each AURA question for significant change between the pre-test and both post-tests within the control (*n*=10) and experimental (*n*=11) groups, a Levene's test for equality of variances was performed. Table 7 shows the mean score for each test question along with the standard deviation. No significant difference was found and therefore no significant change in communication self-efficacy score occurred after control or experimental intervention was performed.

Table 7

Experience/Comprehension Question means and standard deviation for post-tests per group

		Pre-test Mean	Post-test #1	Post-test #2		
		Mean (SD)	Mean (SD)	Mean (SD)	t-value	Sig.
1. It is easy for me to ask my dental hygienist questions	Control	3.90 (0.31)	3.90 (0.31)	4.00 (0.00)	-0.06	0.94
	Experimental	3.91 (0.30)	4.00 (0.00)	3.64 (0.92)		
2. It is easy for me to ask for help if I don't understand something	Control	3.60 (0.96)	3.80 (0.63)	3.80 (0.42)	-0.97	0.35
	Experimental	3.91 (0.30)	3.91 (0.30)	3.91 (0.30)		
3. It is easy for me to understand my dental hygienist's instructions risk of my periodontal disease	Control	3.90 (0.31)	4.00 (0.00)	4.00 (0.00)	-1.05	0.34
	Experimental	4.00 (0.00)	4.00 (0.00)	4.00 (0.00)		
4. It is easy for me to remember my dental hygienist's instructions	Control	3.80 (0.42)	3.90 (0.31)	4.00 (0.00)	1.67	0.11
	Experimental	3.45 (0.52)	3.91 (0.30)	3.91 (0.30)		

Note. No statistical significance found for each question. (p<0.05).

In order to evaluate change in PMS overall score among all three tests taken between the control (n=10) and experimental (n=11) groups, a t-test was run to evaluate if there was a significant difference in score between groups pre-intervention and post-intervention. Evaluation was done to compare PMS total average scores between pre-test to the first post-test, pre-test to the second post-test, and finally between the first post-test and second post-test (see Table 8). The t-test showed no statistically significant change in PMS score for both groups and for all pre-tests and post-tests.

Table 8

Independent Samples t-test Comparing Overall Score Change in Experimental and Control Group PMS Pre-test and Post-tests

	Group	*N*	Mean Change	Std. Deviation	*t*-value	Sig.
Change from PMS Pre-test avg. to Post-test #1 avg.	Control	10	0.00	0.00	-1.00	0.34
	Experimental	11	0.09	0.30		
Change from PMS Pre-test avg. to Post-test #2	Control	10	0.20	0.42	9.00	0.16
	Experimental	11	0.00	0.00		
Change from PMS Post-test #1 avg. to Post-test #2	Control	10	0.30	0.48	-0.70	0.49
	Experimental	11	0.45	0.52		

Neither the control group nor the experimental group experienced significant mean score change after intervention in their PMS scores, thus risk-literacy concerning their periodontal disease had no significant change after intervention.

For the PMS questionnaire, average scores were evaluated further by running *t*-tests for change in individual questions for the control (*n*=10) and experimental (*n*=11) groups. Each of the seven sliding-scale questions present on the PMS targets a specific periodontal disease risk-literacy category: Seriousness of Periodontal disease, Susceptibility, Treatment effectiveness, Self-efficacy, Treatment barriers, Fear, and Intention to follow a treatment plan. In order to evaluate if risk-literacy improved after control and experimental interventions a *t*-test was run to compare the mean score of each question. Reverse coding in SPSS was used for one PMS question (Question 5) while the other six question values remained unchanged. Reverse coding was done due to the value of question 5 being opposite compared to the rest of the questionnaire. A ten-point sliding scale ranging from not at all to extremely so was used to score (1= Not at All, 10=Extremely So) the seven periodontal disease risk-literacy categories between the control (*n*=10) and experimental (*n*=11) groups. An independent samples *t*-test was run and found no significant difference between the control group (*n*=10) mean score per question and the experimental group (*n*=11) mean score per question. Table 9 compares the mean score and standard deviation for each test question between both study groups.

Table 9

PMS Mean Change for Each Question for Pre-test and Post-tests Per Group. Control (n=10) and Experimental (n=11)

		Pre-test Mean (SD)	Post-test #1 Mean (SD)	Post-test #2 Mean (SD)	*t*-Value	Sig.
1. Periodontal disease is a serious illness **(Seriousness)**	Control	9.40 (0.69)	9.80 (0.42)	9.60 (0.51)	1.21	0.24
	Experimental	8.73 (1.67)	9.45 (1.21)	9.27 (1.10)		
2. If left untreated my chances of developing periodontal disease in the future are high **(Susceptibility)**	Control	9.20 (0.78)	9.70 (0.48)	9.60 (0.51)	1.48	0.15
	Experimental	8.45 (1.44)	9.55 (1.03)	9.45 (0.93)		
3. Adhering to my periodontal treatment instructions over the next week will improve my oral health **(Treat_Effectiveness)**	Control	9.30 (0.67)	9.90 (0.31)	9.60 (0.69)	0.28	0.77
	Experimental	9.18 (1.16)	9.91 (0.30)	9.91 (0.30)		
4. I am confident I can follow my periodontal treatment instructions over the next 2weeks **(Self-efficacy)**	Control	9.30 (1.05)	9.50 (0.70)	9.20 (1.13)	1.20	0.24
	Experimental	8.55 (1.75)	9.73 (0.64)	9.18 (0.98)		
5. Adhering to my periodontal treatment instructions over the next 2 weeks will be hard to remember/difficult to do **(Treat_barriers)**	Control	3.90 (3.38)	4.50 (4.06)	2.60 (2.41)	-0.73	0.47
	Experimental	5.00 (3.46)	4.64 (3.82)	2.64 (1.43)		
6. Periodontal disease worries me **(Fear)**	Control	7.50 (2.27)	9.10 (1.19)	8.50 (1.58)	0.34	0.73
	Experimental	7.09 (3.17)	7.82 (2.92)	8.27 (2.32)		
7. I intend to follow my periodontal treatment plan over the next 2 weeks **(Intention)**	Control	9.50 (0.70)	9.80 (0.42)	9.20 (1.13)	1.16	0.26
	Experimental	8.91 (1.51)	9.73 (0.64)	9.45 (0.82)		

Note. No significant difference found. ($p<0.05$)

The *t*-test showed no significant difference between each question and therefore no significant change in risk-literacy score occurred after control or experimental intervention was performed.

The experience/comprehension questions at the end of the first post-test were added in order to see if a higher PMS post-test score (increased risk-literacy) is correlated to a higher experience/comprehension score. The experience questions used a 5-point Likert-scale ranging from strongly disagree to strongly agree (strongly disagree=1, disagree=2, unsure=3, agree=4, strongly agree=5). Among the 21 participants (*N*=21) a total of 18 participants (*n*=18) completed the experience questions that corresponded to their study group. An independent *t*-test was run in order to compare the mean score of each question among the control group and experimental group. No statistical significance was found between the mean scores. Table 10 shows the mean experience score for each question among the control (*n*=9) and experimental (*n*=9) groups.

Table 10

t-test Comparing Individual Experience/Comprehension Question Mean Score Between Control (n=9) and Experimental (n=9) Groups.

	Group	Mean (SD)	t-value	Sig.
1. The periodontal chart was easy to understand	Control	4.22 (0.66)	-1.60	0.13
	Experimental	4.67 (0.50)		
2. I understand what the numbers on the periodontal chart mean	Control	4.78 (0.44)	-0.60	0.55
	Experimental	4.89 (0.33)		
3. Seeing my periodontal chart numbers helped me understand the risk of my periodontal disease	Control	4.78 (0.44)	-0.50	0.62
	Experimental	4.67 (0.50)		
4. Seeing my periodontal chart numbers motivates me to be consistent with my flossing and brushing habits	Control	4.78 (0.44)	-0.60	0.56
	Experimental	4.89 (0.33)		

In order to look at control and experimental groups (*N=21*) combined average experience score per question in correlation to PMS score a Pearson Correlation *t*-test was used (see Table 11).

Table 11

Pearson Correlation Test for Correlation Between Average Experience/Comprehension Scores and Average PMS Survey Scores for Control and Experimental Combined (N=21)

				PMS Pre-test (r-value)	PMS Post-test #1 (r-value)
	N	Mean	Std. Deviation	Sig.	Sig.
Experience Post-test Avg. Score	18	4.715	0.3288	0.22 (0.30)	***0.03*** ***(0.50)***

Note. $p<0.05$

A high correlation ($p< 0.03$) between an elevated PMS post-test #1 score and elevated Experience post-test score, both taken directly after control and experimental interventions, was found. This statistical significance ($p<0.03$) suggests the addition of periodontal disease risk education and explanation of a patient's periodontal chart is beneficial to a patient's perceived comprehension and motivation. No Statistically significant correlation was found for the experimental group's PMS scores and experience questions; however, the control group's PMS post-test average score and experience questions average score found a statistical significance of $p<0.049$ (see Table 12)

Table 12

Pearson Correlation t-Test for Average Control Group Experience Questions Score and PMS Post-test Score

	N	Mean (SD)	Sig. (r-value)
Experience Questions Avg. Score	9	4.63	
PMS Post-test Avg. Score	10	9.18	*0.049* *(0.66)*

Discussion

Summary of Major Findings

Using the AURA survey to measure communication self-efficacy and the PMS questionnaire to measure periodontal disease risk literacy, the following research questions were answered:

- Can the use of digital scan technology, improve patient self-efficacy in relationship to communication?
- Does the use of digital scan technology increase a patients' risk literacy?
- Does the use of a digital scan technology increase a patient's self-reported confidence and ability to ask, understand and remember information in a dental office?

Upon statistical analysis it was shown that participant communication self-efficacy (AURA survey) in the 3D intraoral scan experimental group (n=11) did not statistically improve compared to the control group (n=10) (see Table 6 and Table 7). After breaking down each AURA question for comparison and statistical change from pre-test to post-tests there was still no statistical significance found. Similarly, when evaluating the quantitative data for change in risk-literacy (PMS questionnaire) between the control (n=10) and experimental (n=11) groups, no statistical significance was found between average PMS scores for pre- and post-tests and individual questions (see Table 8 and Table 9). Among the whole study population (N=21), statistical significance ($p< 0.03$) was found between an elevated PMS post-test #1 score and elevated Experience Post-test score (both taken directly after interventions). This statistically significant correlation

indicates the addition of periodontal disease risk education and explanation of a patient's periodontal chart is beneficial to a patient's perceived comprehension and motivation. Statistical significance ($p<0.03$) was found between the control group post-test #1 and the experience questions (taken day of study), and no statistical significance between control post-test #2 (taken 1 week after study) and the experience questions (taken day of study). Likewise, there was no statistical significance found for the experimental group PMS post-tests and experience questions.

Statistical significance was difficult to achieve with a small sample size ($N=21$), and therefore results are inconclusive as to whether or not a 3D digital intraoral scan used as a visual aid can improve patient communication self-efficacy and periodontal disease risk-literacy.

Discussion

Currently 3D intraoral scan technology is not being utilized by dental hygienists or dental hygiene students as a way to visually track recession or as an interactive visual aid during patient education. For a student of dental hygiene, learning how to successfully communicate with a patient is foundational. The self-efficacy theory states that with increased practice of complex educational concepts (i.e. instrumentation, patient education, treatment planning) the more confident students become in their ability to perform these actions and behaviors (Jenkins et al., 2006). Intraoral scan technology, as a personalized visual aid of recession, may be utilized among dental hygiene students to help create discussion points regarding disease diagnosis, treatment options, and homecare suggestions, but training and practice is needed in order for students to feel confident and competent. In order for dental hygienists to be contributing practitioners

within the rapidly evolving world of digital dentistry, training and competency with the 3D intraoral scan is needed.

Patient risk-literacy. Previous to the implementation of this study, the PI theorized the addition of a personalized 3D intraoral scan of a patient's gingival tissue would increase understanding of recession and help clarify the meaning of a patient's periodontal chart and disease status. This improved understanding would lead to increased risk-literacy of periodontal disease and open channels for robust conversation with their provider regarding their periodontal disease status and treatment. The results of this study showed no statistical significance for risk-literacy improvement in either group, control (no 3D scan; n=10) or experimental (3D scan; n=11). In a similarly designed study, Asimakopoulou et al. (2015) found that an individualized risk communication session between patient and provider increases a patient's risk-literacy concerning their periodontal disease. While Asimakopoulou et al. (2015) found significant change within their experimental group's risk-literacy, they also saw significant change within their control group's risk-literacy scores. Asimakopoulou et al. (2015) concluded that both routine (control) and individualized (experimental) periodontal education with patients, positively impacts a patient's perception of their disease. The study conducted by Asimakopoulou et al. (2015) used a significantly larger study population (N=102) compared to this study (N=21) and therefore was able to see significant difference in scores between their control and experimental groups.

Patient communication self-efficacy. A patient's perceived confidence in their ability to communicate with their provider (communication self-efficacy) plays a large part in how they make decisions regarding their health. Effective communication between

provider and patient leads to increased patient comprehension of their disease and an increased ability to ask pertinent questions concerning their health (Clayman et al., 2010; Kaplan et al. 1996). In order to evaluate the impact of the 3D intraoral scan as a visual aid for the enhancement of a patient's communication self-efficacy, the PI used the AURA survey within a pre-test and two post-tests. Prior to the study the PI anticipated utilizing the 3D intraoral scan as a visual aid during periodontal disease education, would open lines of communication between provider and patient regarding risk of disease and treatment, thus increasing patient communication self-efficacy. The PI expected a higher AURA survey score for those (experimental group; n=11) who received periodontal disease education with the addition of a 3D intraoral scan as a visual aid compared to those (control group; n=10) who had no 3D intraoral scan as a visual aid. No statistical significance was found within the control group (n=10) score or experimental group (n=11) score from pre-test to post-tests. Due to neither group seeing any significant change from AURA pre-test to post-test, the PI attributes the results of this study to a small population sample size (N=21), and high education level among the population sampled. As stated above, similarly designed studies that found statistical significance among control and experimental groups had 50 to 875 subjects in their sample size (Brock and Smith, 2007; Fagerlin et al., 2005; Austin et al., 1995; Cleeren et al., 2014; Asimakopoulou et al., 2015). This study had a small sample size of 21 participants (N=21) with the majority (57.2%; n=12) reporting an education level of college degree or higher. Populations with low education levels (less than a high school degree) are the most likely to have low health literacy (Health.gov, n.d.). In their study concerning health literacy, Clayman et al (2010) found that participants (n=100) with low health literacy

scores, scored low on the AURA assessment ($p<0.05$). Seeing significant changes in AURA survey scores may not have been achievable due to the population of this study possessing a high education level. Baseline AURA scores for both the control ($n=10$) and experimental ($n=11$) group had a high mean score of 3.80 and 3.81 respectfully. Minor changes were seen between pre-test and post-test, but none with any statistical significance.

Patient Self-reported Confidence and Communication. At the end of each session with the control ($n=10$) and experimental ($n=11$) groups the PI left time for participants to ask questions concerning their periodontal disease risk and clarify any information presented. Participants ($N=21$) from both the control and experimental groups asked questions that revealed a higher level of comprehension. The PI fielded questions concerning the bacterial cause of periodontal disease, genetic and oral systemic link questions, and the risks of not adhering to homecare suggestions. The addition of the 3D intraoral scan, in the experimental group, produced more questions concerning the causes of recession, and why gingival tissue cannot grow back after recession has occurred. The 3D intraoral scan produced a deeper level of discussion into how periodontal disease causes recession and what prevention measures could be taken to prevent disease progression. This anecdotal finding concerning communication relates to the Commission on Dental Accreditation's (CODA) standard 2.15: "graduates must be competent in communicating and collaborating with other members of the healthcare team to support comprehensive patient care" (CODA, 2018). This standard relates to providing effective communication for better periodontal health outcomes within the American adult population (CDC, 2010). Discussion within the control group did not

produce any questions concerning recession or prevention measures that may reduce CAL. Both groups were concerned about their periodontal disease after periodontal disease education was completed and were fixated on the concept of bone loss. The PI noted that the majority of participants from the control and experimental groups voiced desire to change homecare habits due to not wanting bone loss from periodontal disease. Conversation between provider and participant (N=21) was enhanced by allotting time for periodontal disease education and discussion, and the addition of the 3D intraoral scan provided experimental participants (n=11) with a deeper level of critical thinking concerning the etiology of periodontal disease and how prevention and treatment recommendations impact their periodontal health.

Limitations

Data was collected from a small convenience sample size of 21 participants (N=21). This small sample size was significantly less than that of comparative research and makes finding statistical significance and correlations between control and experimental group data less generalizable. A limitation to the results of the AURA survey is possible participant bias. Study participants were current patients of Kois Dentistry, which is the workplace of the PI. The study participants have known the PI for several years, and therefore participant pre-test AURA scores may have been inflated by the fact that participants already experience open communication concerning their periodontal disease and feel comfortable asking questions to their provider the PI. This may have attributed to the finding of no statistical significance among the control group score and the experimental group score.

Among the study population sampled, 57.2% (*n*=12) reported having a college degree. This high level of education among the participant population (*N*=21) contributed to a high base-line score for the PMS (risk-literacy) and therefore made it difficult to find statistical significance from pre-test to post-test. A low level of risk-literacy is correlated to a low level of education. A desired sample population would have an evenly distributed education level for participants in order to make the results more generalizable. The limitations of this study should be considered when conducting future research.

Recommendations/Suggestions for Future Research

During the implementation of the study the PI noted ways in which the study could be enhanced for future research. The PI suggests using two control groups and one experimental group in order to better evaluate the effectiveness of the 3D intraoral scan and visual aids as educational tools. The first control group would receive verbal periodontal education concerning their periodontal chart, the second control group would receive verbal education with the addition of seeing their periodontal chart, and the experimental group would receive verbal education along with seeing their periodontal chart and 3D intraoral scan. A larger sample size is also encouraged for future research, as well as recruiting examiners who do not have previous affiliation with the patients. This would ensure a more accurate AURA score and eliminate participant bias. The PI also suggests conducting the study over a one-year time frame in order to test adherence to homecare suggestions, and to allow two 3D intraoral scans to be performed. These two separate scans could be compared and shown to participants in order to show them progression of their own recession. These recommendations may improve future research

and unveil how effective the 3D intraoral scan is concerning patient risk-literacy education and communication self-efficacy improvement.

Conclusions

Although this study resulted in an unexpected outcome, further research on the effects of the 3D intraoral scan on patient risk-literacy and communication self-efficacy should continue to be conducted and evaluated. Increasing the periodontal disease knowledge level of a patient alone does not equal patient behavioral change, nor does it equal patient adherence to treatment suggestions. Patients who feel comfortable stating opinions and asking questions tend to have better overall health outcomes (Kaplan et al. 1996). Using the 3D intraoral scan to help inspire constructive talking points between provider and patient is one way in which this tool could enhance treatment adherence success rates. Knowing the stage of change a patient is in may also be helpful in determining how receptive a patient is to the intraoral scan. Providing avenues for patients and providers to successfully communicate regarding their periodontal disease is needed in order for successful treatment adherence and patient behavioral change to occur. In order to understand and appreciate 3D intraoral scan technology in the field of dental hygiene, continuing education courses concerning the use and applications of this new technology should be developed.

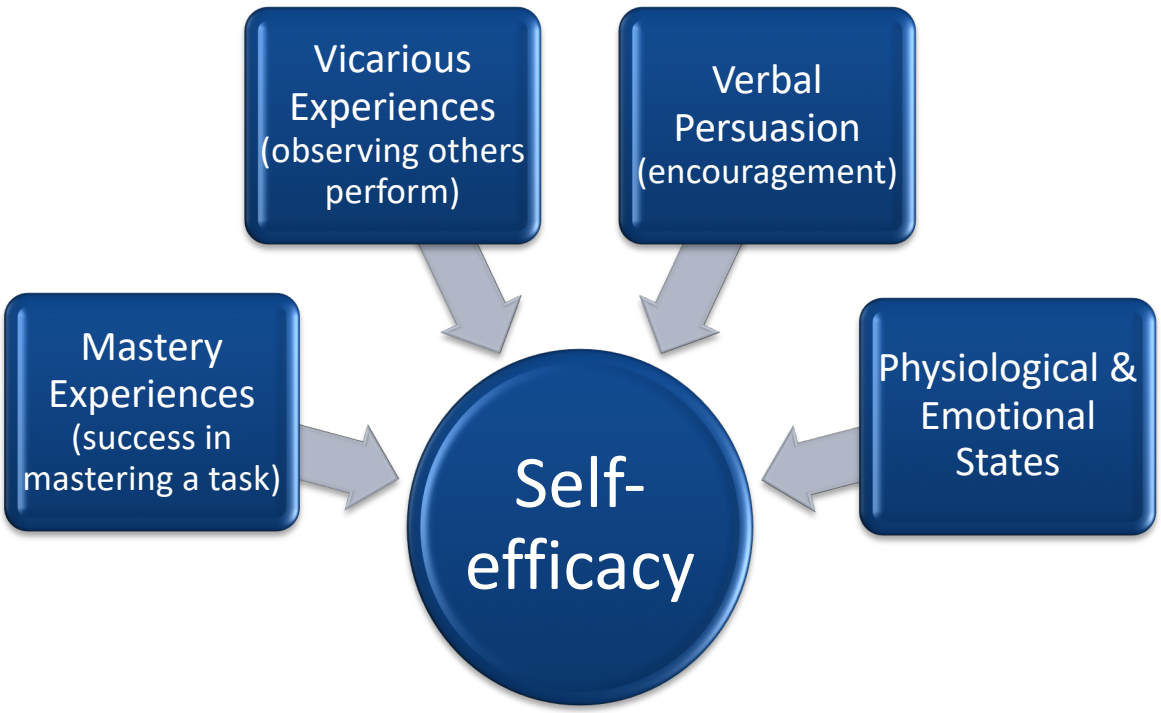

Figure 7. Four Sources of Self-efficacy

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Appendix A

Pre-Test Questionnaire

Pre-Test Questionnaire

Gender:	**Education:**
☐ Male ☐ Female **Age:** ☐ 21-25 ☐ 26-34 ☐ 35-44 ☐ 45-54 ☐ 55+	☐ Highschool ☐ Some College ☐ College Degree ☐ Graduate Degree

Ask, Understand, Remember Assessment Questionnaire (AURA)
Adapted from Clayman et al. (2011)

Please circle the answer that best represents how you feel
1 = Disagree a lot, 2 = Disagree a little, 3 = Agree a little, 4 = Agree a lot

	Disagree A Lot	Disagree A Little	Agree A Little	Agree A Lot
1. It is easy for me to ask my dental hygienist questions	1	2	3	4
2. It is easy for me to ask for help if I don't understand something	1	2	3	4
3. It is easy for me to understand my dental hygienist's instructions	1	2	3	4
4. It is easy for me to remember my dental hygienist's instructions	1	2	3	4

Pre-Test Questionnaire Continued

Protection Motivation Survey (PMS) Adapted from Asimakopoulou et al. (2015) On a scale of 1-10, please circle the answer that best represents how you feel 1 = Not at all, 10 = Extremely so										
	Not at all →				Neutral					Extremely so
1. Periodontal disease is a serious illness	1	2	3	4	5	6	7	8	9	10
2. If left untreated my chances of developing periodontal disease in the future are high	1	2	3	4	5	6	7	8	9	10
3. Adhering to my periodontal treatment instructions over the next 2 weeks will improve my oral health	1	2	3	4	5	6	7	8	9	10
4. I am confident I can follow my periodontal treatment instructions over the next 2 weeks	1	2	3	4	5	6	7	8	9	10
5. Adhering to my periodontal treatment instructions over the next 2 weeks will be hard to remember/difficult to do	1	2	3	4	5	6	7	8	9	10
6. Periodontal disease worries me	1	2	3	4	5	6	7	8	9	10
7. I intend to follow my periodontal treatment plan over the next 2 weeks	1	2	3	4	5	6	7	8	9	10

Appendix B

Post-Test Questionnaire for Control Group

Post-Test Questionnaire				
Ask, Understand, Remember Assessment Questionnaire (AURA) Adapted from Clayman et al. (2011) Please circle the answer that best represents how you feel 1 = Disagree a lot, 2 = Disagree a little, 3 = Agree a little, 4 = Agree a lot				
	Disagree A Lot	Disagree A Little	Agree A Little	Agree A Lot
1. It is easy for me to ask my dental hygienist questions	1	2	3	4
2. It is easy for me to ask for help if I don't understand something	1	2	3	4
3. It is easy for me to understand my dental hygienist's instructions	1	2	3	4
4. It is easy for me to remember my dental hygienist's instructions	1	2	3	4

Post-Test for Control Group Continued

Protection Motivation Survey (PMS)
Adapted from Asimakopoulou et al. (2015)

On a scale of 1-10, please circle the answer that best represents how you feel
1 = Not at all, 10 = Extremely so

	Not at all				Neutral					Extremely so
1. Periodontal disease is a serious illness	1	2	3	4	5	6	7	8	9	10
2. If left untreated my chances of developing periodontal disease in the future are high	1	2	3	4	5	6	7	8	9	10
3. Adhering to my periodontal treatment instructions over the next 8-12 weeks will improve my oral health	1	2	3	4	5	6	7	8	9	10
4. I am confident I can follow my periodontal treatment instructions over the next 8-12 weeks	1	2	3	4	5	6	7	8	9	10
5. Adhering to my periodontal treatment instructions over the next 8-12 weeks will be hard to remember/difficult to do	1	2	3	4	5	6	7	8	9	10
6. Periodontal disease worries me	1	2	3	4	5	6	7	8	9	10
7. I intend to follow my periodontal treatment plan over the next 8-12 weeks	1	2	3	4	5	6	7	8	9	10

Experience with Periodontal Chart as a Visual Aid

Please circle the following based on how you feel
1 = Strongly Disagree, 2 = Disagree, 3 = Unsure, 4 = Agree, 5 = Strongly Agree

	Strongly Disagree	Disagree	Unsure	Agree	Strongly Agree
1. The periodontal chart was easy to understand	1	2	3	4	5
2. I understand what the numbers on the periodontal chart mean	1	2	3	4	5
3. Seeing my periodontal chart numbers helped me understand the risk of my periodontal disease	1	2	3	4	5

4. Seeing my periodontal chart numbers motivates me to be consistent with my flossing and brushing habits	1	2	3	4	5

Appendix C

Post-Test Questionnaire for Experimental Group

Post-Test Questionnaire				
Ask, Understand, Remember Assessment Questionnaire (AURA) Adapted from Clayman et al. (2011) Please circle the answer that best represents how you feel 1 = Disagree a lot, 2 = Disagree a little, 3 = Agree a little, 4 = Agree a lot				
	Disagree A Lot	Disagree A Little	Agree A Little	Agree A Lot
1. It is easy for me to ask my dental hygienist questions	1	2	3	4
2. It is easy for me to ask for help if I don't understand something	1	2	3	4
3. It is easy for me to understand my dental hygienist's instructions	1	2	3	4
4. It is easy for me to remember my dental hygienist's instructions	1	2	3	4

Post-Test Questionnaire for Experimental Group Continued

Protection Motivation Survey (PMS)
Adapted from Asimakopoulou et al. (2015)

On a scale of 1-10, please circle the answer that best represents how you feel
1 = Not at all, 10 = Extremely so

	Not at all				Neutral					Extremely so
1. Periodontal disease is a serious illness	1	2	3	4	5	6	7	8	9	10
2. If left untreated my chances of developing periodontal disease in the future are high	1	2	3	4	5	6	7	8	9	10
3. Adhering to my periodontal treatment instructions over the next 8-12 weeks will improve my oral health	1	2	3	4	5	6	7	8	9	10
4. I am confident I can follow my periodontal treatment instructions over the next 8-12 weeks	1	2	3	4	5	6	7	8	9	10
5. Adhering to my periodontal treatment instructions over the next 8-12 weeks will be hard to remember/difficult to do	1	2	3	4	5	6	7	8	9	10
6. Periodontal disease worries me	1	2	3	4	5	6	7	8	9	10
7. I intend to follow my periodontal treatment plan over the next 8-12 weeks	1	2	3	4	5	6	7	8	9	10

Experience with Periodontal Chart and Scan as a Visual Aid

Please circle the following based on how you feel
1 = Strongly Disagree, 2 = Disagree, 3 = Unsure, 4 = Agree, 5 = Strongly Agree

	Strongly Disagree	Disagree	Unsure	Agree	Strongly Agree
1. The periodontal chart was easy to understand	1	2	3	4	5
2. I understand what the numbers on the periodontal chart mean	1	2	3	4	5
3. Seeing my periodontal chart numbers helped me understand the risk of my periodontal disease	1	2	3	4	5
4. Seeing my periodontal chart numbers motivates me to be consistent with my flossing and brushing habits	1	2	3	4	5
5. The 3D scan of my teeth and gums was easy to understand	1	2	3	4	5
6. The 3D scan was helpful in explaining my recession	1	2	3	4	5
7. Seeing my 3D scan helped me understand the risk of my periodontal disease	1	2	3	4	5
8. Seeing my 3D scan motivates me to be consistent with my flossing and brushing habits	1	2	3	4	5

Appendix D

Script for Periodontal Evaluation Without iTero® Element

- Today I am going to measure your gum tissue. I am going to do this by using a small measuring device called a probe. The probe measures the natural pocket that is created by the boarder of the gum tissue and the tooth. A healthy pocket depth is 1mm-3mm in depth, and unhealthy pocket depths can range from 4mm and deeper. We want shallow pocket depths.
- After I measure your gum tissue pocket depths, I will also measure the recession of your gum tissue. Recession is when the gums have receded due to periodontal disease. Knowing your periodontal pocket depths and recession is important in order to get a clear picture of your overall oral health and periodontal disease status.
- After I take your pocket depth measurements and recession measurements, I will show you your periodontal chart measurements and discuss your periodontal disease status, as well as what you can do to prevent further disease progression.

Explanation of periodontal chart key talking points:

- Explain orientation of periodontal chart: This will be done while pointing at periodontal chart as a visual aid.
    - The upper portion of measurements at the top of the screen are your upper teeth and the lower portion is your lower teeth.

  - The left side of the screen is the right side of your mouth and the right side of the screen is the left side of your mouth.
  - The vertical black lines depict the in-between spaces between each tooth.
  - To give you some orientation, where it says #2, that is your upper right molar. I took three pocket measurements on the cheek side of that tooth and three on the corresponding tongue side of that same tooth.
- Show and explain where 4mm and deeper pocket depths are and recession on patient's chart
  - If there is an area with more than 3-4mm pocket depths point these areas out and start discussion on the inflammatory process.
- Explain inflammatory process of periodontal disease
  - Many patients ask why deep pocket depths are concerning or bad to have. Let me explain how inflammation in your gum tissue can cause permanent destruction of your jaw bone and tissue.
  - When the bacteria that lives in our mouth and on the surface of our teeth migrates down into the gum pocket your body responds by sending millions of cells to the area to fight the bacteria. Your body continues to send cells with hopes of winning the bacterial battle, but if the bacteria are not removed with brushing or flossing the battle can be easily lost. If this inflammatory response continues for a long period of time it can actually start to destroy and harm the gums. The elevated temperature and still present bacteria cause the underlying jaw bone to be destroyed. When the bone is destroyed the tissue follows, for it is attached to your jaw bone. In

simple terms when we don't clean all surfaces of our teeth bacteria takes advantage and permanent damage can be caused. This is called the inflammatory process. Let us equate your gum inflammation to a cut on your hand. When you get a cut you immediately clean it so that it does not get infected. In order for healing to occur and to avoid infection you clean it daily and change the band aid. If your cut gets dirt in it, you immediately wash it. In the mouth we have billions of bacteria, and we are feeding them with the food we eat. It is a very hostile environment. Allowing bacteria to live in the pocket depths is like not cleaning a wound. Instead we are feeding the bacteria that are causing infection, bleeding gums, bad breath, and eventual bone loss.

- Explain risk of periodontal disease
- Explain how to prevent periodontal disease
- Explain importance of homecare and recall hygiene appointments
- Recommended Care

Appendix E

Script for Periodontal Evaluation with iTero® Scan and Periodontal Chart

- Today I am going to measure your gum tissue. I am going to do this by using a small measuring device called a probe. The probe measures the natural pocket that is created by the boarder of the gum tissue and the tooth. A healthy pocket depth is 1mm-3mm in depth, and unhealthy pocket depths can range from 4mm and deeper. We want shallow pocket depths.
- After I measure your gum tissue pocket depths, I will also measure the recession of your gum tissue. Recession is when the gums have receded due to periodontal disease. Knowing your periodontal pocket depths and recession is important in order to get a clear picture of your overall oral health and periodontal disease status.
- After I take your pocket depth measurements and recession measurements, I will show you your periodontal chart measurements and discuss your periodontal disease status, as well as what you can do to prevent further disease progression.

Explanation of periodontal chart key talking points:

- Explain orientation of periodontal chart: This will be done while pointing at periodontal chart as a visual aid.
    - The upper portion of measurements at the top of the screen are your upper teeth and the lower portion is your lower teeth.

  - The left side of the screen is the right side of your mouth and the right side of the screen is the left side of your mouth.
  - The vertical black lines depict the in-between spaces between each tooth.
  - To give you some orientation, where it says #2, that is your upper right molar. I took three pocket measurements on the cheek side of that tooth and three on the corresponding tongue side of that same tooth.

- Show and explain where 4mm and deeper pocket depths are and recession on patient's chart
  - If there is an area with more than 3 4mm pocket depths point these areas out and start discussion on the inflammatory process.
- Explain inflammatory process of periodontal disease
  - Many patients ask why deep pocket depths are concerning or bad to have. Let me explain how inflammation in your gum tissue can cause permanent destruction of your jaw bone and tissue.
  - When the bacteria that lives in our mouth and on the surface of our teeth migrates down into the gum pocket your body responds by sending millions of cells to the area to fight the bacteria. Your body continues to send cells with hopes of winning the bacterial battle, but if the bacteria are not removed with brushing or flossing the battle can be easily lost. If this inflammatory response continues for a long period of time it can actually start to destroy and harm the gums. The elevated temperature and still present bacteria cause the underlying jaw bone to be destroyed. When the bone is destroyed the tissue follows, for it is attached to your jaw bone. In

simple terms when we don't clean all surfaces of our teeth bacteria takes advantage and permanent damage can be caused. This is called the inflammatory process. Let us equate your gum inflammation to a cut on your hand. When you get a cut you immediately clean it so that it does not get infected. In order for healing to occur and to avoid infection you clean it daily and change the band aid. If your cut gets dirt in it, you immediately wash it. In the mouth we have billions of bacteria, and we are feeding them with the food we eat. It is a very hostile environment. Allowing bacteria to live in the pocket depths is like not cleaning a wound. Instead we are feeding the bacteria that are causing infection, bleeding gums, bad breath, and eventual bone loss.

- **SCAN with iTero® Element**
    - Show and explain recession sites and correlate back to patient's periodontal chart recession.
- Show and explain iTero® TimeLapse demo mode of 6-month recession progression.
    - Explain factors that affect patient's recession progressing
- Explain risk of periodontal disease
- Explain how to prevent periodontal disease
- Explain importance of homecare and recall hygiene appointments
- Recommended Care

Appendix F

Master List

Master List					
Experimental Group (green envelopes)			Control Group (blue envelopes)		
1			11		
2			12		
3			13		
4			14		
5			15		
6			16		
7			17		
8			18		
9			19		
10			20		

Appendix G

Sample Email for One Week Post-Test

Dear Participant,

Thank you for participating in the Periodontitis study at Kois Dentistry. As indicated on the day of the study, I am sending you a SurveyMonkey® link to a questionnaire. Your experience is very important to me and I would appreciate your honest input.

Please take the 5-minute questionnaire below.

Questionnaire: [SurveyMonkey link]

Thank you in advance!

Dana Tasche RDH, BSDH, MSDH candidate
Principal Investigator for Periodontitis Study
Kois Dentistry
(206) 515-9500

Appendix H

Consent Form

EASTERN WASHINGTON UNIVERSITY
start something big

Consent Form
Intraoral Scan to Enhance Patient Education

Principal Investigator:
Dana L. Tasche RDH, BS, MSDH (c)
MSDH Student
Eastern Washington University
310 N. Riverpoint Blvd. Box E
Spokane, WA 99202
(208)964-5868 (cell)
(509) 828-1300 (Dental Hygiene Dept. office)

Responsible Project Investigator:
Lisa Bilich RDH, MSEd, CHSE
Professor of Dental Hygiene
Eastern Washington University
310 N. Riverpoint Blvd. Box E
Spokane, WA 99202
(509)828-1295

Purpose and Benefits

This clinical study is being conducted as part of the requirements needed to receive a Master of Science in Dental Hygiene degree from Eastern Washington University (EWU). This research study aims to test if a patient's comprehension and understanding of the risk of their gum disease improve with the addition of a digital intraoral scan when used as a visual aid during periodontal disease education. The primary investigator (PI) of this study believes that using a digital intraoral scan in conjunction with a 2D periodontal chart will improve a patient's understanding of the risk of their periodontal disease as well as improve provider to patient communication.

Procedures

Participation in this study will require an extra 30 minutes added on to your routine dental visit. If you agree to participate you will be scheduled for a 90-minute appointment on a research study day at Kois Dentistry. On the day of your appointment you will be asked to complete two surveys. One will be given before your appointment and the second will be given after your appointment is complete. An additional survey will be sent to your email one week after your appointment. Each survey helps the Principal Investigator to determine if each visual aid used to explain your gum disease risk was successful or not. All study and survey information will remain anonymous by issuing each study participant a special identifying number. No names or personal information will be used. Participants of the study may also opt out of answering any questions that they deem as objectionable.

Sample survey Questions:

1. Periodontal disease is a serious illness
2. It is easy for me to ask my dental hygienist questions

Consent form continued

EASTERN WASHINGTON UNIVERSITY
start something big

Intraoral Scan to Enhance Patient Education

Risk, Stress, or Discomfort

Participation in the study has no known risks, nor is there any known side effects associated with completion of the study. Invasion of privacy is of the utmost importance, and all identifying information will not be used or shared. In order to keep your privacy as a priority each participant will be given a personal identifying number in place of writing their name for each survey. The third survey, sent through email, will be sent through Kois Dentistry's encrypted email server.

Other Information

Participation is voluntary and confidential, and participants are free to withdraw at any time without penalty or jeopardizing future care. Upon completion of all three surveys, participants will be entered into a random drawing for a $50 Amazon gift card. Participants who withdraw from the study early, and do not complete all three surveys, will not be eligible for these incentives.

Upon completion of the study, the results will be published in my final thesis document and available to participants for review.

Signature of Principal Investigator _____ Date _____

Subject's Statement

The study described above has been explained to me, and I voluntarily consent to participate in this study. I have had an opportunity to ask questions, and my questions have been answered to my satisfaction. I understand that by signing this form, I am not waiving my legal rights. I understand that I will receive a signed copy of this form.

Signature of Subject _____ Date _____

If you have any concerns about your rights as a participant in this research or any complaints you wish to make, you may contact myself at dana.tasche@eagles.ewu.edu or Ruth Galm, Human Protections Administrator, at (509) 359-7971 or rgalm@ewu.edu or the Faculty Advisor, Lisa Bilich at (509) 828-1295 or lbilich@ewu.edu.

Department of Dental Hygiene
Health Sciences Building #160 • 310 N. Riverpoint Blvd. Box E • Spokane, WA 99202-1609 • 509.828.1300 • fax: 509.828.1283

Appendix I

Email to Accompany Consent Form

Thank you for your interest and willingness to participate in the upcoming study at Kois Dentistry. The primary investigator of this study believes that using a 3D scan/image of a patient's own teeth and gums in conjunction with a 2D periodontal chart will help a patient understand the risk of their periodontal disease as well as improve provider to patient communication.

In order to participate in this study each participant must be 21 years of age or older and be a current patient of Kois Dentistry.

Attached is the Consent Form for participation in the study. This form also outlines what will take place on the day of your appointment, as well as incentives for completing the study.

Finally, the study and its results are completely separate from any dental services you will be receiving on the day of the study.

Please see attached Consent Form.

Thank you again,

Dana Tasche (Principal Investigator and graduate student of Eastern Washington University)
Kois Dentistry
(206) 515-9500

Appendix J

Telephone Script for Participation in Study

Hi this is Dana calling from Kois Dentistry. I am calling in regard to scheduling your recare appointment for a dental cleaning. Before I get you scheduled, I would like to invite you to participate in a study I am conducting on patient education and the use of visual aids. This study is part of a requirement for me to receive my Master of Science in Dental Hygiene from Eastern Washington University.

If you choose to participate, your appointment will be 90 minutes instead of 60 minutes. The extra time is needed for the education portion of the appointment. You will still have your dental cleaning and exam on this day and you will also take two small surveys at this appointment. The surveys help me understand how certain visual aids enhance your understanding of gum disease. Because this study focuses on education and visual aids, your dental cleaning and exam have nothing to do with the study results.

If you choose to participate in this exciting study and finish all surveys, your name will be put into a drawing for a $50.00 Amazon gift card.

If patient says yes:

Thank you for wanting to participate. Let's get you scheduled for your appointment time. We will be sending you a reminder email 2 weeks before your appointment with a consent for your participation attached. Please arrive 5 minutes before your scheduled appointment to fill out paperwork.

Appendix K

Kois Dentistry Release Form

KOIS DENTISTRY
Restorative · Aesthetic · Implant

November 30, 2018

To Whom it May Concern,

I authorize Dana Tasche, RDH, to conduct her study, Digital Scan to Enhance Patient Education, on the premises of Kois Dentistry. This authorization includes the use of our equipment, technology, and patient data base (all information to be used within HIPAA guidelines) during the study.

Regards,

Dean E. Kois, DMD, MSD

Tara L. Kois, DMD

KOIS DENTISTRY
1001 FAIRVIEW AVE N.
SUITE 2000
SEATTLE, WA 98109
TEL 206.515.9500
FAX 206.624.6030
WEB www.koisdentistry.com

DEAN E. KOIS, DMD, MSD
TARA L. KOIS, DMD

Curriculum Vita
Dana Tasche, RDH, BSDH

Kois Dentistry
1001 Fairview Ave N. #2000
Seattle, WA 98103
206-515-9500
Dana.Tasche@gmail.com

Graduate Education:
Master of Science in Dental Hygiene — May 2018
Eastern Washington University
Cheney, Washington

Undergraduate Education:
Bachelor of Science in Dental Hygiene — June 2010
Eastern Washington University
Cheney, Washington

Academic Appointments:
Clinical Instructor (part-time) — January 2017 – Present
University of Washington School of Dentistry
Seattle, Washington

Restorative Clinic Lab Instructor (part-time) — January2011 – March 2011
Department of Dental Hygiene
Eastern Washington University
Spokane Campus
Spokane, Washington

Professional Experience:
Dental Hygienist (full-time) — July 2012 – Present
Kois Dentistry
Dr. Dean Kois & Dr. Tara Kois
Seattle, Washington

Dental Hygienist (part-time) — March 2012 – October 2014
Anabella Dentistry
Dr. Clara Song

Bellevue, Washington

Dental Hygienist (full-time) March 2011 – June 2012
Essence of Dentistry
Dr. Alison Han
Redmond, Washington

Professional Licensure:
Washington State Dental Hygiene July 2010 – Present
Washington Board of Dental Examiner

Certifications:
Washington State Registered Dental Hygienist July 2010 – Present
Healthcare Provider Certification in Basic Life Support/CPR/First Aid July 2007 – Present

Professional Affiliations/Memberships:
American Dental Educator's Association (ADEA) August 2016 – Present
American Dental Hygienist's Association (ADHA) September 2007 – Present

Honors and Awards:
Eastern Washington University June 2010
Cum Laude

Advisory Boards/Committee Membership:
University of Washington July 2017 – Present
Advisory board member for the
Early Childhood Oral Health
Training program (EChOTrain)

Professional Presentations:
"Pediatric Behavioral Management" May 2017
Presented a half day course to first
year dental students in The University
Of Washington's RIDE program.
Spokane, Washington

"Pediatric Behavioral Management: August 2017 & November 2017
What are Your Protocols?"
Presented five, round robin sessions, for
The University of Washington's RIDE
program preceptor staff meeting.
Continuing Education Credits were
awarded upon staff completion of session.
Spokane, Washington and Great Falls, Montana

"Oral Health: What Is It?" Presented a one-day presentation and workshop for Bhutanese refugees. Facilitated donations of free oral health goods. Spokane, Washington	July 2009

Community Service:

Provided professional dental prophylaxis cleanings and hygiene instruction for orphans and staff members of Casa De Benedicion Orphanage. Bachiniva, Mexico	September 2016
Facilitated scouting trip for future Mission trips to Casa De Benedicion Orphanage. Provided pediatric oral hygiene instruction and consultation to staff members of orphanage. Bachiniva, Mexico	February 2016
Hope Place Woman's Shelter Soup Kitchen Volunteer Seattle, Washington	October 2014
Jubilee Reach Clothing Drive Bellevue, Washington	September 2012
Spokane Paralympics volunteer Spokane, Washington	June 2009
Spokane District Dental Society Give Kid's a Smile Day Spokane, Washington	April 2008, 2009, 2010

Professional References:

Lisa Bilich, RDH, BS, Med
Professor, Dental Hygiene
Eastern Washington University
509-828-1295

Dr. Dean Kois, DMD, MSD
Kois Dentistry
206-515-9500

Dr. Diane Daubert, RDH, MD, PhD
Professor, Periodontology
University of Washington School of Dentistry
206-685-3766