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The Journal of Dental Hygiene is the refereed, scientific publication of the American Dental Hygienists' Association. The JDH promotes the publication of original research related to the profession, education, and practice of dental hygiene and supports the development and dissemination of a dental hygiene body of knowledge through scientific inquiry in basic, applied and clinical research.

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Remembering Steven Offenbacher, DDS, PhD

Rebecca Wilder, RDH, BS, MS

Editor-in-Chief, *Journal of Dental Hygiene*



The dental profession lost a giant last summer when Dr. Steven Offenbacher passed away suddenly while on vacation. The editorial below is being reprinted with permission from the *Journal of Dental Research*. It is an excellent tribute to Steve, but I want to add my personal thoughts. First, Steve Offenbacher was a leader in periodontal medicine. Much of what we know today about the relationship between oral and systemic disease can be traced back to his research. He was the author of hundreds of publications on these topics. Everyone should have a passion in life and research was his.

Second, Steve was a great friend to dental hygiene. Many of my graduate dental hygiene students here at the University of North Carolina worked with him on thesis projects, conducted research in his labs and clinics or merely sought him out for advice; I did as well. No matter how difficult the concept, I always felt like Steve could explain it to me and I could understand it...at least until I tried to explain it to someone else! He was a truly brilliant scientist, plus his sense of humor was contagious. Steve was always witty and friendly to everyone he met. I hope you will read the following editorial and pause for a minute to pay tribute to a national treasure and to a life well lived.

In Memoriam – Dr. Steven Offenbacher¹



Dr. Steven Offenbacher died unexpectedly on August 9th, 2018 at the age of 67 while on vacation in Norway with his family and friends. He served as the 29th President of the American Association for Dental Research (2000-2001). Steve was born in Zanesville, Ohio, on December 26, 1950 to George

and Shirley Offenbacher and completed his undergraduate education in Chemistry at Boston University. He earned a DDS degree from Virginia Commonwealth University (VCU)

in 1976 and in 1977 received his Ph.D. in Biochemistry also from VCU. He then returned to Boston and in 1980 received a certificate in Periodontology and Oral Medicine from Harvard School of Dental Medicine. In addition, he completed a M.MSc. degree in Oral Biology at Harvard Medical School and a Postdoctoral fellowship in Pharmacology at Forsyth Dental Center.

Upon completion of his formal education, Steven accepted an Assistant Professor position at Emory University in Atlanta, Georgia from 1981-91. During those eleven years at Emory, he broadened his research endeavors and served for a period of time as the Department Chair of Periodontology. He had appointments in Periodontology, Oral Biology, Biochemistry, and the Winship Cancer Institute. In addition, he was a guest researcher in Anaerobic Microbiology at the Centers for Disease Control and the Yerkes National Primate Research Center. Even as a junior faculty member, he did not hesitate to seek opportunities to collaborate, grow and think outside-the-box. It was during this time that he began his first study on the associations between periodontal disease in pregnant women and adverse birth outcomes.

Steven and I first met at a Conference on Risk Assessment in Dentistry we held at the University of North Carolina in 1989. The conference was designed to bring more attention to the use of 'risk factors' in dental studies along with the search for 'causes.' It was not long after that meeting that Emory University's dental school closed and Steven came to UNC as an Associate Professor in the Department of Periodontology. This was a fortunate move for both of us. Steven had received grant application reviews suggesting his clinical studies needed larger sample sizes and I had received a review for an epidemiological study recommending more biomarkers. Even though Steven had indicated that as a biochemist, he could be very happy working with one liver, we have had a very productive partnership over the last 25 years.

Steven had an incredibly noteworthy career. He was a brilliant scientist and was considered the father of “periodontal medicine” due to his work on cardiovascular disease and adverse pregnancy outcomes. While he was not the first to publish on the relationship between periodontal disease and cardiovascular disease, he was the first to publish a biological model of how periodontal disease becomes systemic. Knowledge in this area keeps expanding, but it remains supported by the basic model he proposed. He also pioneered the research between periodontal disease and adverse pregnancy outcomes. Since his work in the area of oral and systemic diseases was novel, few appreciated how these associations also led to a better understanding of periodontal disease itself. For example, being a part of a medical study of coronary heart disease that collected a wide variety of biomarkers and along with detailed genotyping provided the opportunity to more completely characterize periodontal disease in large, representative groups of people. Steven believed that we should have the ability, when it was needed, to conduct research on a topic that involves basic, animal, translational, clinical, population-based studies, and most recently, the individual, bringing precision medicine to periodontology. He not only envisioned moving discovery made in animal models eventually to treatment of a patient, but also to take observations from clinical findings back to the laboratory to explore underlying mechanisms in animals. To facilitate this research, he established the Center for Oral and Systemic Disease in the dental school that included a clinical research unit (General and Oral Health Clinic), a laboratory, an animal research arm, a unit to train examiners for clinical studies, and the ability to conduct epidemiology studies.

Steven was honored many times throughout his career, beginning when he was a student. As a faculty member, he was awarded the 1999 International Association for Dental Research (IADR) Basic Science Award in Periodontology; the 1999 William J. Gies Award for Achievements in Periodontology; the 2006 American Dental Association (ADA) Norton M. Ross Award for Excellence in Clinical Research; the 2014 American Academy of Periodontology (AAP) Distinguished Scientist Award; and the 2015 ADA Gold Medal Award for Excellence in Dental Research. He was particularly fond of the 2001 Foundation for Healthy Mothers, Healthy Babies Coalition Special Impact Award as he had testified at a congressional hearing regarding this topic. He also was fond of the 2008 AAP Educator Award for Outstanding Teaching and Mentoring in Periodontics. That fondness was a result of the 104 pre-doctoral, MS, PhD, and

Post-Doctoral students he mentored. Additionally, he won the AAP Clinical Research Award four times (2004, 2006, 2008 and 2009). In 2013, competing with faculty members throughout the University, Steve was awarded a W.R. Kenan Jr. Distinguished Professorship by the University of North Carolina, which represented a rank above Full Professor.

Steven was a bundle of positive energy. Multiple collaborators characterized him as a “kid in a candy store” due to his excitement about research. He was very entrepreneurial and believed strongly in collaboration with others. He was an optimist at heart and while recognizing that something negative had happened, it was something to learn from, but time to move on. He neither dwelled on it nor wanted to talk about it again. Those who knew him knew that he greatly appreciated humor (although his jokes were not always that good) and that he had a quick wit that often resulted in self-deprecating humor. In addition to his research, He served more than two terms as Chair of the Department of Periodontology and taught in the DDS Curriculum. Steven also took time to be a terrific mentor to residents, graduate students, postdocs, and junior faculty. Those who worked with him would tell stories about how he always wanted to see new data and when there were interesting findings he would do a “data dance”. Everyone knew that no matter how busy he was, they could get his attention if they told him they had new data.

Since Steven loved data, it is appropriate to summarize the data that pertain to his career. At the time of his passing, he had published 339 articles in peer reviewed Journals with twelve papers in press. Two of the *in press* papers are Nature Publishing Group publications. During the last five years, his articles were cited 12,801 times (not counting self-citations) and his H-Index was 61. During his career, he had continuous grant support totaling 56 grants from NIH and industry. The subject areas of his research included articles in dentistry, medicine, biochemistry, genetics, microbiology, immunology, pharmacology, toxicology, chemical engineering, social sciences, mathematics, and neuroscience. While his name is most associated with his work in periodontal medicine, his passion for learning led him to help pioneer different areas of expertise. This included work in epigenetics, classification of periodontal disease, and exploration of the role of single nucleotide polymorphisms genetics (GWAS) using multiple approaches to identify and characterize genes potentially involved in the pathogenesis of periodontitis. His research network included more than 200 scientists around the world.

While these data are impressive, they do not tell the whole story. As consumed with work as he was, Steve did have balance in his life. He loved his family and frequently traveled around the world with his wife, Julie. He enjoyed fishing with his son, Cody, as well as taking father-son trips. He was always reading and constantly absorbing new ideas as well as mystery novels. He loved to cook and enjoyed spending time with his dogs, in the outdoors, and at his home. He had a life-long love of music. In fact, Steven paid his way through dental school playing guitar with a lounge act he organized. Music remained a big part of his life and he planned to spend even more time exploring it when he retired.

Steven made impactful contributions to science, especially in the field of Periodontology. His work was important in raising awareness that the mouth, indeed, was linked to the rest of the body in ways we had not anticipated previously. In doing that, he also made contributions to our understanding of periodontal disease and its treatment. As busy as he was, he always scheduled time to see patients and those experiences contributed to his quest for discovery. Steven touched the lives of those he taught, especially mentees ranging from pre-dental students to junior dental and medical faculty. Those of us who knew him well will not be able to replace him in our lives, but the knowledge and excitement about discovery that we gained and experienced with him will keep inspiring us as we move forward.

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Magnification and Coaxial Illumination in Dental Hygiene Education: Experience and attitudes of clinical educators

Denise Kissell, RDH, MPH; Brian B. Partido, RDH, MSDH; Wendy Moore, RDH, MSA

Abstract

Purpose: Static postural demands and precise movements involved with instrumentation, place dental professionals at high occupational risk for developing musculoskeletal disorders (MSDs). Using magnification loupes and coaxial illumination may lower the risk of developing a future MSD. The purpose of this study was to evaluate the experiences and attitudes among clinical dental hygiene educators in Ohio regarding requiring the use of magnification loupes and coaxial illumination in academic settings.

Methods: Clinical dental hygiene faculty members from the 12 dental hygiene programs in Ohio were invited to participate in a cross-sectional, electronic survey consisting of 28 items. Descriptive statistics were used to analyze the educators' experiences with magnification loupes and coaxial illumination in academic settings.

Results: Responses from 54 participants from the non-probability sample were analyzed. A majority (86%) of the respondents used magnification in their role as clinical faculty members; 94% felt that clinical faculty members and 92% felt students should be required to use magnification in academic settings. Of the 54% using coaxial illumination while caring for patients, 94% used illumination in their role as clinical faculty members. A majority of these respondents (94%) felt clinical faculty members, and students (82%) should be required to use coaxial illumination in academic settings. Improved ergonomics, increased accuracy, and efficiency were cited as the perceived rationale for mandating the use of magnification and illumination.

Conclusion: Dental hygiene faculty using magnification loupes and coaxial illumination in clinical practice and in academic settings supported requiring faculty and students to use magnification and illumination.

Keywords: magnification, loupes, coaxial illumination, ergonomics, clinical dental hygiene education, musculoskeletal disorders

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Introduction

Dental professionals are considered to be at elevated occupational risk for developing musculoskeletal disorders due to static postural demands and the precise movements involved with instrumentation.¹⁻⁵ In a survey of dental professionals, 74% of respondents reported musculoskeletal pain.³ Multiple studies have demonstrated, through the use of electromyography and photography, that dental professionals most commonly experience pain in the shoulders, neck, upper back, lower back, and wrists.^{6,7} Forward flexion of the neck and anterior carriage of the head have been identified as major sources of pain for dental hygienists in clinical practice.^{7,8} However, what is more concerning, is the pain experienced

during entry-level clinical training by dental professionals may be a precursor to the musculoskeletal disorders experienced in later in clinical practice.^{9,10}

An aspect of ergonomics involves the science of equipment design, maximizing working spaces for productivity, and minimizing operator fatigue and pain.^{11,12} Magnification loupes have been shown to provide both positive and negative aspects for clinicians.^{1,8,13,14} While more acceptable postures in students have linked to the use of loupes, additional faculty feedback was also required to achieve those postures.^{1,15} Dental hygiene students have self-reported improved postures while using indirect vision with magnification, however, there

were no significant differences in accuracy and efficiency demonstrated while using magnification.¹⁶ Despite the lack of clarity regarding the ergonomic benefits associated with the use of magnification, it has been suggested that there may be postural and clinical benefits associated with the use of coaxial illumination, or light sources aligned with the sight line.¹⁷⁻²⁰

Headlights using light-emitting diode (LED) technology provide an alternative source of illumination to the overhead dental operatory light. The use of the LED light combined with low-powered magnification (2.5X) has been shown to enhance the detection of caries in the primary dentition.²¹ Since coaxial illumination also provides shadow-free lighting in alignment to the working area, operators have reported experiencing ergonomic benefits as a result of eliminating the need for adjustments of the overhead light.^{17,19} Although ocular hazards exist with the use of LED lights, most headlight manufacturers use LED beams within the safe zone spectrum and operators are advised to use minimal settings to reduce glare while maintaining optimal visual acuity.²²

Dental hygiene educators in both clinical practice and educational settings have been shown to have a range of experiences and opinions regarding the use of magnification loupes, however, there has been an increasing trend to require dental hygiene students to use loupes. Results from a national survey of dental hygiene programs in the United States showed that only 25% of the schools mandated students to use magnification loupes and less than 10% required faculty to used magnification in 2012.²³ Five years later in 2017, results from a second national survey showed the number of dental hygiene programs mandating the use of magnification by students had increased to 44%.²⁰ However, when the additional component of coaxial illumination was considered, only 9% of the dental hygiene programs surveyed mandated the use of illumination.²⁰ In a survey of dental faculty at a single institution, the majority of dental faculty used magnification and of those, 70% used coaxial illumination concomitantly with magnification.²⁴ While the majority (91%) of the dental faculty supported students use of magnification loupes, only about three-fourths of the faculty felt that use of magnification should be required.²⁴

It has been hypothesized that the proper use of magnification and coaxial illumination can support improved ergonomic postures and a reduction of musculoskeletal strain. However, institutional requirements regarding the use of magnification and coaxial illumination by students may be influenced by the experiences and attitudes of clinical dental hygiene faculty members. Limited research exists examining the experiences and attitudes towards magnification and

coaxial illumination among dental hygiene educators who work in clinical practice and in educational settings. The purpose of this study was to evaluate dental hygiene educators' experiences towards using magnification loupes and coaxial illumination in clinical practice and in academic settings. Perceptions of dental hygiene educators in regards to the benefits of magnification and coaxial illumination in academic settings was also evaluated.

Methods

This study was deemed exempt by the Institutional Review Board of the Ohio State University. A cross-sectional survey research design, utilizing an anonymous web-based survey, was used for the study population of dental hygiene educators in the state of Ohio. There were 12 dental hygiene programs in Ohio at the time of the study, with an estimated average of 12 faculty (part-time and full-time) per program, with a minimum of one-half day of clinical teaching responsibilities per week. An estimated total of 144 dental hygiene faculty members met the inclusion criteria and were invited to participate.

Survey Instrument

The 28-item survey was self-developed to include demographic information; investigate the respondents' experience with magnification loupes and coaxial illumination; and explore dental hygiene faculty attitudes about the perceived benefits of magnification loupes and coaxial illumination to practitioners and patients. The majority of the questions required yes/no responses or Likert-style responses ranging from 1-strongly agree to 5-strongly disagree. Two questions elucidated open ended responses from participants identifying as not using magnification loupes and/or coaxial illumination.

A panel of 4 dental hygiene faculty member experts created the survey questions by patterning them after two existing surveys.^{24,25} The survey instrument was originally designed for student responses; questions were pilot tested by 30 dental hygiene students for clarity and feedback. Following revisions for clarity, the survey was modified for faculty responses by the panel of experts.

Qualtrics web-based survey software (Provo; UT, USA) was used to construct and administer the survey. An invitation e-mail was sent to the 12 dental hygiene program directors in Ohio followed by an additional e-mail instructing the program directors to forward the invitation to their dental hygiene faculty members. A reminder and separate forwarding e-mail was sent to the program director two weeks after the first notification. The survey was closed after a total elapsed running time of 28 days.

Data Analysis

Data were analyzed using SPSS Version 25 (IBM; Armonk, New York). Descriptive statistics were used to describe the dental hygiene educators' experiences with magnification loupes and coaxial illumination. Chi-square analysis and Mann Whitney U-tests were used to explore the associations between experience and attitudes with the use of magnification loupes and coaxial illumination in academic settings.

Results

Of the twelve dental hygiene programs in Ohio, eight program directors agreed to participate and forwarded the invitation to their clinical faculty. Since the total number of clinical faculty who were sent the survey was unknown, the responses represent a non-probability sample. Out of the 57 respondents who completed the survey, three were disqualified because they were either incomplete or completed by dentists. From the data of 54 respondents, 67% (n=36) worked in an associate degree program and 33% (n=18) worked in a baccalaureate program; 91% (n=49) were female and 9% (n=5) were male; the median age range was between 40-49 years (Table I).

Table I. Demographics

	Percentage and number of respondents (n=54)	
College structure	Associate degree program 66.7% (n=36)	Baccalaureate degree program 33.3% (n=18)
Gender	Female 90.7% (n=49)	Male 9.3% (n=5)
Age group	Median age group 40-49 years (n=8)	Interquartile Range 30-39 years (n=15) to 50-59 years (n=15)

The first aim of the study was to determine the current experiences of dental hygiene educators using magnification loupes and coaxial illumination in clinical practice and academic settings. Over three-fourths (80%) of the respondents used magnification loupes while delivering patient care in clinical practice, while 70% reported using loupes in their role as a clinical faculty member. Most program directors (87%) did not require clinical faculty to wear magnification loupes while overseeing students however, half of the respondents stated that students were required to purchase magnification loupes. In regards to coaxial illumination, about half (54%) reported using illumination both while

delivering patient care and in their role as a clinical faculty member. Five responses were received from the open-ended question regarding the rationale for not using magnification loupes and included: difficulty with the adjustment period/lack of proper fitting (n=3), lack of perceived need (n=1), and lack of peripheral vision (n=1). The majority (96%) of the program directors did not require clinical faculty to use coaxial illumination when overseeing students and over three quarters (78%) of the respondents stated that students were not required to use coaxial illumination. Nine open-ended responses were received regarding the rationale for not using coaxial illumination and included: difficulty with adjustment due to weight or compromised ergonomics (n=4), cost (n=2), not using loupes (n=1), no perceived need (n=1), and intent to purchase in the future (n=1). Clinical faculty experiences with magnification and illumination are shown in Table II.

The second study aim was to evaluate the attitudes of dental hygiene educators regarding the perceived benefits of magnification loupes alone in academic settings (Table III). Chi-square test of independence was calculated comparing the frequency of faculty wearing loupes while providing patient care and faculty wearing loupes while working in student clinics. A significant interaction was found ($\chi^2(1)=24.879$, $p<.001$) revealing that dental hygiene faculty who wear loupes while providing patient care were also more likely to wear loupes in the academic setting. Chi-square test of independence was calculated comparing the frequency of faculty wearing loupes while providing patient care and programs requiring students to purchase magnification loupes; no significant relationship was found ($\chi^2(1)=2.854$, $p>.05$). Chi-square test of independence was calculated comparing whether faculty wearing loupes while providing patient care and their attitude as to whether dental and dental hygiene faculty should be required to wear loupes while overseeing patient care in academic settings. A significant interaction was found ($\chi^2(1)=8.693$, $p<.01$) revealing that dental hygiene faculty who wear loupes while providing patient care were more likely to feel that dental hygiene faculty should be required to wear loupes while overseeing patient care in student clinics. Chi-square test of independence was calculated comparing the frequency of faculty wearing loupes while provide patient care and faculty wearing loupes as clinical faculty in student clinics. A significant interaction was found ($\chi^2(1)=12.306$, $p<.01$) showing that dental hygiene faculty who wear loupes while providing patient care were more likely to feel that dental hygiene students should also be required to wear loupes while providing patient care.

Table II. Faculty Experiences with Magnification Loupes and Coaxial Illumination

Question	Frequency of responses % (n)				
Do you currently use magnification loupes while providing patient care to your own patients?	Yes 79.6% (n=43)			No 20.4% (n=11)	
If yes, how often do you use the magnification loupes while providing patient care?	Always 61.1% (n=33)	Most of the time 11.1% (n=6)		Sometimes 9.3% (n=5)	No answer 18.5% (n=10)
If yes, which best describes how you would feel if you were unable to use magnification during patient care?	I would feel as comfortable provid- ing patient care 11.1% (n=6)	I would feel like I was compromising my ergonomics 40.7% (n=22)		I would feel unsure about providing adequate patient care 27.8% (n=15)	I would feel unable to provide care 1.9% (n=1)
Do you wear magnification loupes while working as a clinical faculty member in the student clinic?	Yes 70.4% (n=38)			No 29.6% (n=16)	
Does your school require the students to purchase magnification loupes for patient care?	Yes 50.0% (n=27)			No 50.0% (n=27)	
Does your employer require you to wear magnification loupes while overseeing students treating patients in the student clinic?	Yes 5.6% (n=3)	No 87.0% (n=47)		No answer 7.4% (n=4)	
Do you feel that dental and dental hygiene clinical faculty members should be required to use magnification while overseeing patient care in the student clinic?	Yes 57.4% (n=31)			No 42.6% (n=23)	
Do you use a headlight (coaxial illumination) while providing patient care to your own patients?	Yes 53.7% (n=29)		No 38.9% (n=21)		No answer 7.4% (n=4)
If yes, how often do you use a headlight while providing patient care?	Always 48.1% (n=26)	Most of the time 3.7% (n=2)	Sometimes 5.6% (n=3)	Rarely 9.3% (n=5)	No answer 33.3% (n=18)
If yes, which best describes how you would feel if you were unable to use a headlight during patient care?	I would feel as comfortable providing patient care 20.4% (n=11)		I would feel like I was compromising my ergonomics 18.5% (n=10)		I would feel unsure about providing adequate patient care No answer 38.9% (n=21)
Do you wear a headlight while overseeing students treating patients in the student clinic?	Yes 50.0% (n=27)		No 35.2% (n=19)		22.2% (n=12)
Does your employer require you to wear a headlight while overseeing students treating patients in the student clinic?	Yes 0.0% (n=0)		No 96.3% (n=52)		No answer 3.7% (n=2)
Do you feel that dental and dental hygiene clinical faculty members should be required to wear a headlight while overseeing patient care in the student clinic?	Yes 33.3% (n=18)		No 63.0% (n=34)		No answer 3.7% (n=2)
Does your school require the students to purchase a headlight for patient care?	Yes 18.5% (n=10)		No 77.8% (n=42)		No answer 3.7% (n=2)
Do you feel that dental and dental hygiene students should be required to wear a headlight while providing patient care?	Yes 44.4% (n=24)		No 51.9% (n=28)		No answer 3.7% (n=2)
The use of a headlight during patient care increases the use of proper ergonomics by the practitioner.	Strongly agree 27.8% (n=15)	Agree 48.1% (n=26)	Neutral 16.7% (n=9)	Disagree 5.6% (n=3)	No answer 1.9% (n=1)

Table III. Relationships Between Magnification Loupe Experience and Attitudes

Magnification loupe experience	Do you currently use magnification loupes in clinical practice?		χ^2	<i>p</i> -value
Magnification loupe attitudes	Yes	No		
Faculty who wore magnification loupes while working as a clinical faculty member in the student clinic	86.0%	9.1%	24.879	<.001
Schools who required students to purchase magnification loupes for patient care	55.8%	27.3%	2.854	>.05
Faculty members in dental hygiene programs should be required to wear magnification loupes while overseeing patient care in the student clinic	93.5%	60.9%	8.693	<.01
Dental hygiene students should be required to wear magnification loupes while providing patient care	92.1%	50.0%	12.306	<.001

Table IV. Relationships Between Magnification Loupe Experience and Associated Benefits

	All respondents			Faculty wearing loupes in clinical practice.		<i>p</i> -value
	<i>n</i>	Median	IQR	Yes	No	
Loupes increase the use of proper ergonomics	54	1.0	1.0-2.0	24.91 <i>n</i> =43	37.64 <i>n</i> =11	<.01
Loupes increase the accuracy of assessment and procedure	54	1.0	1.0-2.0	24.28 <i>n</i> =43	40.09 <i>n</i> =11	<.001
Loupes increase the efficiency of providing care	54	2.0	1.0-3.0	23.56 <i>n</i> =43	42.91 <i>n</i> =11	<.001

A Mann-Whitney *U*-test was used to examine faculty attitudes of whether loupes increase proper ergonomics, increase the accuracy of assessment and procedures, and increase the efficiency of providing care (Table IV). Dental hygiene faculty wearing loupes when providing patient care believe that loupes increase the use of proper ergonomics (*M* place=24.91; *U*=348.00, *p*<.01), increase the accuracy of assessment and procedures (*M* place=24.28; *U*=375.00, *p*<.01), and increase the efficiency of providing care (*M* place=23.56; *U*=406.00, *p*<.001).

The third aim was to evaluate the attitudes of dental hygiene educators regarding the perceived benefits of coaxial illumination in academic settings (Table V). Chi-square test of independence was calculated comparing the frequency of faculty using coaxial illumination while providing patient care and faculty using coaxial illumination in academic settings. A significant interaction was found ($\chi^2(2)$ =30.015, *p*<.01) revealing that dental hygiene faculty

who use coaxial illumination while providing patient care were more likely to also use coaxial illumination while working in student clinics. Chi-square test of independence was calculated comparing whether faculty using coaxial illumination while providing patient care and attitudes towards whether dental hygiene faculty should be required to using coaxial illumination in academic settings. A significant interaction was found ($\chi^2(2)$ =17.831, *p*<.001) showing that dental hygiene faculty who used coaxial illumination while providing patient care were more likely to feel that dental hygiene faculty members should be required to using coaxial illumination while working in student clinics. Chi-square test of independence was calculated comparing the frequency of faculty using coaxial illumination while providing patient care and attitudes regarding whether dental hygiene students should be required to use coaxial illumination while providing patient care. A significant interaction was found ($\chi^2(2)$ =11.077, *p*<.01) revealing that dental hygiene faculty using coaxial illumination while providing patient care themselves are more likely to feel that dental hygiene students should be required to use coaxial illumination while providing care.

A Mann-Whitney *U* test was used to examine the attitudes of whether using coaxial illumination increases the use of proper ergonomics, increases the accuracy of assessment and procedures, and increases the efficiency of providing care among dental hygiene faculty who use coaxial illumination when providing patient care (Table VI). Dental hygiene faculty using coaxial illumination when providing patient care believe that coaxial illumination increases the use of proper ergonomics (*M* place=19.74; *U*=442.50, *p*<.01), increases the accuracy of assessment and procedure (*M* place=17.45; *U*=509.00,

$p<.001$), and increases the efficiency of providing care (M place=17.83; $U=498.00$, $p<.001$).

Discussion

Since the precursors to musculoskeletal disorders may begin early, during professional education,^{9,10} efforts must be taken to reduce the occupational risks for dental professionals during the education process. The use of magnification combined coaxial illumination has been shown in some studies to improve ergonomic postures.^{1,8,13} However, a disparity exists between the use of magnification loupes by dental professionals in clinical practice and students in educational settings.²⁵ Although a majority of dental and dental hygiene faculty utilize magnification loupes, it is estimated that less than half of dental and dental hygiene programs mandate the use of magnification loupes by students.^{20,23,24} Limited evidence exists regarding the experiences and attitudes of dental hygiene educators with respect to coaxial illumination. Understanding this critical information will help support changes in educational policies requiring the use of magnification and/or coaxial illumination by dental and dental hygiene students and potentially reduce the risks for future musculoskeletal disorders.

This study evaluated the experiences and attitudes among dental hygiene educators in Ohio regarding the use of magnification loupes and coaxial illumination. Most dental hygiene educators participating in this study, used both magnification loupes and coaxial illumination when personally delivering patient care and while overseeing students. The study data suggests that dental hygiene faculty who use loupes and coaxial illumination also believe that all clinical faculty and students should be required to use magnification and

Table V. Relationships Between Coaxial Illumination Experience and Attitudes

Coaxial illumination experience	Do you currently use coaxial illumination in clinical practice?		χ^2	p -value
	Yes	No		
Used coaxial illumination while working as a clinical faculty member in the student clinic	94.4%	6.3%	30.015	$<.001$
Felt that faculty members in dental hygiene programs should be required to use coaxial illumination while overseeing patient care in the student clinic	94.4%	32.3%	17.831	$<.001$
Felt that dental hygiene students should be required to use coaxial illumination while providing patient care	81.8%	34.6%	11.077	$<.01$

Table VI. Relationships Between Coaxial Illumination Experience and Associated Benefits

	All respondents			Faculty using coaxial illumination for patient care		p -value
	n	Median	IQR	Yes	No	
Coaxial illumination increases the use of proper ergonomics	49	2.0	1.0-2.0	19.74 n=29	32.62 n=20	$<.001$
Coaxial illumination increases the accuracy of assessment and procedure	49	1.0	1.0-2.0	17.45 n=29	35.95 n=20	$<.001$
Coaxial illumination increases the efficiency of providing care	49	2.0	1.0-3.0	17.83 n=29	35.40 n=20	$<.001$

illumination due to perceived benefits of improved ergonomic postures, increased accuracy of assessments and procedures, and improved efficiency.

The use of magnification loupes is more prevalent among dental hygiene educators when providing patient care than when overseeing students in academic settings. Of the 80% of dental hygiene educators who used loupes in this study, 82% used loupes during patient care while 70% used loupes while working with students. In a study by Thomas et al of practicing dental hygienists, 71% of respondents used loupes when providing patient care²⁵ whereas more than half of dental hygiene educators used magnification loupes in clinical teaching settings.²³ When considering dental educators, Meraner et al. found that certain dental specialties, such as periodontics, endodontics, and general restorative dentistry, were more likely to use magnification loupes than other specialties.²⁴ The higher percentage of magnification loupe users among practicing dental hygienists may be due to the majority of clinical

practitioners working in periodontal or general dentistry settings. This study also found that dental hygiene faculty who use magnification loupes when providing patient care are more likely to use magnification loupes when working as a clinical faculty member.

The use of coaxial illumination follows a similar trend with a higher prevalence among dental hygiene educators when providing patient care than when overseeing students in academic settings. Of the 54% of dental hygiene educators using coaxial illumination, 57% used illumination when delivering patient care but only half used illumination when working as a clinical faculty member. Coaxial illumination usage in this study was less than the 71% of dental educators reporting the use of coaxial illumination in conjunction with magnification loupes from one institution.²⁴ A lack of evidence exists in the literature regarding the use of coaxial illumination among practicing dental hygienists however, results from this study demonstrated that dental hygiene faculty who use coaxial illumination when providing patient care are more likely to use illumination in their role as a clinical faculty member.

Dental hygiene educators in this study perceived the benefits of improved ergonomics, increased accuracy of assessments and procedures, and increased efficiency of providing care resulted from the use of magnification loupes and coaxial illumination. In previous studies, both dental educators and practicing dental hygienists agreed that one of the benefits of using magnification loupes included improved overall quality of care.²³⁻²⁵ Despite the literature identifying improved ergonomic benefits from the use of magnification loupes,^{1,14} dental hygiene educators were more skeptical than practicing clinicians regarding the ergonomic benefits.²³⁻²⁵ However, other factors, such as the overall cost or the necessary learning curve for adjusting to loupes, may hinder the adoption of magnification among some dental hygiene educators.²³

The present study revealed that although most dental hygiene faculty utilize magnification loupes, only half of the respondents' dental hygiene programs required the use of loupes by students and only a few mandated the use of loupes by clinical faculty. In regards to coaxial illumination, a limited number of respondents indicated that their dental hygiene programs mandated students to purchase a headlight however none of the programs required clinical faculty to purchase a headlight. Further analysis showed that dental hygiene faculty using magnification loupes in clinical practice were more likely to support of the required use of loupes by students and clinical faculty. Dental hygiene faculty using coaxial illumination in clinical practice were also more supportive

of requiring the use of coaxial illumination by students and clinical faculty. Attitudes of dental hygiene educators surveyed in this study aligned with mandating student requirements for the use of magnification and coaxial illumination.

Differing views exist regarding the required use of magnification loupes by students and clinical faculty. Previous studies have shown that dental educators using magnification loupes were not entirely supportive of mandating students and clinical faculty members to use magnification loupes.^{20,24} Dental hygienists with a history of using magnification loupes in clinical practice have been shown to support the required use of loupes by students during their first year due to the perceived benefits of loupes.²⁵ Although the occasional user and non-users of magnification loupes stated the use of loupes would be beneficial when delivering patient care, most favored having the option, rather than the requirement of purchasing and using loupes while in school.²⁵ Enforcing student requirements to use magnification loupes and coaxial illumination may become problematic if the clinical faculty themselves are not compliant with the use of magnification loupes and coaxial illumination. Financial support from dental hygiene programs towards purchasing magnification and illumination may help increase their use among dental hygiene educators.

This study had several limitations. Distribution of the online survey relied on program directors to disseminate the survey to their dental hygiene faculty. Since the program directors were not asked how many faculty members were sent the online survey, the sample size could not be calculated. The survey relied on faculty self-reported data and did not ask respondents whether they worked in clinical practice. Future studies should address these limitations and include a larger number of programs. Other instruments could be used to quantitatively measure the benefits from using magnification and coaxial illumination to expand the information gained from the self-reported data in the present study,

Conclusion

Dental hygiene faculty using magnification loupes and coaxial illumination themselves, supported the requirement of clinical faculty and students to use loupes and illumination because of the perceived benefits of improved ergonomic postures, increased accuracy of assessments and procedures, and improved efficiency. However, a disparity exists regarding the use of magnification loupes and coaxial illumination among dental hygiene faculty working in clinical practice settings and academic settings, and dental hygiene students. Financial and logistic barriers should be identified and addressed prior to

mandating the use of magnification and coaxial illumination by clinical faculty and dental hygiene students.

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Evaluating Oral Health in Pregnant Women: Knowledge, attitudes and practices of health professionals

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Abstract

Purpose: Complex physiological changes occur during pregnancy thus increasing the risk of periodontitis and potentially adverse pregnancy outcomes. The purpose of this study was to assess prenatal health care professionals' levels of knowledge regarding oral health and its effect on pregnancy outcomes, examine their current practices in evaluating oral health, and determine their attitudes towards a multidisciplinary approach to providing comprehensive prenatal care.

Methods: Data was collected from a web-based survey administered to a convenience sample of prenatal health professionals in a healthcare organization located in the Midwestern United States. Responses were summarized with descriptive statistics. A knowledge score was utilized to compare midwives and nurse practitioners to physicians and residents.

Results: Seventy-six prenatal health care professionals (n=76) agreed to participate for a response rate of 37%, with the majority (80%) of respondents considering oral health to be an important component of prenatal care. In regards to the inclusion of oral health in current practice, only 6% of the respondents "always" include an oral health history interview and only 7% "always" include a dental screening as part of prenatal care. A moderate correlation was found between the knowledge score and the frequency of including oral health history interviews during prenatal visits (correlation = 0.36, $p=0.002$).

Conclusion: The majority of prenatal health care professionals surveyed were knowledgeable about oral health as it relates to prenatal care; however, a deficit was identified in current practice in regards to oral health history interviewing and conducting dental screenings. There is a need to implement best practice guidelines that include routine dental screenings and to engage pregnant women in oral health prevention practices. Optimal oral health requires a multidisciplinary approach in which dental hygienists can play a significant role by educating women's healthcare providers and raising awareness of the connection between oral health and pregnancy outcomes.

Keywords: oral health prevention, oral systemic health, provider practices, pregnancy, pregnancy outcomes, prenatal care

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Introduction

Approximately 1.1 million infants die due to prematurity and 15 million more are born preterm, according to reports from the Joint European Federation of Periodontology and the American Academy of Periodontology.¹ Preterm birth has been identified worldwide as the second most common cause of death in children under the age of five.¹ Multiple risk factors, including behavioral, psychosocial, environmental, medical, nutritional, and biological, have been associated with adverse pregnancy outcomes.^{1,2} Evidence suggests that periodontitis is a risk factor for adverse pregnancy outcomes, including low birthweight babies (<2500 g), preterm birth (<37 weeks), pre-eclampsia, and miscarriage.^{2-3, 5-10} Research

investigating periodontitis as a risk factor has shown that a number of adverse pregnancy outcomes increase significantly in the presence of periodontal disease.^{1, 2, 8}

Complex physiological changes occur during pregnancy, resulting in a heightened risk of gingivitis in the oral cavity.^{2, 3} Gingivitis during pregnancy is common, affecting from 30 to 86% of all pregnant women.^{3, 4} Left untreated, gingivitis can progress to periodontitis, resulting in attachment loss and permanent damage to the supporting structures of teeth.^{3, 4} The American College of Obstetricians and Gynecologists (ACOG) reports that approximately 40% of pregnant women have some form of periodontal disease,⁵ which is not only detrimental to the oral

cavity, but could potentially impact the health of the developing fetus.¹ Despite the evidence supporting the importance of oral health, the ACOG reports that over half (59%) of all women do not receive oral health counseling during their pregnancy.⁵ In an additional study, the vast majority (96%) of pregnant women surveyed, reported being unaware of the impact of oral health on pregnancy outcomes.¹¹

Preventive, diagnostic, and restorative dental treatment has been shown to be safe during any trimester of pregnancy and essential to maintaining optimal oral health.⁵ The American Dental Association (ADA) supports the importance of oral health care during pregnancy and recommends a semiannual dental examination and prophylaxis.⁵ Oral health prevention requires a larger taskforce than dental professionals alone; therefore, physicians, midwives, nurse practitioners, and all prenatal health professionals play an equally important role in promoting oral health.¹² Professional organizations have launched web portals, toolkits, and guidelines targeting the promotion of women's oral health during pregnancy.¹² Oral health is such an important component of overall health that the ACOG developed suggested guidelines to include assessment of oral health at the first prenatal visit with subsequent prenatal visits providing opportunity for oral health promotion.⁵ While numerous research studies have been published in the literature suggesting periodontal disease may be a risk factor for adverse pregnancy outcomes,¹⁻¹⁰ medical providers, who are ideally positioned to disseminate this information, may have gaps in their education. The purpose of this study was to assess prenatal health care professionals' levels of knowledge regarding oral health and its effect on pregnancy outcomes, examine their current practices in evaluating oral health, and determine their attitudes towards a multidisciplinary approach to providing comprehensive prenatal care.

Methods

A convenience sample of prenatal health professionals (n=208) from a healthcare organization in the Midwestern United States, were invited to participate in a voluntary, web-based survey administered by Qualtrics™ (Provo, UT). Participants were given six weeks to complete the survey; non-responders were sent an email reminder four weeks after the initial request. Survey questions utilized for this study were modified from existing survey instruments used by Schramm et al,¹³ Bamanikar et al,¹⁴ and Sharif et al.¹⁵ targeting dental hygienists, nurses, physicians and pregnant women. Target subjects in this study were the health care providers (midwives, nurse practitioners, physicians and residents), in a prenatal specialty practice within a healthcare organization. The survey included participants' demographic information, including

gender, ethnicity and years of experience. Six questions addressed participants' knowledge, three questions addressed attitude, and six questions addressed participants' current clinical practice using a Likert Scale of 5 = strongly agree, 4 = somewhat agree, 3 = neither agree nor disagree, 2 = somewhat disagree, and 1 = strongly disagree. Experts in the field reviewed the survey questions for face validity; Institutional Review Board approval was granted for the study.

Responses were summarized with frequencies and percentages. A "knowledge score" was computed as the sum of the following items: I consider oral health care to be an important part of prenatal care; Pregnancy increases the tendency for the gingiva to bleed, swell, or be red; Pregnant mothers should be advised to stop brushing/flossing their teeth if their gingival tissues bleed; and Periodontal disease can be treated safely during pregnancy. The third item was reversed prior to calculating the score as a "disagree" response reflected more knowledge. Knowledge scores ranged from 4 (low knowledge) to 20 (high knowledge) and were compared between midwives and nurse practitioners versus physicians and residents using Wilcoxon Rank-Sum tests. Associations between this score and ordinal survey items were quantified with Spearman Correlations. All analyses were performed using SAS version 9.4™ (SAS Institute Inc; Cary, NC).

Results

A total of 208 questionnaires (n=208) were emailed to prenatal health care professionals including nurse practitioners, midwives, physicians and residents; 76 participants (n=76) consented to complete the survey, resulting in a 37% response rate. Of those participants, 3 were ineligible as they were not currently providing prenatal care. An additional 4 participants were excluded as they only answered the first survey question; a total of 69 survey responses were analysed.

The majority of the participants were physicians (58%), identified as being female (78%) and white (93%). Participants reported a range of years of prenatal care experience, with one third of the respondents having fewer than 5 years of experience (33%), followed by one quarter (26%) with 16 or more years of experience. Demographic characteristics are shown in Table I.

Clinical practice characteristics of prenatal health professionals towards identifying oral health needs are displayed in Table II. Only 6% of the respondents "always" included an interview of the oral health history and 7% "always" included a dental screening to check the mouth for swollen or bleeding gingival tissue, mucosal lesions or signs of infection. Approximately 60% "never" or "rarely" performed

Table I. Characteristics of prenatal health professionals (n=69)

Variable	Frequency (%)
Gender	
Male	15 (21.7%)
Female	54 (78.3%)
Provider Discipline	
Midwife	13 (18.8%)
Nurse Practitioner	5 (7.2%)
Physician	40 (58.0%)
Physician Assistant	0 (0.0%)
Resident	11 (15.9%)
Ethnic Group*	
American Indian or Alaska Native	2 (2.9%)
Asian	4 (5.8%)
Black or African American	2 (2.9%)
Hispanic or Latino	3 (4.3%)
White	64 (92.8%)
Length of service providing prenatal care (years)	
≤ 1-5	23 (33.3%)
6-10	17 (24.6%)
11-15	11 (15.9%)
≥ 16	18 (26.1%)

*Participants could select all that apply.

an interview regarding the patient's oral health history and approximately 60% "never" or "rarely" included a dental screening during prenatal care. The most common reasons cited by the respondents who indicated not "always" including dental screenings were related to lack of time (64%), feeling this is the responsibility of dental professionals (48%), lack of patient request (47%), and lack of a current dental referral system (42%).

Respondents reported that they advise or refer a patient to see a dentist during pregnancy at least most of the time (39%) or sometimes (35%). However, the majority (84%) never advise a patient to delay their dental visits until after pregnancy. Over half of the respondents (61%), stated that oral health topics are rarely or never integrated into prenatal classes. Eight respondents skipped this question, perhaps due to lack of knowledge regarding all the topics covered in prenatal classes.

Over 80% of the respondents considered oral health to be an important part of prenatal care. A majority (84%) agreed that pregnancy increases the tendency of gingival inflammation and strongly disagreed (67%) regarding advising pregnant mothers to stop brushing or flossing if their gingival tissues bleed. Most agreed (90%) that gingival problems can be treated safely during pregnancy. Responses were more variable when questioned regarding the correlation between periodontal disease and adverse pregnancy outcomes. However, more than half agreed (61%) that gingival problems could result in low birthweight babies and that gingival problems may result in preterm birth (71%). The oral health knowledge of prenatal health professionals is shown in Table III.

Table II. Clinical Practices to Identify Oral Health Needs (n=69)

Clinical Practice	Frequency (%)				
	Always	Most of the time	Sometimes	Rarely	Never
Interview of oral health history	4 (5.8%)	7 (10.1%)	15 (21.7%)	30 (43.5%)	13 (18.8%)
Dental screening (checking for gingival inflammation, mucosal lesions, or signs of infection)	5 (7.2%)	6 (8.7%)	15 (21.7%)	29 (42.0%)	14 (20.3%)
Advise/refer a patient to see dentists during pregnancy	12 (17.4%)	15 (21.7%)	24 (34.8%)	14 (20.3%)	4 (5.8%)
Advise a patient to delay dental visits until after pregnancy	0 (0.0%)	0 (0.0%)	1 (1.4%)	10 (14.5%)	58 (84.1%)
Oral health topics integrated into prenatal classes*	1 (1.6%)	5 (8.2%)	18 (29.5%)	24 (39.3%)	13 (21.3%)

*Survey question was not answered by 8 participants.

Table III. Oral Health Knowledge Levels (n=69)

Knowledge	Frequency (%)				
	Strongly Agree	Somewhat Agree	Neither agree or disagree	Somewhat disagree	Strongly disagree
I consider oral health to be an important part of prenatal care.	28 (40.6%)	28 (40.6%)	11 (15.9%)	2 (2.9%)	0 (0.0%)
Pregnancy increases the tendency for gingival inflammation.	33 (47.8%)	25 (36.2%)	9 (13.0%)	1 (1.4%)	1 (1.4%)
Pregnant mothers should be advised to stop brushing/flossing their teeth if their gums bleed.	2 (2.9%)	5 (7.2%)	16 (23.2%)	0 (0.0%)	46 (66.7%)
Gingival problems can be treated safely during pregnancy.	39 (56.5%)	23 (33.3%)	6 (8.7%)	1 (1.4%)	0 (0.0%)
Gingival problems in pregnant women may result in low birth weight babies.	13 (18.8%)	29 (42.0%)	22 (31.9%)	4 (5.8%)	1 (1.4%)
Gingival problems in pregnant women may result in preterm birth.	19 (27.5%)	30 (43.5%)	16 (23.2%)	4 (5.8%)	0 (0.0%)

Attitudes towards oral health by the respondents were positive with over half (60%) agreeing that they should be trained to perform oral health screenings and over 80% agreeing that they should update their knowledge regarding oral health during pregnancy. Only about 25% felt that it was not their responsibility to look into the patient's mouth to detect oral health problems (Table IV).

Respondent's average knowledge score was 17.4 (SD 1.8, range 11-20). Midwives and nurse practitioners had higher knowledge scores as compared to physicians and residents (average 18.6 vs 17.1, $p=0.002$). The oral health knowledge of the prenatal health professional groups and comparisons between midwives and nurse practitioners versus physicians and residents is shown in Table V. A moderate correlation was found between the knowledge score and frequency of including oral health history interviews during prenatal care visits (correlation = 0.36, $p=0.002$). A small correlation was found between the knowledge score and frequency of including a dental screening during prenatal care visits.

Results presented are largely descriptive, with the frequency and percentage in each response category reported. Between 7% and 16% of the responses were in the "neither agree nor disagree" category. In general, physicians and residents were more likely to select "neither agree nor disagree" option as compared to midwives and nurse practitioners. It is not possible to determine how the respondents interpreted this option, whether it indicates a lack of knowledge or a neutral attitude.

Discussion

Key inconsistencies in prenatal health professionals oral health knowledge and current clinical practice were found in this study as compared to previous studies.^{15, 16, 17} Comparable to this study, a previous survey of obstetricians, found that a majority (84%) reported that periodontal disease may have an adverse effect on pregnancy outcomes.¹⁷ However, less than half (46%) performed an oral health screening as part of prenatal care and fewer than one-fourth (22%) looked into a women's mouth at their prenatal examination.¹⁷ Discussing the patient's oral health history and evaluating the oral health status of a pregnant women should be a critical component of prenatal care, yet only 6% of the providers in this study "always" interviewed the patient about their oral health history and 7% "always" conducted a dental screening.¹⁷ Prenatal health professionals play a pivotal role in identifying potential oral health conditions which may ultimately pose a risk on the developing fetus or pregnancy outcome. Conducting a visual screening of the oral cavity should be a required component of the prenatal health professionals' clinical practice routine.

Reasons for not consistently evaluating oral health during prenatal care included "need more training to specifically know what to look for," "unclear and not well-defined referral process," "no knowledge of teeth," "not adequately trained," and "currently not part of the routine exam." In general, while prenatal health professionals consider oral health to be an important part of prenatal care; a minimal number of

Table IV. Oral Health Attitudes of Prenatal Health Professionals (n=69)

Attitude	Frequency (%)				
	Strongly Agree	Somewhat Agree	Neither agree or disagree	Somewhat disagree	Strongly disagree
I should be trained to perform oral health screenings.	15 (21.7%)	27 (39.1%)	14 (20.3%)	10 (14.5%)	3 (4.3%)
It is not my responsibility to look into the patient's mouth to detect oral health problems.	3 (4.3%)	14 (20.3%)	14 (20.3%)	20 (29.0%)	18 (26.1%)
I should update my knowledge on oral health of pregnant women.	28 (40.6%)	28 (40.6%)	9 (13.0%)	3 (4.3%)	1 (1.4%)

**Table V. Oral Health Knowledge Between Practitioner Groups
Midwife/Nurse Practitioner, (n=18); Physician/Resident, (n=51)**

Knowledge	Frequency (%)				
	Strongly Agree	Somewhat Agree	Neither Agree or Disagree	Somewhat Disagree	Strongly Disagree
I consider oral health to be an important part of prenatal care.					
Midwife/Nurse Practitioner	10 (55.6%)	7 (38.9%)	1 (5.6%)	0 (0.0%)	0 (0.0%)
Physician/Resident	18 (35.3%)	21 (41.2%)	10 (19.6%)	2 (3.9%)	0 (0.0%)
Pregnancy increases the tendency for gingival inflammation.					
Midwife/Nurse Practitioner	14 (77.8%)	3 (16.7%)	1 (5.6%)	0 (0.0%)	0 (0.0%)
Physician/Resident	19 (37.3%)	22 (43.1%)	8 (15.7%)	1 (2.0%)	1 (2.0%)
Pregnant mothers should be advised to stop brushing/flossing their teeth if their gums bleed.					
Midwife/Nurse Practitioner	0 (0.0%)	1 (5.6%)	0 (0.0%)	3 (16.7%)	14 (77.8%)
Physician/Resident	0 (0.0%)	1 (2.0%)	5 (9.8%)	13 (25.5%)	32 (62.7%)
Gingival problems can be treated safely during pregnancy.					
Midwife/Nurse Practitioner	12 (66.7%)	6 (33.3%)	0 (0.0%)	0 (0.0%)	0 (0.0%)
Physician/Resident	27 (52.9%)	17 (33.3%)	6 (11.8%)	1 (2.0%)	0 (0.0%)
Gingival problems in pregnant women may result in low birth weight babies.					
Midwife/Nurse Practitioner	6 (33.3%)	6 (33.3%)	5 (27.8%)	1 (5.6%)	0 (0.0%)
Physician/Resident	7 (13.7%)	23 (45.1%)	17 (33.3%)	3 (5.9%)	1 (2.0%)
Gingival problems in pregnant women may result in preterm birth.					
Midwife/Nurse Practitioner	9 (50.0%)	6 (33.3%)	2 (11.1%)	1 (5.6%)	0 (0.0%)
Physician/Resident	10 (19.6%)	24 (47.1%)	14 (27.5%)	3 (5.9%)	0 (0.0%)

prenatal health professionals actually evaluate oral health as part of their prenatal evaluations.^{5,16,17} Support for a more comprehensive approach to oral care during prenatal visits comes from the National Maternal and Child Oral Health Resource Center recommending that prenatal health care professionals take an oral health history, check the mouth for problems such as swollen or bleeding gingival tissue or tooth decay, and encourage women to seek dental care during the initial prenatal evaluation.^{18, 19}

While prenatal health professionals have expressed an interest in updating their oral health knowledge in a number of studies, they may be reluctant to ask about oral symptoms or screen for disease if they do not have a structured framework.^{15,16,17, 20} Dental hygienists are well prepared to collaborate with prenatal health professionals, provide continuing education sessions on oral health during pregnancy, and conduct hands-on training designed to

develop the skills necessary to identify oral conditions of concern. Guidelines recommended in the white paper on oral health and primary care commissioned by the National Interprofessional Initiative describe five essential components of an oral health delivery framework in health care settings.²⁰ Health care providers should ask about oral health risk factors and symptoms of oral disease, look for signs that indicate oral health risk or active oral disease, decide on the most appropriate response, act by offering preventive interventions and/or referral for treatment, and document as structured data for decision support and population management.²⁰ Utilization of this framework can serve to routinely address oral health as well as create a multidisciplinary relationship between health professionals and dental professionals.

Future studies could explore a multidisciplinary approach to providing comprehensive care to women with dental professionals collaborating with primary care providers and gynecologists to implement oral health education along with professional dental and dental hygiene care as part of the preconception period. In a study by Hashim and Akbar, the majority of gynecologists surveyed were shown to be highly knowledgeable about the relationship between oral health and pregnancy outcomes, and advised their pregnant patients to visit a dentist during their pregnancy.²¹ While gynecologists in the Hashim and Akbar study appeared to be very knowledgeable about the importance of oral health during pregnancy, there were misconceptions regarding the safety of dental treatments during pregnancy particularly in regards to the use of vasoconstrictors in local anesthetics and limiting dental treatment to the second trimester.²¹ Dental hygienists can play a key role in education of gynecologists as well as all other medical colleagues regarding the importance and safety of oral health before, during, and after pregnancy. Increasing the awareness of oral health among all women, whether during preconception or pregnancy, may also influence better oral health for their children.

Education of pregnant women is also a critical component to prenatal care. Habashneh et al. found less than half of the women surveyed reported a visit to the dentist during their most recent pregnancy.²² One of the factors contributing to this low rate was the lack of knowledge of the possible connection between oral health and pregnancy outcomes.²² Institutions should consider synchronizing oral health promotion with prenatal care visits, requiring women to view educational videos and provide informational brochures discussing the link between oral health and pregnancy outcomes and other topics related to pregnancy. Additional factors associated with the Habashneh et al. findings were cost of care and lack of an established dentist.

Prenatal health care providers should develop contact information lists for non-profit dental clinics to serve those who may be faced with financial barriers. Increasing oral health awareness among pregnant women may ultimately reduce the risk of adverse pregnancy outcomes.

Limitations of this study included the use of a self-administered questionnaire versus direct observations of the prenatal health professionals in real time. There was no way to verify whether the prenatal health professional actually obtained an oral health history, provided a dental screening, or recommended dental treatment to their pregnant patients. An additional limitation of this study was the small sample size from one health care system, and the low response rate, limiting the generalization of the results.

Conclusion

The majority of prenatal health care professionals surveyed were knowledgeable about oral health and its importance as it relates to prenatal care; however, a deficit was identified in current practice in regards to oral health history interviewing and conducting dental screenings. There is a need to implement best practice guidelines for prenatal care to include routine dental screenings as well as to engage pregnant women in oral health prevention. Optimal oral health requires a multidisciplinary approach in which dental hygienists can play a significant role by educating women's healthcare providers and raising awareness of the connection between oral health and pregnancy outcomes.

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Oral Rapid HIV Testing: Implementation experiences of dental hygiene faculty and students

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Abstract

Purpose: The goal of oral rapid HIV testing (ORHT) in the dental setting is to identify persons who are unaware of their positive HIV status. The purpose of this study was to describe the experiences of dental hygiene faculty and students who implemented ORHT in university-based dental hygiene clinics and to assess the facilitators and barriers to implementation of ORHT in the dental setting.

Methods: Data were collected via semi-structured interviews with dental hygiene faculty and students who conducted ORHT in three dental clinics located in academic institutions. All interview sessions were audio-recorded and transcribed. An inductive approach informed by grounded theory methodology was used to code data and inform theme development. The interview sessions were completed when conceptual saturation was reached.

Results: Five themes were identified by the study participants consisting of dental hygiene faculty (n= 8) and dental hygiene students (n=14). Participants felt dental hygienists are qualified to administer ORHT, which fits within their scope of practice; dental hygienists have the skills to feel comfortable offering ORHT without judgement; training is needed with ORHT administration, reading/discussing test results, and counseling for those who receive reactive results; most patients were receptive to being offered the ORHT; and patients accepted the ORHT because it was free, quick to administer and receive results, and convenient since they were already in the dental setting.

Conclusion: Results from this study indicate that dental hygienists can play a key role in public health efforts to identify persons who are unaware of their HIV status.

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Keywords: HIV testing, oral rapid HIV testing, HIV counseling, people living with HIV, dental hygienists

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Introduction

Healthy People 2020, the United States (U.S.) public health agenda, includes goals to reduce human immunodeficiency virus (HIV) infections, increase testing, prevent infection risk, increase access to care and improve health outcomes for people living with HIV (PLWH).¹ The Healthy People initiative encourages providers and the public health community to expand HIV testing so PLWH, but unaware of their status, receive a definitive diagnosis and linkage to care.¹ The 2015 National HIV/AIDS Strategy,² states that despite remaining a major public health issue, early diagnosis and treatment of HIV allows most infected individuals to live long and healthy lives. The strategy highlights testing and linkage to care as one of four key areas of critical focus to increase the awareness

of HIV status, decreasing the likelihood of transmission, and enable access to treatment following an early diagnosis.² The U.S. Preventive Services Task Force recommends routine screening for HIV infection in persons 15-65 years old and pregnant women as a means to achieve this goal.³ In addition, the Centers for Disease Control and Prevention (CDC) recommends annual screening for individuals with specific risk factors.⁴

In alignment with the federal response, the New York State (NYS) Department of Health, developed plans to reduce the number of new HIV infections and improve care and treatment outcomes.² The NYS “End AIDS” program seeks to reduce new HIV infections from 3,000 to 750 by

the year 2020 and decrease HIV prevalence by identifying undiagnosed persons with HIV, linking and retaining PLWH in care and treatment, and facilitating access to pre-exposure prophylaxis (PrEP).⁵

Even though dramatic successes during the late 1990s and early 2000s demonstrated reductions in HIV incidence and transmission (including perinatal transmission),⁶ much remains to be done to increase screening and testing opportunities. According to the CDC, there are 37,600 HIV infections each year with Black and Hispanic communities being disproportionately affected by HIV,⁶ and 22% of new infections were classified as stage 3 (AIDS) during the initial diagnosis in 2015, representing late diagnoses.⁷ Linkage to care during that surveillance year was at 75% within one month of diagnosis and 57% of PLWH met criteria for continuous medical care.⁷ More importantly, about 15% of the estimated 1,107,700 PLWH that year had an undiagnosed HIV infection, with the highest percentage of undiagnosed infections in younger individuals between the ages of 13-24 years of age.⁷

The NYS Health Department reported 145,900 PLWH in 2014, representing a rate of 872.1 per 100,000, the second highest estimated prevalence in the U.S. after the District of Columbia.⁸ There were 3,128 new HIV diagnoses in NYS in 2015, a rate higher than the national average (15.8 vs. 12.3 per 100,000).⁷ Despite the NYS Public Health Law (2010) requiring health care providers to routinely offer HIV testing to all individuals aged 13 to 64 years,⁹ about 12% of HIV infections in 2014 were undiagnosed, although this rate was lower than nationwide.⁸ Suboptimal compliance with the law leads to reduced identification of undiagnosed people with HIV, therefore, implementation of testing is essential.⁹ Among the measures designed to increase early HIV diagnosis by making “routine HIV testing truly routine,” the importance of offering HIV testing in additional health care facilities, including dental offices, has been stressed.⁹

New York City (NYC) has successfully implemented several high impact prevention strategies to help end the HIV epidemic.¹⁰ For the first time since the early 1980's, the number of new HIV diagnoses in NYC has fallen below 2,500.¹⁰ While the all-cause mortality and HIV-related deaths continues to decline, the number of PLWH achieving viral suppression has increased. Additionally, there were no perinatal HIV transmissions reported in 2015.¹⁰ However, disparities by gender, race/ethnicity, transmission risk, geography and area-based poverty level persist both among newly diagnosed people with HIV/AIDS (2,493) and among people living with HIV/AIDS in 2015 (121,616).¹⁰

Much more remains to be done to end the HIV epidemic; including improved screening of persons at risk. Towards that goal, the nation's largest HIV testing initiative, *New York Knows* launched in 2014 with the goal of having all NYC residents learn their HIV status and connect them to care if needed.¹¹ Integrating latest 4th generation HIV tests, capable of detecting HIV infection in its earliest and most infectious stage, is encouraged in non-traditional settings, promoting early diagnosis and linkage to care.⁹ In order to conduct rapid HIV testing in non-traditional settings such as the dental office, providers must obtain a Clinical Laboratory Improvement Amendment (CLIA) waiver from the NYS Health Department.¹² Several CLIA-waived rapid HIV tests of whole blood or oral fluid are simple, low-risk, require minimal training, and are available in settings such as community-based organizations, field test sites, mobile clinics, or university clinics.¹³ Availability of salivary tests such as OraQuick ADVANCE Rapid HIV-1/2 Antibody Test (OraSure Technologies, Inc.; Bethlehem, PA)¹⁴ facilitates screening in the dental setting.

A recent study comparing the effectiveness of oral rapid HIV testing (ORHT) and routine serum-based testing in an outpatient dental clinic in China demonstrated patients' preference of ORHT (96% preferred ORHT vs. 28% for routine serum-based testing).¹⁵ In addition to better acceptance rate, the study also found superior test completion and receiving/discussion of results rates in the ORHT group, suggesting feasibility of this testing method in a dental setting.¹⁵

A number of reports have examined patients'^{16,17} and providers'¹⁸⁻²³ attitudes and acceptance of screenings for medical conditions, including HIV, in dental settings. Dentists^{18,23} and dental hygienists^{19,23} exhibited favorable attitudes toward conducting screenings for medical conditions and were willing to conduct chairside testing, showing preference for non-invasive methods with immediate results.^{18,19,23} While generally high, willingness to conduct HIV testing among dental providers was lower than screening for other medical conditions (cardiovascular diseases, diabetes mellitus).^{18,19} Interestingly, fewer dentists (69%, n=1,903)¹⁸ considered HIV testing in dental offices ‘very’ or ‘somewhat’ important than dental hygienists (78%, n=3,102).¹⁹ Results of a 2015 nationwide study evaluating physicians' attitudes toward incorporating chair-side screenings for HIV in dental practices were similar to the views of dental providers.²⁴ The majority of study participants supported screenings for medical conditions by dentists along with appropriate referrals for any necessary follow-up, and over half (58%) felt HIV screenings were worthwhile to identify infected patients. However,

ORHT was viewed less favorably than other screening tests and respondents felt that HIV point-of-care testing in dental settings was the least effective when compared to all other medical conditions. Patients' willingness to accept HIV screenings, a concern shared by dental providers,^{18,19} and the level of training required by dentists to perform the screenings were the most important considerations for physicians.²⁴

While universal screening of all dental patients seems unlikely, an approach targeting high-risk persons may be more appropriate,²⁵ and dental providers may be uniquely positioned to offer ORHT.²⁶ A survey identified that over 70% of adults with self-reported HIV risk, who either were never tested or have not been tested in the last five years, had seen a dentist in the prior two years, demonstrating the potential role of dental care providers in identifying HIV infections.²⁶ Attitudes toward HIV screening, specifically ORHT, among dentists,^{21,27} dental hygienists,²² and dental faculty²⁸ have been examined in the literature ranging from qualitative studies to larger nationally representative surveys of dentists.^{21,22,27,28} There is agreement regarding the role of dentists in identifying undiagnosed HIV infections. A recent qualitative study evaluating the experiences and perspectives of U.S. dental providers offering ORHT in their offices found that both dentists and dental hygienists strongly supported ORHT in the dental setting.²⁹ In a representative sample of dentists,²¹ most respondents (60%, n=1,802), indicated at least some willingness to offer HIV screenings to their patients while 40% felt HIV testing should be part of the dental role.²¹ However, only 14 of the dentists surveyed offered ORHT testing and less than 12% were familiar with the CDC guidelines,⁴ dating back to 2006, recommending routine HIV testing of adults in health care settings.²¹ In another study only one out of 40 interviewed dentists were aware that ORHT has been available since 2004.²⁷ These findings indicate the need to incorporate HIV education and prevention programs in dental school curricula.^{21,27} This is especially important due to the significant association of previous clinical knowledge and HIV training with acceptance of HIV testing as part of dental professional role.²¹ In a pilot study of patient and provider acceptance of HIV testing at a dental school, the majority of faculty accepted incorporating HIV testing into routine patient care.²⁸

Dental hygienists, as members of a dental team whose primary role includes disease prevention and patient education, may be ideally positioned to offer and conduct ORHT.³⁰ A national survey of dental hygienists was conducted to evaluate knowledge and attitudes towards PLWH and an assessment of willingness to provide HIV testing.²² While increased knowledge about HIV was associated with increased comfort in working

with medically compromised patients and HIV prevention methods counseling, the majority of respondents indicated that they would be willing to receive training/certification in HIV testing and would be willing to conduct HIV tests, independent of their level of knowledge of the disease.²²

Feasibility of offering HIV testing in the dental setting has been shown to be dependent on the patients' acceptance of the testing and willingness to be tested by a dental professional.^{18,19,24} Several studies examining patients' attitudes towards testing in dental settings,^{17,31} including the dental school/clinic setting²⁸ and most recently, three dental hygiene clinics located in academic institutions in NYC,³² demonstrated that most patients viewed the opportunity to have HIV testing in dental settings positively and were willing to be tested in dental settings. Importantly, the majority of patients surveyed were willing to accept screenings from dental hygienists,³² supporting the potential role of dental hygienists in administering ORHT.

Dental providers with experience in administering ORHT showed positive support towards implementing HIV screening in dental settings. However, experiences and attitudes of dental hygiene faculty and students with administering ORHT in dental clinics located in academic institutions have not been studied. The purpose of this study was to evaluate the experiences of dental hygiene faculty and students administering ORHT in dental clinics located in academic institutions and to assess their views of the facilitators and barriers to implementing ORHT in the dental setting.

Methods

Three dental hygiene clinics located in academic institutions, Hostos Community College in the Bronx, NYC College of Technology in Brooklyn, and Farmingdale State College on Long Island, were chosen as study sites. Each site had a study coordinator, laboratory director, and dental hygiene faculty and students implementing ORHT. The methods of the original implementation study have been previously described in the literature.³² The focus of this study was to evaluate the experiences of the dental hygiene faculty and students who implemented ORHT in dental clinics located in academic institutions through one-on-one interviews and Institutional Review Board (IRB) approval was granted.

All senior dental hygiene students enrolled in the three participating dental hygiene programs were invited to be trained in HIV testing through didactic classroom training, online modules, and practice sessions. The training included an overview of HIV epidemiology, ORHT technology, best practices in conducting rapid HIV testing, how to deliver

HIV testing results in a compassionate and professional manner, a review of the study protocol and paperwork, and practice sessions. Fourteen students accepted the offer and were approved to participate by their dental hygiene faculty.

Once the study site completed the OHRT training, participants were interviewed in order to gauge their level of comfort in administering ORHT and their perceptions on barriers and facilitators to incorporating the testing in dental hygiene clinics located in academic institutions. Data were collected using semi-structured interviews with faculty and student participants (n=22). Interview topics were discussed using a semi-structured discussion guide developed by the research team with expert consultation. Interview topics, shown in Table I, were selected after a careful review of the literature and discussion with HIV testing experts. Semi-structured one-on-one interviews, conducted by the same researcher, took place at the three dental clinic sites. Written consent was obtained prior to recording the interview session. Further exploration of new insights allowed for a better understanding of the extrapolated topics and additional probes were included as well as adapting interview questions as needed. Audio-recordings were transcribed and analyzed for thematic saturation of any barriers or facilitators to administering ORHT in the dental setting.

Using a grounded theory approach, analysis began following the first interview so the schedule could be altered as needed in subsequent interviews.³³ A framework analysis using a theme-based approach was used.³⁴ This process continued in order to examine new themes as they emerged as well as to ensure all concepts and ideas were explored. The first two coders performed line by line coding of all transcripts and a third coder reviewed 30% of transcripts. The coding team met to determine that the coding was approached in a consistent manner. Following code development, a constant comparative approach was used to cross-examine codes within and across transcripts to discover and extrapolate themes.³⁵ Specific quotes were highlighted and connected to the themes they supported. After themes were generated and analysis was complete, findings were shared with all involved to ensure validity.

Results

Support for ORHT and Desire for Training

Themes from dental hygiene faculty (n=8) and senior dental hygiene students (n=14) are presented in Table I. Most participants (subsequently noted as interviewees) interviewed strongly supported the idea of ORHT in the dental setting and believed so because the test was quick to administer, noninvasive, and could be easily performed by practicing

clinicians or dental hygiene students. In addition, interviewees felt that dental hygienists have optimal relationships with their patients, therefore patients may be more comfortable and thus more inclined to agree to HIV testing in a dental office. It is important to note the ORHT was provided for free in this study. While most dental hygienists have not discussed HIV testing with their colleagues, many felt there would be mixed reactions regarding providing the testing with some agreeing with the idea, and others not. Some interviewees felt that within an academic environment, HIV testing might be recognized as a needed service; however, there may be some degree of discomfort in administering the test as well as time constraint issues. While most interviewees noted they had the necessary skills and were capable of performing ORHT, the majority agreed that additional training regarding the proper administration of the test and empathetic strategies for approaching a patient with a reactive HIV test were essential. Many were also uncomfortable with the concept of telling the patient that their test result was reactive.

Assessing HIV Status and Offering ORHT

Many dental hygienists did not verbally ask the patients to self-report their HIV status, however, interviewees noted that it is common practice not to ask because this information is available on the medical intake forms. When asked about oral symptoms associated with HIV, all interviewees acknowledged that while they do not look for HIV-specific symptoms, all patients received a comprehensive oral exam to assess for any abnormal clinical pathology. All suspicious lesions were documented and reported with scheduled follow up visits. Throughout the study period, most interviewees offered the ORHT to all of their patients. In some instances, the ORHT was only offered to some individuals due to time constraint issues. With the added education received, the majority of the participants were very comfortable offering the ORHT to their patients. While some noted initial hesitation due to the sensitivity and sometimes stigmatization of HIV, they felt they gained confidence and improved their administration techniques over time.

Patient Reactions to ORHT

In general, no interviewee encountered any difficulties with offering the ORHT to patients and noted that most patients were very receptive and enthusiastic to get tested since it was incorporated into the dental appointment, and was fast, easy, and free. Some patients were surprised that HIV testing was offered in a dental setting, but no one appeared to be offended. Many patients agreed to receive the test because they wanted to know their HIV status. It was hypothesized that patients refusing the test did so because they already

knew their status, had been previously tested, or did not feel they were at risk for contracting HIV.

Systemic Screenings Including ORHT in the Dental Setting

Most interviewees mentioned that they perform oral cancer screening, caries screening and blood pressure monitoring, which are considered standard of care within a dental clinic. They also screened for tobacco use, offering smoking cessation information and education on how tobacco use affects periodontal health. Overconsumption of alcohol was included in some medical intake forms, but the interviewees did not note related cessation or harm reduction policies and practices.

General recommendations of the interviewees to dental hygienists included that they be trained to administer ORHT and to comfortably discuss results with patients if they have a reactive test result. In addition, the ORHT should be offered to all patients at the beginning of the dental appointment, the ORHT can then be administered to consenting patients so they can receive their results by the end of the appointment.

Discussion

This study evaluated the experiences and viewpoints of dental hygiene faculty and students regarding the facilitators and barriers to implementing ORHT in dental settings. Dental hygienists and dental hygiene students strongly support the concept of administering ORHT; such feelings have been attributed to the efficiency, simplicity, reliability, non-invasiveness, and rapidity of the test.²⁹ Findings from this study are comparable to previous studies evaluating the viewpoints of dental and medical professionals regarding screening for medical conditions in the dental setting;²⁸ with the majority of health care providers indicating that systemic conditions should be assessed in the dental setting.^{18, 19, 23, 24} These attitudes can be used to support efforts aimed at incorporating ORHT in the dental setting, creating plans to allow dental hygienists to play a key role in educating patients and advancing total health.³⁰

The majority of participants were confident and comfortable offering HIV testing to patients possibly due to strong communication skills acquired during professional training. In turn, most patients seemed receptive and enthusiastic in accepting ORHT. These results are consistent with the findings of Nassry et al. demonstrating that patients may be likely to agree to ORHT when their dental provider is the individual offering the test.²⁸ Patient willingness for ORHT may also be due to ease of testing, no associated cost, and the fact that it was a component of the overall dental hygiene appointment; suggesting that by increasing ORHT in dental settings, may also increase the numbers of individuals tested for HIV.

Time constraints and the prospect of delivering reactive results were distinguished as the main impediments to implementing ORHT in the dental setting. Patient appointment is often limited, making it difficult to incorporate additional services. When the appointment time was limited, study participants did not offer ORHT. Participants were also concerned delivering reactive results. These findings align with those of Siegel et al. indicating a primary concern of dentists regarding implementing ORHT was their ability to adequately communicate positive results to patients, in addition to feeling that they were too busy to incorporate ORHT into daily practice.²⁷ These barriers will need to be addressed as efforts are made to implement ORHT in dental settings.

Recommendations to assist with preparing dental hygienists to conduct ORHT were explored through the interview process. Participants expressed the urgency in providing training on administering ORHT and strategies for approaching patients with reactive results. Familiarity with the procedure is required to conduct the test and properly read results; knowledge and communication skills are needed to empathetically discuss any reactive findings. Similarly, previous research identified “communicating with patients about test outcomes” as an important factor that needs to be addressed to strengthen implementation.²⁷ Incorporating ORHT into dental hygiene curriculum and providing practitioners with professional development opportunities to develop the appropriate knowledge base and skill set can assist in achieving these outcomes.

Findings from this study demonstrate that dental hygienists are well positioned to perform ORHT. This finding is supported by Pollack et al. who showed that a large percentage of adults at risk for HIV have little to no communication with other medical providers but are in regular contact with the dental provider.²⁶ Participants in this study indicated they have a unique role in identifying HIV infection and that ORHT falls within their scope of practice, findings that were also highlighted by Santella et al., who explored the nature of salivary HIV testing within the realm of dentistry.²⁵ Dental hygienists often see their patients multiple times throughout the year, developing trusting relationships with their patients, who in turn often experience a high level of comfort with them. As a result, these patients may be more inclined to accept ORHT in dental settings, evidence that can be used to support the HIV testing objectives and recommendations of Healthy People 2020,¹ the 2015 National HIV/AIDS strategy,² the U.S. Preventive Services Task Force,³ and the CDC.⁴ Additionally, these findings can be used to implement action strategies enabling dental providers to take advantage of

Table I. Themes from Semi-Structured Interviews
(n=22; dental hygiene faculty: n=8; dental hygiene students: n=14)

Topic	Theme	Illustrative Quote(s)
Opinions on dental hygienists as a professional group conducting oral rapid HIV testing (ORHT)	Dental hygienists are qualified to administer ORHT testing and it is within their scope of practice.	<p>"I personally believe that it's a good idea because we are healthcare providers. We do see our patients usually every 6 months, if not more often, so we do see our patient frequently, we develop a relationship with our patients where they trust us." (<i>Faculty</i>)</p> <p>"I think it fits into their scope of practice. I think it fits into what we expect them to do as part of a healthcare team, and I think that they are a logical choice to work with dentists and the physician to do HIV testing." (<i>Faculty</i>)</p>
Feelings of dental hygiene colleagues regarding providing ORHT to their patients	There was a mixed level of support when study participants discussed ORHT in the dental setting with their colleagues. The most significant issue noted was discussing reactive ORHT results with patients.	<p>"Like I said, you know, something that they agree would be great for us to move into doing, or offer in a, in a dental setting." (<i>Faculty</i>)</p> <p>"I think, at first when you ask a lot of us, oh, it's great. It's fine. But again, I think the dilemma is when you have a positive result. How do you deal with that after?" (<i>Student</i>)</p>
Additional training needed by dental hygienists in order to conduct ORHT	Training is needed with test administration, reading/discussing test results, and counseling those who receive reactive test results.	<p>"I would say when, if a patient, when it's positive, I feel like we need to do more of a training for counseling, and how you would approach the situation and talk to the patient about their results." (<i>Student</i>)</p> <p>"Yeah, definitely. Delivering results. Speaking to patients about the test. What the results of the test mean. That's about it." (<i>Faculty</i>)</p> <p>"Yes". "They already have the skills. I think they need confidence. The skill set is part of what we do all the time. We work in the mouth.....this is not a stretch. It's the confidence of being able to do the testing and to be able to do it correctly, what to do if there's a positive: how do you handle the situation and how do you talk to patient?" (<i>Faculty</i>)</p>
Clinical examination of oral symptoms associated with HIV infection	A thorough intra- and extraoral examination is performed on all patients. While not specific for HIV, it is standard professional practice to assess for anything abnormal.	<p>"Well, not specifically, but definitely we'll look for all signs of oral lesions and all signs of, different signs of inflammation." (<i>Faculty</i>)</p> <p>"Yeah, I guess the answer would be yes, because we really look for anything that falls under outside of the umbrella of normal, or within normal limits. So any type of lesion, discoloration, would be something that we would absolutely, absolutely report on." (<i>Faculty</i>)</p>
Frequency of offering ORHT to dental patients	Although the majority of study participants (dental hygiene faculty and students) offered all patients the opportunity to be tested, some patients agreed to testing while others refused.	<p>"To everyone. Sorry, to every patient. To every patient, it was definitely asked. A lot of them were very interested, half the time, it's just a matter of time, availability." (<i>Student</i>)</p> <p>"Yeah, for some people. I can't remember. Yeah, I think most of my patients that I really know; I was able to ask them, but not everybody because – yeah, I think also the time constraint." (<i>Student</i>)</p> <p>"Some of them. Well, most of the patients I see are family members, so it was just kind of awkward to ask my grandmother. So, it's just different scenarios for different patients, but I did notice that I would ask the younger patients. I had a couple who weren't family members, so in that instance, I would always ask them." (<i>Student</i>)</p>

Topic	Theme	Illustrative Quote(s)
Level of comfort offering ORHT to dental patients	Most dental hygienists were very comfortable offering ORHT to patients since they have acquired the necessary skills to interact well with patients.	<p>“Very comfortable conducting this through this study. The first couple (of times), I was apprehensive, nervous, but I feel very comfortable now, like anything else.” (<i>Faculty</i>)</p> <p>“In my case, I am. Because, I mean, we were taught how to do it and everything, so I am comfortable offering it.” (<i>Student</i>)</p>
Patients reaction to being offered ORHT in dental setting	Most patients were receptive to the idea of being tested since it was convenient, fast, and free, but yet some were surprised that the request was coming from a dental hygienist. While some patients politely refused testing, no one was offended.	<p>“Some said, okay, I’ll keep that in mind, you know, some of them had a, a look on their face as to, sometimes why she did ask me. Some reacted by saying, okay, I’ll come back, but then they would never return, you know.” (<i>Faculty</i>)</p> <p>“No, I mean nobody was really offended. Like I said, they were really all for it or they had to be just like no thank you. I’ve already been tested.” (<i>Student</i>)</p>
Problems as a result of offering ORHT to dental patients	None of the dental hygienists had any problems offering HIV test to patients since most people were receptive while some politely refused.	<p>“No difficulties, Nobody gave us a hard time.” (<i>Student</i>)</p> <p>“No, we didn’t seem to have any issues with it.” (<i>Student</i>)</p>
Other chairside screenings offered in the dental setting	Oral cancer screenings and blood pressure were standard screenings practiced in the university-based dental hygiene clinics. While patients were asked about alcohol and tobacco use, there were limited resources for cessation services.	<p>“We do an oral cancer screening and a clinical oral pathology exam. Here, we also do blood pressure routinely and blood glucose levels if needed.” (<i>Faculty</i>)</p> <p>“We do ask about alcohol use and we ask frequency, and that’s it. It kind of stay there.” (<i>Faculty</i>)</p> <p>“We do discuss tobacco use and we do offer tobacco cessation programs...” (<i>Student</i>)</p>
Recommendations for implementing ORHT in the dental setting	The major recommendation was to make sure that anyone who conducts HIV testing has an adequate training to correctly perform the HIV test and interpret/discuss results.	<p>“ I think they need to be very well versed in the actual, what HIV is, and be able to answer questions. And again, back to the counseling component, in terms of if someone is positive that they would need to be able to answer questions and make the patient feel comfortable.” (<i>Faculty</i>)</p> <p>“I would recommend all that we received in our preparation through the department of health; I think those prep training programs were outstanding. It was wonderful that they were able to put it into a one-day or half-day, and I do think if hygienists are, if they can gear it and put it in that one package like they did for us, I think that would be very advantageous and beneficial. I do feel that everyone should attend and complete that.” (<i>Faculty</i>)</p>

the opportunity to administer ORHT. Executing such plans can result in early diagnosis, improved treatment modalities and decreased disease transmission, thus reducing morbidity and mortality.

While the academic dental hygiene clinic settings can provide valuable data regarding the administration of ORHT, there are limitations due to the treatment time-frame, experience level of the operator and the unique socioeconomic category of the patient. Dental hygiene academic clinical settings require patients to be available for periods of up to four hours, placing the patient in a different frame of mind regarding time usage versus the private practice setting. Student experience levels are limited, as compared to those of a practicing professional. As clinical skills and the art of patient communication develop, the practicing clinician may form more sophisticated opinions regarding the utility of ORHT. Also, because the academic setting appeals to a patient population seeking a quality service for a reduced fee, it attracts only a portion of the at-risk population, which may influence results of studies limited to these settings.

Recommendations for further studies in this area involve the use of experienced clinicians working in a variety of dental care settings including private practice, public health clinics, and military health care facilities. Studies that include payment options and insurance plans may also prove to be useful tools in correlating relationships between affordability and patient acceptance of ORHT. Studies could be also be designed to assess the opinions of dental providers in different types of practices.

Education and training are important factors in the incorporation of ORHT as a routine aspect of patient care. With greater levels of knowledge and experience, dental hygiene graduates will likely be more comfortable administering ORHT and communicating test results. Research in the areas of course design and academic scheduling are recommended. Consideration could be given to introducing HIV epidemiology into the content of didactic courses addressing disease prevention. Additionally, clinical courses could provide an opportunity to practice time management, patient acceptance of ORHT and discussion of the results of routine HIV screening.

Limitations include the location of the study and the academic clinic sites. Study participants were located within one geographic area (metro NYC and Long Island) and may not represent the views of all providers. The ORHT was implemented within dental hygiene clinics located within academic institutions. Although similar to traditional dental settings, academic settings likely serve patients who do not routinely access private dental practices, so their experiences may be different.

Conclusions

Results from this study support the need for more widespread and large-scale implementation studies to document the feasibility of incorporating ORHT as a routine part of dental care. The dental setting may be a convenient and accessible venue to expand efforts in the education, detection, and linkage to care services for individuals at risk or infected with HIV. Long-standing patient-clinician relationships built on trust and respect, may make the dental environment conducive and comfortable for administering ORHT. As educators and clinicians, dental hygienists are often on the front lines of disease detection and health promotion. Findings from this study support the need for increased education on ORHT and indicate the willingness of dental hygiene educators and students to conduct testing as part of dental hygiene process of care. Now is the time to include ORHT in the chairside health screenings offered in the dental setting.

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Knowledge, Attitudes and Practices Regarding Human Papilloma Virus Communication and Vaccine Advocacy Among Minnesota Dentists and Dental Hygienists

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Abstract

Purpose: Recent increases in oropharyngeal cancer (OPSCC) have been attributed to Human Papillomavirus (HPV) infections. Vaccinations for HPV have been available since 2006, however, vaccine uptake in the United States has been poor. Dental hygienists and dentists have the opportunity to increase vaccine uptake through patient education. The purpose of this study was to ascertain the knowledge, attitudes, and practices of Minnesota dentists and dental hygienists toward conversations regarding HPV infections and vaccine advocacy.

Methods: A paper survey was mailed to a random sample of dentists and dental hygienists licensed in the state of Minnesota. Descriptive statistics were used to summarize the data. Two group t-tests or analysis of variance (ANOVA) was used to compare mean knowledge and attitude scores between question responses. Pearson correlation coefficient was calculated for the knowledge and attitude scores.

Results: The overall response rate was 21% (dentists n= 750; dental hygienists n=750). Less than half (44%) of the respondents discuss risk factors for oropharyngeal cancer with their patients, and fewer than one quarter (21%) specifically discuss HPV as a risk factor. HPV vaccination was discussed by 9% of the respondents. Barriers to patient education on HPV included discomfort in sensitive conversations (66%) and feeling unqualified (35%). Over three fourths (80%) of the respondents were in favor of receiving training regarding HPV discussions.

Conclusion: Barriers preventing dental providers from discussing the HPV with patients, included a lack of knowledge and discomfort in discussing a sexually transmitted infection. Minnesota dentists and hygienists are interested in seeking guidance, including communication tools to discuss HPV infections and the HPV vaccine.

Keywords: human papilloma virus, oropharyngeal cancer, HPV vaccine, sexually transmitted infections

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Introduction

Oropharyngeal cancers (OPSCC) are a subset of head and neck squamous cell carcinomas (HNSCC); the sixth most common cancer globally with an incidence of 45,000 annually in the United States.¹ Head and neck squamous cell carcinomas have been traditionally associated with tobacco and alcohol exposure. However, surveillance data show that as tobacco use has declined, so has the incidence of tobacco-associated HNSCC.² Concurrently, there has been an increase in the incidence of HNSCC in oropharyngeal sites including the base of the tongue, soft palate, uvula, palatine

tonsil fossa, and oropharynx.²⁻⁴ In particular, the incidence of oropharyngeal cancer is occurring disproportionately in white, non-smoking males, of moderate to upper income, between the ages of 35-55.⁵ This epidemiological difference has been attributed to the human papilloma virus (HPV), a sexually transmitted infection (STI), particularly HPV-16, which accounts for 90% of HPV-positive oropharyngeal squamous cell carcinomas (OPSCC).¹ The prevalence of HPV-positive OPSCC in the United States has increased more than 300% in the past 30 years and is estimated to surpass the numbers

of HPV-related cervical cancers by 2020¹ as well as being predicted to become the most common cancer of the upper aerodigestive tract.¹

Three U. S. Food and Drug Administration (FDA)-approved HPV vaccinations have been found to be safe and effective against the oncogenic and non-oncogenic types of HPV associated with genital warts and cervical and other anogenital cancers.⁶ Although there is a lack of direct evidence supporting the efficacy of the vaccine in the prevention of oropharyngeal cancers, it is predicted that vaccination against HPV-16 prior to an initial infection can prevent HPV-positive OPSCC.⁵ The Advisory Committee on Immunization Practices (ACIP) has been recommending routine HPV vaccination for girls, between the ages of 9 and 26 since 2006. However, it wasn't until 2011 that the vaccine was recommended for boys, who are also most at risk for HPV-positive OPSCC. In 2016, the ACIP, FDA, and Centers for Disease Control and Prevention (CDC), released a recommendation for a two-dose schedule of a 9-valent HPV vaccine (Gardasil9, Merk & Co, Inc.) for both boys and girls, ages 9-14, aiming to increase compliance.⁷ Individuals being vaccinated between the ages of 15-26 require three doses of the vaccine.

Recent CDC statistics show that while 60% of adolescents aged 13-17 have received at least one dose of the vaccine, only 43% are up to date on all recommended doses.⁸ Vaccination uptake is still far below the Healthy People 2020 goal of 80% for both males and females.⁹ In examining the slow uptake of the vaccine, a number of factors have been identified including a lack of awareness and knowledge of HPV, misconceptions regarding the susceptibility to and implications of HPV infections, unawareness regarding the availability, safety, efficacy and cost of the vaccine, and lack of perceived risk factors.^{10,11} However, research has repeatedly shown that the most compelling positive influence on increasing vaccination uptake is provider recommendation.¹²⁻¹⁴

Patients have been shown to trust and follow their healthcare providers' advice when given decisively.¹⁵ Dorell et al. study of 8,652 adolescents and their parents in the United States found that over three-fourths of parents (78%) reported that their healthcare providers played a role in their child's vaccine uptake.¹⁵ These findings were supported in subsequent studies by Small et al. and Moss et al.^{11,16} Despite support from these studies, many healthcare providers are hesitant to make strong recommendations regarding the HPV vaccination. Many providers are reluctant to discuss sexual activity with their patients.¹⁷ Other providers stratify patients into perceived risk categories, discussing and recommending vaccination for HPV only for persons perceived to be high

risk¹⁸ creating an ethical challenge in terms of beneficence towards all patients.

Dental professionals are also reluctant to discuss HPV with their patients. At the core is the dilemma of communicating with patients about the risk factors and oral manifestations of a STI.¹⁹ Some dentists perceive it is their professional and ethical responsibility to include discussing the HPV-oropharyngeal cancer link, while others believe any discussion involving sensitive topics, such as STIs, should be entrusted to medical professionals.^{19,20} Daley et al. found that dentists and dental hygienists believed HPV discussions were inappropriate in the dental setting due to confidentiality issues, especially in open-designed clinics.²⁰ Additionally, some male practitioners worried that discussions about sexual practices would put them at risk for sexual harassment accusations. Dental professionals also report a lack of confidence in their knowledge of oral HPV infections, including HPV+ OPSCC, and the HPV vaccination, resulting in an avoidance of the topic completely.^{19,20,21} Finally, the lack of standard of care guidelines, by professional organizations, has been cited as a barrier to communicating about HPV.^{20,21} The overall result has been a lack of clearly defined roles with many dental professionals taking a "wait and see" attitude.^{20,21}

Dental professionals are well positioned to influence HPV vaccination uptake.¹¹ According to the CDC, 85% of children ages 2-17 had at least one visit to the dentist during 2015, presenting an opportunity to advocate for the HPV vaccine.²² The purpose of this study was to ascertain the knowledge, attitudes, and practices of Minnesota dentists and dental hygienists regarding HPV+ OPSCC and HPV vaccination.

Methods

This study received an exempt status from the University of Minnesota Institutional Review Board (IRB). A mailing list consisting of a randomized sample of the 4015 dentists and 5688 dental hygienists holding a current Minnesota license was purchased by the principle investigator (PI) from the Department of Administration. The sample size was determined based on a 5% margin of error, for a study sample size of 369 out of approximately 9600 professionals. Assuming a response rate of approximately 25%, 1500 paper questionnaires (750 dentists and 750 dental hygienists) were mailed to the target population.

No validated instrument specifically designed to assess the attitudes of dental professionals toward HPV and HPV vaccination was found in the literature; therefore, a survey instrument originally targeted to head and neck surgeons was selected for use.²³ Questions were modified with profession-

specific vocabulary, as needed. The survey was pilot tested with dental and dental hygiene faculty members and revisions were made based on their feedback. The 32-item paper questionnaire was formatted into five sections: demographics, current practices, knowledge of HPV+ OPSCC and the HPV vaccine, attitudes toward vaccination advocacy, and awareness efforts. A cover letter and information sheet explaining the purpose of the survey, how the respondents' information was obtained, the voluntary and confidential nature of the survey, and contact information for the PI along with the University of Minnesota IRB were attached to the questionnaire and mailed to the sample population. Survey participation was confidential; no personal identifiers were obtained. Questionnaires were coded for tracking purposes to ensure only non-responders received a second mailing sent one month after the initial mailing.

Descriptive statistics were used to summarize the data. Two group t-tests or analysis of variance (ANOVA) was used to compare mean knowledge and attitude scores between question responses. If the overall test for ANOVA was statistically significant, Tukey adjusted pairwise comparisons were performed. A Pearson correlation coefficient was calculated between the knowledge and attitude scores. *P*-values less than 0.05 were considered statistically significant. SAS V9.3 (SAS Institute Inc.; Cary, NC) was used for the analysis.

Results

A total of 111 dentists and 207 dental hygienists (n=318) returned completed surveys for an overall response rate of 21%. Over two-thirds (67%) identified as female and 33% identified as male, with a non-response rate of .94%. A majority of the respondents (82%) worked in private practices, while the others were practicing in academic institutions (6%), public health settings (6%), and managed care practices (1%). Non-responses to questions were unweighted. Demographic information, including profession, age, gender, practice type, and year of graduation from professional school, is presented in Table I.

Current Practices

While the majority of respondents (92%) perform oral cancer screenings, only 44% discuss risk factors for oropharyngeal cancer, with even fewer (21%) discussing HPV as a risk factor. Only 9% of respondents discuss the HPV vaccination for persons (both male and female) between ages 11 and 26. Respondents were asked to select the two most important factors for not discussing vaccination. The most common factors include not remembering (41%), not feeling qualified (35%), and the belief that discussing the vaccine

Table I. Demographic Information

Characteristic	Respondents (n=318) n (%)
Gender	
Male	102 (32.1)
Female	213 (66.9)
Unanswered	3 (0.9)
Profession	
Dental Hygienist	165 (51.9)
Dentist	149 (46.9)
Unanswered	4 (1.3)
Year of Graduation	
1960's	9 (2.8)
1970's	39 (12.3)
1980's	47 (14.8)
1990's	63 (19.8)
2000's	79 (24.8)
2010 - Present	64 (20.1)
Unanswered	17 (5.3)
Practice Type	
Academic Setting	18 (5.6)
Public Health Setting	19 (5.90)
Private Practice (Solo or Group)	260 (81.8)
Managed Care Organization	4 (1.3)
Other	13 (4.1)
Unanswered	6 (1.3)

is not within their role as a healthcare professional (22%). There were no statistically significant differences between demographics and current practices ($p>0.05$). Responses rates are shown in Table II.

Knowledge

The mean knowledge score was 61%; differences between profession, practice type, or gender were not statistically significant. Overall, mean knowledge scores differed between graduation years ($p=0.0079$). In pairwise comparisons, mean knowledge scores for graduations years in the 1960s was lower when compared to the 1980s ($p=0.18$), 1990s ($p=0.044$), 2000s ($p=0.018$), and 2010s ($p=0.006$). Analysis of variance (ANOVA) or two group t-tests or were used to compare mean knowledge between genders, professions, graduation years, and practice types. Tukey adjusted pairwise comparisons were performed when the overall test for ANOVA was statistically significant. Knowledge question response rates are displayed in Table III.

Table II. Current Practices

Question	Respondents (n= 318) n(%)		
	Yes	No	Unanswered
1. Do you routinely discuss the risk factors for oropharyngeal cancer with your patients?	140 (44.0)	173 (54.4)	5 (1.6)
2. Do you routinely perform oral cancer screenings on your patients?	294 (92.5)	20 (6.3)	4 (1.3)
3. If yes, do you discuss HPV as a risk factor?	66 (20.8)	239 (75.1)	13 (4.1)
4. Do you discuss the importance of current efforts to provide HPV vaccination to preadolescents (ages 11-12) with your patients?	27 (8.5)	286 (89.9)	5 (1.6)
5. Do you discuss the importance of current efforts to provide HPV vaccination to persons (both males and females) between the ages of 11 and 26?	29 (9.1)	284 (89.3)	5 (1.6)
6. If your answer was no to question 5, what are the two primary reasons for not discussing these HPV vaccination efforts with your patients.			
a) The HPV vaccine is not appropriate for most adults so my patients are not interested.	52 (16.4)		
b) Safety and effectiveness of the HPV vaccine are not yet proven.	26 (8.2)		
c) Discussing the HPV vaccine is not part of my healthcare role.	69 (21.7)		
d) I don't have the time to discuss the HPV vaccine with patients.	56 (17.6)		
e) I don't support the current effort to provide HPV vaccination to preadolescents.	16 (5.0)		
f) I do not want to discuss with patients how HPV is transmitted.	42 (13.2)		
g) I don't remember to discuss the HPV vaccine with patients, but will do so if asked.	131 (41.2)		
h) The patients I see are not benefited by the HPV vaccine and I don't want to discuss the potential benefits to others (such as their children).	6 (1.9)		
i) The HPV vaccine has not been proven to protect against oropharyngeal cancer.	2 (0.6)		
j) I don't feel qualified to discuss HPV vaccination with my patients.	111 (34.9)		
k) Other	37 (11.6)		

Attitudes

Slightly more than half (57%), of respondents strongly agree or somewhat agree that medical professionals should remain the sole appropriate source of information regarding the HPV vaccine. A majority also strongly agree or somewhat agreed (66%) that they were uncomfortable in discussing HPV with their patients and/or their parents, however 82% disagreed with the statement, "Discussing the HPV vaccination is not appropriate in my practice because it cannot help my patients." Over half (57%), of respondents believed that it is necessary to discuss issues relating to sexuality before recommending the HPV vaccination. Over two-thirds (70%) of respondents disagreed with the statement stating that the safety of the HPV vaccination has not been established while 67% disagreed with the statement that since the efficacy of the vaccine has not been established for oropharyngeal cancer, it is inappropriate to discuss vaccination with their patients (Table IV).

Attitude scores were analyzed by demographic characteristics. Mean attitude scores did not differ for gender, ($p=0.0619$), graduation year ($p=0.0716$), or practice type ($p=0.1650$). However, mean attitude scores were higher for dentists when compared to dental hygienists ($p=0.0021$). Mean attitude scores by demographics are shown in Table V. Overall, there was a statistically significant difference between questions ($p<.0001$). Question 2.7 had the highest mean and question 2.4 had the smallest mean. In pairwise comparisons (Tukey adjusted for multiple comparisons), all pairwise comparisons were significant ($p<0.05$) except 2.1 vs 2.4 ($p=0.1335$) and 2.5 vs 2.6 ($p=0.9917$). Pairwise comparisons of scores by attitude statement are shown in Table VI.

Future Awareness Efforts

Respondents were overwhelmingly in favor of efforts by dental professional organizations to raise awareness of HPV+ OPSCC and HPV vaccination. This included supporting efforts by professional organizations in educating dental professionals regarding advocacy for HPV vaccination (80%), raising public

Table III. General Knowledge of HPV and HPV Prevention Education

Statement	Respondents (n = 318) n (%)		
	True	False	Unanswered
1. All types of HPV infection can lead to oropharyngeal cancer.	92 (28.9)	201 (63.2)	25 (7.9)
2. The tongue is the principal oropharyngeal cancer site associated with HPV.	119 (37.4)	169 (53.1)	30 (9.4)
3. HPV is a relatively uncommon sexually transmitted infection.	28 (8.8)	272 (85.5)	18 (5.7)
4. HPV is associated with a much improved prognosis for patients with oropharyngeal cancer.	106 (33.3)	181 (56.9)	31 (9.8)
5. Oropharyngeal cancer is associated more with males than females.	142 (44.7)	155 (48.7)	21 (6.6)
6. Patients with a history of HPV infection should not be offered the HPV vaccine.	81 (25.5)	206 (64.8)	31 (9.8)
7. Most patients with HPV experience symptoms of the infection.	17 (5.4)	283 (88.9)	18 (5.7)

awareness of the relationship between HPV infection and oropharyngeal cancer (76%), HPV vaccination (70%), patient education by dental professionals (75%), and distributing printed material on HPV infection (90%). Respondents also indicated they would follow HPV vaccination advocacy guidelines issued by dental professional organizations. The majority of respondents (90%) reported they would use printed information on HPV+ OPSCC to educate patients if the materials were made available through professional organizations. When asked whether or not dentists in Minnesota should be licensed to administer the HPV vaccine, the majority of respondents were either opposed (33%) or unsure

Table IV. Attitudes Regarding HPV Vaccination

Statement	Mean Score	Respondents (n = 318) n(%)				
		Strongly Agree	Somewhat Agree	Somewhat Disagree	Strongly Disagree	Unanswered
1. Medical professionals should remain the sole appropriate source of information regarding the HPV vaccine.	2.4	59 (18.5)	122 (38.4)	88 (27.7)	42 (13.2)	7 (2.2)
2. It is necessary to discuss issues of sexuality before recommending HPV vaccines to patients.	2.7	39 (12.3)	88 (27.7)	104 (32.7)	78 (24.5)	9 (2.8)
3. Discussing the HPV vaccination is not appropriate in my practice because it cannot help my patients.	3.2	7 (2.2)	34 (10.7)	142 (44.7)	120 (37.7)	15 (4.7)
4. I am uncomfortable discussing HPV and HPV vaccination with my patients and/or their parents.	2.2	62 (19.5)	149 (46.9)	62 (19.5)	33 (10.4)	12 (3.8)
5. The safety of HPV vaccination has not been established.	3.0	14(4.4)	65 (20.4)	132 (41.5)	90 (28.3)	17 (5.4)
6. The efficacy of the HPV vaccination has not been established for oropharyngeal cancer, therefore it is inappropriate for me to discuss the vaccine with my patients.	2.9	13 (4.1)	74 (23.3)	128 (40.2)	84 (26.4)	19 (5.9)
7. For religious reasons, I am opposed to recommending HPV vaccinations to my patients and/or their parents.	3.7	2 (0.6)	16 (5.0)	52 (16.3)	235 (73.9)	13 (4.1)

(40%). Those who were opposed or unsure, had a lower mean attitude score when compared to those who were in favor ($p < .0001$ and $p = 0.0163$, respectively). Respondents' beliefs toward future efforts to raise awareness of HPV related cancers and HPV vaccination are shown in Table VII.

Discussion

HPV is thought to be responsible for 70% of OPSCC cases,²⁴ a 300% increase from the 1980's and the most recent statistics reported by the CDC show that HPV oropharyngeal cancer is now the most common HPV-associated cancer.²⁵ Despite the increased prevalence of HPV+ OPSCC, several studies have shown that few dentists or dental hygienists discuss HPV infection as a risk factor for OPSCC.^{19,20,21} The majority (92%) of the Minnesota dentists and dental hygienists in this study reported practicing secondary cancer prevention practices through visual and tactile examinations or oral cancer screenings, however only 21% discussed HPV as a risk factor, consistent with other studies.^{19,20,21} While considered the standard of care by both the American Dental Association and the American Dental Hygienists' Association, there is limited evidence that oral cancer screenings reduce the incidence of morbidity.^{26,27} Early detection can be difficult, particularly for HPV+ OPSCC, which develop in areas of the oral cavity that are difficult to visualize, even with the use of adjunctive screening tools.^{26,27} Additionally, no precursor lesion exists for HPV+ OPSCC as in cervical cancer.

The opportunity exists for a primary prevention activity for HPV+ OPSCC in vaccine advocacy. While the efficacy of HPV vaccines in prevention of oral HPV is unknown, it is well known that the vaccines are effective against HPV-16, which is implicated in 90% of HPV+ OPSCC. With the increase in HPV+ OPSCC, it can be argued that dental providers have a professional and ethical obligation to discuss HPV infections with patients and promote the vaccine for eligible patients.^{4,20} Only 9% of the respondents in this study discussed the vaccine with their patients. Barriers to HPV communication and vaccine advocacy within the Minnesota dental community were identified. The most common reasons cited included forgetting to discuss the vaccine (41%), not feeling qualified (35%), denying vaccine advocacy as within their professional role (22%), and not wanting to discuss how HPV is transmitted (13%). Further, 66% of respondents reported feeling discomfort in HPV discussions with patients and/or parents. Barriers identified in this study support the findings of other researchers that identified practitioners expressing discomfort in discussing sexual behaviors with patients, perceiving such discussions as not within a dental professional's role, and a lack of knowledge of the HPV disease

Table V. Attitude Score by Demographic

Characteristic	Mean Score (SD)
Male vs. Female	
Male Female	Mean (SD) = 2.9 (0.6) Mean (SD) = 2.8 (0.5) T-test p -value = 0.0619; Mean attitude score did not differ by gender ($p > 0.05$).
Dental Hygienist vs Dentist	
Dental Hygienist Dentist	Mean (SD) = 2.8 (0.5) Mean (SD) = 3.0 (0.5) T-test p -value = 0.0021; Mean attitude score was higher for dentists.
Graduation year	
1960s 1970s 1980s 1990s 2000s 2010s	Mean (SD) = 2.9 (0.7) Mean (SD) = 3.1 (0.6) Mean (SD) = 2.8 (0.4) Mean (SD) = 2.8 (0.6) Mean (SD) = 2.8 (0.5) Mean (SD) = 2.8 (0.5) ANOVA p -value = 0.0716; Mean attitude scores did not differ by graduation year ($p > 0.05$).
Practice Type	
Academic Public health Private practice Managed care	Mean (SD) = 3.0 (0.5) Mean (SD) = 3.0 (0.5) Mean (SD) = 2.8 (0.5) Mean (SD) = 2.5 (0.7) Mean (SD) = 3.0 (0.5) Other ANOVA p -value = 0.1650; Mean attitude scores did not differ by practice type ($p > 0.05$).

Table VI. Pairwise comparison of Scores by Attitude Statement

Comparisons	P-Value
1 vs 4	$p = 0.1335$
2 vs 5	$p = 0.0001$
2 vs 6	$p = 0.0029$
3 vs 5	$p = 0.0008$
5 vs 6	$p = 0.9917$

All other pairwise comparisons are $p < .0001$

process and vaccination.^{20, 28-30} An overwhelming majority of respondents in this study indicated an interest in increased educational and policy support for HPV awareness and vaccine advocacy by professional organizations presenting an educational opportunity for academic institutions, foundations, and professional organizations.

In response to the increased incidence of HPV+ OPSCC, the American Dental Association and the American Academy of Pediatric Dentistry have been encouraging dental providers to discuss the connection between HPV and OPSCC.^{4,30} In addition, recently, the number articles related to HPV+ OPSCC in dental journals and continuing education courses has increased, signaling the important role oral health professionals play in HPV+ OPSCC.^{4,30} Dental hygienists are well trained in prevention counseling activities, such as tobacco cessation, diabetes prevention, and motivational interviewing.²⁸ These skills can be easily transferred to HPV prevention and risk factor management activities.²⁸ Just as tobacco cessation efforts focus on the prevention of cancer, HPV discussions can be presented within the framework of cancer prevention. Adjusting the attitude of dental providers toward HPV may serve to improve the practice of HPV prevention in the

dental setting. By framing HPV as cancer-causing virus rather than a STI, dental professionals may be more comfortable and inclined to developing protocols regarding HPV including communication scripting and referrals to other healthcare providers.

Re-framing the conversation to cancer prevention has the potential to change at-risk behaviors and increase HPV vaccine uptake.⁴ With the increasing public awareness of HPV and its association with OPSCC, patients will expect their dental providers to not only be knowledgeable on the topic but to also initiate conversations on risk factors and prevention.²⁰ The recommended HPV vaccine's two dose schedule, administered between 6 to 12 months apart, is concurrent with the American Academy of Pediatric Dentistry's periodicity of examination guidelines for children and adolescents.^{31,32} This provides an opportunity for oral health professionals to collaborate in the prevention of HPV+ cancers through reinforcement of health promotion and disease prevention messages promulgated by other healthcare providers.³³ Parental attitudes toward vaccination also influences vaccine uptake.³⁴ Underwood, et al. reported that parents who received information on HPV vaccination from three or more sources have a more positive attitude when compared to parents who receive information from less than three sources.³⁴ It has also been found that educational materials alone do not increase vaccine uptake. However, when education is received through trusted sources, such as healthcare professionals, uptake increases.^{11,34}

Furthermore, to increase vaccine uptake, innovative approaches to vaccine delivery are currently being discussed. McRee et al. found adolescent boys and their parents were amenable to alternative settings other than the traditional medical setting for receiving the HPV vaccine.³⁵ Minnesota State Statute currently allows trained dentists to administer the influenza vaccine.³⁶ A similar opportunity exists to petition the Minnesota State Board of Dentistry to support administration of the HPV vaccine by dentists during adolescent preventive dental visits, potentially increasing vaccine uptake. However, in a recent study investigating parental attitudes toward HPV vaccination in the dental setting, parents expressed low comfort levels in regards having a dentist vaccinate their children.³⁷ Lack of trust in a dentist's role as vaccinator and the staff's ability to manage adverse events were cited as the primary reasons,³⁶ highlighting the need for better patient education in regards to dentists' training.

Limitations of this study include the small sample size and low response rate. The sample size was limited to 750 dentists and 750 dental hygienists from candidate pools of 4,015 dentists and 5,688 dental hygienists for an overall response rate of 21%. Paper surveys were mailed to the sample population, and were limited to the random sample of 1,500 for financial reasons. Results of this survey are limited to dental professionals licensed in Minnesota. Additionally, the survey used was not validated.

Future research should investigate providing HPV vaccines in the dental setting. Researchers have used the health literacy framework to gather baseline data to inform the development of health literacy interventions for dental hygienists and dentists.³⁰ Further study is needed to investigate effective strategies and tools for HPV communication in the dental setting; perhaps using the health literacy framework or other health communication theories. Collaboration with other healthcare providers may also increase HPV vaccine uptake. A number of sources including the Centers for Disease Control and Prevention (CDC) and the World Health Organization (WHO) provide HPV communication tools that can be adapted to the dental setting.^{38,39}

Table VII. Future Efforts to Raise Awareness on HPV+ OPSCC and HPV Vaccination

Question	Respondents, % (n= 318)			
	YES Total DH DDS	NO Total DH DDS	UNSURE Total DH DDS	UNANSWERED Total DH DDS
1. Would you support an effort by professional organizations (such as ADA and ADHA) to educate oral health professionals regarding advocacy for HPV vaccination?	79.9	5.9	11.9	2.2
	78.8	6.0	13.9	1.2
	81.2	6.0	10.1	2.7
2. If dental professional organizations issued a recommendation that oral health professionals advocate for HPV vaccination, would you do so?	70.4	6.3	21.1	2.2
	80.6	6.7	22.4	1.2
	71.1	6.0	19.5	2.7
3. Do you think that dental professional organizations should attempt to increase media coverage and public awareness of the link between HPV infection and oropharyngeal cancer?	75.8	5.7	16.4	2.2
	80.6	6.7	11.5	1.2
	71.1	4.7	21.5	2.7
4. Do you think dental professional organizations should attempt to increase media coverage and public awareness of HPV vaccination?	70.1	8.8	18.9	2.2
	72.1	9.7	17.0	1.2
	68.5	8.0	20.8	2.7
5. Do you think dental professional organizations should issue a statement in support of the CDC recommendations for the routine vaccination of all pre-adolescents against HPV infection?	64.5	8.8	24.2	2.5
	66.0	10.9	21.2	1.2
	63.1	6.7	27.5	3.7
6. If your professional organization were to make a recommendation that oral health professionals discuss the role of HPV in head and neck cancer with patients, would you do so?	75.2	3.1	19.2	2.5
	78.2	4.2	16.4	1.2
	72.5	2.0	22.2	3.7
7. If accurate, appropriately detailed, printed information about HPV infection and its relation to oropharyngeal cancer was provided by dental professional organizations, would you make it available to your patients?	90.25	0.63	6.60	2.52
	92.1	0.6	6.1	1.2
	88.6	7.4	7.4	3.7
8. Dentists in the State of Minnesota can now be trained to administer the flu vaccine. Do you think dentists should also be trained to administer the HPV vaccine?	24.53	32.70	40.25	2.52
	22.4	32.7	43.6	1.2
	26.2	33.6	36.9	3.7

Conclusion

Research shows that HPV vaccine uptake can be improved when there is a stronger provider recommendation. Advocacy of the HPV vaccine by dental providers may prompt an increase in vaccine uptake among adolescents. However, there are barriers including lack of knowledge about HPV and HPV vaccination, discomfort in discussing HPV infection with patients, and denying that vaccine advocacy is within their professional role that prevent most dental providers from discussing HPV with patients. Findings in this study suggest

dentists and dental hygienists would support the promotional efforts of their professional associations to increase public awareness of HPV+ OPSCC and HPV vaccine advocacy. Dental providers are looking to their professional associations for leadership, direction, and training in HPV patient communication. These findings highlight an opportunity for schools and professional associations to better educate dental providers in HPV communication and vaccine advocacy as it relates to cancer prevention.

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Electronic Nicotine Delivery Systems: Current trends and patient education opportunities for dental hygienists

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Abstract

Concerns regarding the overall health consequences, product safety, impact on youth brain development, and possible gateways to other tobacco products of Electronic Nicotine Delivery Systems (ENDS) are increasing. However, evidence suggests little is known about ENDS among health care professionals and the public. The purpose of this review was to explore the literature for opportunities to inform dental patients about the possible health consequences of ENDS and prevention strategies to consider for implementation in dental practice. A literature search was conducted on ENDS appeal, product users, health and safety concerns, regulations, major health care organization positions, research needs, and use in tobacco cessation strategies. Search terms included ENDS (electronic nicotine delivery systems), tobacco cessation, tobacco use intervention, dental education, dental professionals, dental hygiene, health care professionals and health professional organizations. The following data sources were utilized: PubMed, MEDLINE, Google Scholar, and the Smoking, and Tobacco Abstracts and News Bulletin. Published articles from peer-reviewed journals, relevant websites, and government documents were included; 85 resources were selected as most relevant for this review. Health risk related ENDS research, without updated information prior to 2010, was excluded. Opportunities exist for dental hygienists to develop a greater awareness about ENDS based on scientific evidence in order to assist patients in making informed decisions regarding ENDS use.

Keywords: electronic nicotine delivery systems, ENDS, tobacco cessation, tobacco use intervention, dental education, dental professionals, e-cigarettes

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Introduction

Statistics from the United States Department of Health and Human Services (HHS) “Health Consequences of Smoking - 50 Years of Progress,” showed that from 2005-2009 smoking and exposure to secondhand smoke, were responsible for more than 480,000 deaths annually.¹ An additional report finding was the identification of changing patterns of tobacco use, with a decrease of traditional tobacco and increased use of non-traditional products including the use of what is known as electronic cigarettes.¹ These findings have implications for dental hygienists who provide guidance and education regarding tobacco use. Originally developed and designed by a Chinese pharmacist in 2003 as a safer use of nicotine, minus tobacco, e-cigarettes were originally promoted with claims of emitting vapor rather than smoke.³ Introduced in the United States in 2007,³ electronic cigarettes have also been referred to as electronic nicotine delivery systems (ENDS), electronic smoking device, e-hookah, e-vapor device, hookah pen,

personal vaporizer, vape or vapor pen, vapor cigarette, mods, tank systems and others.^{1,4-9} It has been estimated that over 95% of ENDS are manufactured in China leading to product quality concerns.⁹ Over 5,000 vape shops exist in the United States, with more opening every month, creating challenges for research studies regarding product safety.¹⁰

A review of the literature suggests that there is a gap in the knowledge among healthcare professionals regarding ENDS and there is a lack of credible resources on safety and effectiveness of use for the public.^{9, 11, 12-19} Healthcare challenges have resulted due to the lack of public health data regarding the health implications, potential environmental impact, along with rapidly evolving ENDS technology.²⁰ Appropriately educated dental hygienists can be effective in assisting patients in tobacco cessation and in patient education strategies.^{12,13} The purpose of this literature review was to explore opportunities to inform dental patients and the public

about possible health consequences of ENDS and prevention strategies to consider for implementation in dental practice.

ENDS Appeal and Promotion

The basic design of a typical e-cigarette consists of a mouthpiece to withdraw the vapor, a tank which holds the liquid nicotine or “juice”, a battery, and a heating apparatus that vaporizes the juice (Figure 1).²¹ With over 500 types and more than 7,000 flavors available, the various flavors are particularly appealing to youth.⁹ A cross-section of ENDS prototypes are shown in Figure 2. The most popular product has been designed to resemble a flash drive and is USB charged, with increasing reports of youth use during school hours.²³⁻²⁵ Commonly known by the brand name JUUL (JUUL Labs, San Francisco, CA), this product features a nicotine flavored pod that contains concentrations higher than those found in a cigarette (Figure 3).²³⁻²⁵ Containing as much nicotine as a pack of cigarettes, youth users often share devices and refer to the process of using them as “juuling”.²⁴ Johnston et al. found between 52% - 75% of youth in the 8th, 10th and 12th grades believed that ENDS mist only contains flavoring and were unaware of the nicotine content.²⁷ ENDS products have also been used for the delivery of illicit substances, with marijuana most commonly reported.^{7,9}

Figure 1. Components of Electronic Nicotine Delivery Systems

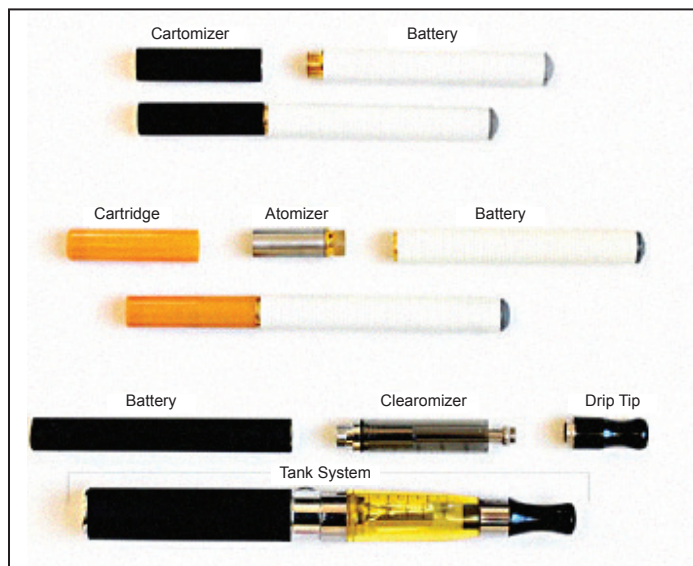


Image courtesy of the United States Food and Drug Administration²²

ENDS product packaging frequently use youth-oriented and cartoon-like images with flavors and themes appealing to youth.^{23, 28} Investigators of one study found 82% of the current youth ENDS users engage in using because of

Figure 2. Variations of ENDS products



Image courtesy of the United States Food and Drug Administration²²

Figure 3. JUUL product design



Photo credit: Evan Godell, University of Detroit Mercy Dental, Detroit, MI

appealing flavors.²⁹ Product marketing approaches help create a common misconception among youth that ENDS are a safer and healthier alternative to traditional tobacco.^{29,30} In a 2014 Truth Initiative report on youth and young adult exposure to ENDS product marketing, it was shown that advertising across TV and print reached approximately 80% of 13 to 17-year-olds and 94% of 18 to 24-year-olds.³¹ An analysis of National Youth Tobacco Survey (NYTS) 2014 findings, associated the surge in youth use of ENDS with increased exposure to advertising.²⁸

The 2016 NYTS revealed nearly 80% of youth reported exposure to ENDS marketing from at least one source.²⁸ Current ENDS marketing approaches lack restrictions and appear reminiscent of those used in advertising traditional tobacco products with misleading messaging designed to attract youth.^{9,28} Receptivity to ENDS product advertising has also been found to be associated with trying a cigarette.³²

Adults may be initially drawn to ENDS for tobacco cessation efforts however, safety and efficacy studies have conflicting results.¹⁰⁻¹⁶ Reasons for adult ENDS use include the behavioral aspect that resembles cigarette smoking and the perceived social acceptability.³³⁻⁴⁰ Other reasons cited relate to less negative public perceptions, being viewed as “vapers” rather than “smokers,” and product features allowing for preferences in flavors, dosage and voltage.^{40, 41} Research using content analysis of public postings on social media related to ENDS use from 2012-2015 demonstrated that in 2012, quitting combustibles was the major reason for ENDS use (43%). Three years later in 2015, social image (39%) emerged as a primary reason suggesting that the use of ENDS is moving away from use as an aid for quitting combustibles.⁴²

ENDS User Demographics

Data confirm increased popularity and use of ENDS by youth.^{9,43} From 2011 to 2015, the rise in ENDS use represented a ten-fold increase. ENDS are used more frequently than any other tobacco product and are used more often by youth than adults.^{9,44} The 2016 NYTS reports ENDS use among middle school students at 4%, representing a population of close to 500,000.⁴⁴ High school student use was reported at 11%, indicating approximately 1.6 million users.⁴⁴ Additional findings indicate dual use of tobacco products for middle school students at 3% and high school student use was at 10%, with nearly half of youth using more than one product.⁴⁴ Another finding for youth revealed 17% of middle and high school students believe using ENDS is less harmful than other forms of tobacco.⁴⁵ While ENDS were the most popular product used by middle and high school students NYTS survey findings demonstrated a decline in tobacco product use in 2016 as compared to 2015.⁴⁶

Research on prevalence of adult ENDS use identified nearly one third of current users as never smokers, which may indicate that ENDS use is contributing to nicotine addiction and re-normalization of tobacco use.⁴⁷ Data from the National Center on Health Statistics (NCHS) showed that of current cigarette smokers who had tried to quit smoking in the past year, over 50% had tried ENDS.³³ and nearly 10% of 18-24 year-olds who never smoked a cigarette, had tried ENDS.³³ National Health Interview Survey (NHIS) 2016 data indicate that 15% of adults aged 18 and older reported ever having tried ENDS, even once, a higher level when compared to 13% identified in 2014.^{33,48} Adult awareness of e-cigarettes rose from 77% in 2012 to 94% in 2014 as reported by the Health Information National Trends Survey,¹⁴ while 48% of current or former smokers responded that they have tried ENDS, substantiating findings from other national surveys.^{14,48}

Health and Safety Concerns

There is a gap in the literature regarding guidance on safety of ENDS use.^{9,49,50} Studies have identified possible exposure to

nicotine, volatile organic compounds, carcinogenic compounds, and heavy metals emitted into the air as ultrafine particles all have potential for causing health consequences.^{8,51,52} Flavoring chemicals have been implicated as having an effect on the respiratory system.⁵² Additional research suggests that flavorings may influence free radical production, potentially damaging living cells.⁵³ Exposure to nicotine as well as other chemicals may have secondhand exposure health harms.^{54,55} Nicotine exposure has been linked to tachycardia, vasoconstriction, and hypertension.⁵⁶ Liquid nicotine exposure resulting from ingestion or through contact with skin or eyes can be toxic.^{9,49} Findings from several studies suggest nicotine exposure may result in insulin resistance, preterm births, and impaired development of fetal brains and lungs.^{1,11,12}

Nicotine exposure during adolescence is of particular concern due to potential lifelong consequences, with multiple studies identifying addiction vulnerability and impact on brain development.^{1,9,12,46,49,55} Research has demonstrated that youth ENDS use progresses to cigarette smoking, with a recent study showing youth being more than four times more likely to progress to cigarette smoking.^{30,49,57-59,60} Youth ENDS use has been linked not only to an increased risk of trying conventional cigarettes and waterpipe, but additionally, multiple product use was shown to be more frequent than single product use.³⁰ Other findings revealed the presence of at least five potentially harmful toxicants that suggest an increased youth cancer risk.⁶¹ Nicotine use in any form by youth has been deemed unsafe and ENDS, with or without nicotine, carries risk for harm to health.^{9, 49,61} Intervention strategies for youth should focus on use prevention of all tobacco products, including ENDS.^{9,28,31,49,60-63}

Explosions and fires have resulted while using ENDS and a recent National Academies of Sciences, Engineering, and Medicine report reveals that the number of fires or explosions can be expected to increase.^{2,49} With 195 separate incidents reported between January 2009 and December 2016, 62% occurred when the device was actively used or carried in a pocket.²

Evidence-based research identifying the impact of ENDS on oral health is limited with much of what is known based on laboratory studies.⁴⁹ Poor wound healing and DNA damage effecting the periodontal ligament have been suggested, as well as the possibility of human fibroblast damage due to ENDS product fluids with or without nicotine.^{64,65} Flavoring chemicals can release inflammatory proteins leading to cell damage

and increased risk for periodontal disease; higher risks are associated with frequency of use.²¹ Other research has identified damage linked to the nanoparticles contained in the vapor,^{49,66} with one study showing ENDS users reporting mouth irritation, oral ulcers, sore throat, and coughing.⁶⁷ Potential carcinogenicity has been suggested as a concern with exposure to the mouth and throat.⁸ Burns, broken teeth and damage to supporting oral structures have all been reported when using ENDS products.⁶⁸ Conclusive evidence on health harm is difficult when considering different ENDS use patterns, varying sample sizes and groups being studied, along with the wide-range of ENDS products available.^{3,9,11,14,20,49,71,76} Research findings are considered to be at a very early stage, calling for further investigation and the need for evidence-based studies.⁴⁹

Harm Reduction and Tobacco Cessation

Efficacy of ENDS use for smoking cessation has insufficient evidence due to a limited number of studies, small sample sizes and findings limited to short-term results.^{9,49, 67} Inconsistencies also occur due to the wide variability of product type, design, and contents.^{9,49,50,69,70} Continued use of ENDS after a failed attempt to quit combustible tobacco is not uncommon as a potential consequence.^{9,49} Research suggests that when the use of combustible tobacco is reduced but not completely eliminated while simultaneously using an ENDS product, improved health is unlikely.^{20,49}

The United States Preventive Services Task Force (USPSTF) provided evidence-based recommendations on the use of ENDS in December 2016 stating that there is a lack of evidence regarding the effect of ENDS use for tobacco cessation and stressing the need for more quality studies.¹⁵ The 2018 National Academies of Sciences, Engineering, and Medicine report on the public health consequences of e-cigarettes concluded that there is limited evidence to demonstrate ENDS effectiveness when used in conjunction with tobacco cessation efforts, citing study limitations based on evidence drawn exclusively from laboratory testing of ENDS ingredients.⁴⁹ Further findings from the National Academies report concluded that studies evaluating chemical toxicity through use of cultured bacteria or tissue samples were inconclusive since the results were limited to in vitro studies.⁴⁹ Some studies have suggested ENDS may have a place in reducing health risks when compared to the potential detrimental health effects of using combustible tobacco,^{9,54} creating a dilemma for health care providers when providing guidance regarding ENDS use. While short-term ENDS use may be less harmful than combustible tobacco, harms of long-term use, levels of safe use, along with other variables

are unknown, supporting the need for more evidence-based research and product regulation.^{11, 49, 50,71}

Regulation of ENDS

Research is limited regarding the potential health harms related to exposure to secondhand ENDS aerosol, however several studies suggest smoke and tobacco-free environment policies should include ENDS.^{8, 9, 49,72} Smoke-free environment legislation has been expanded in some areas in the United States (U.S.) prohibiting the use of ENDS in indoor as well as outdoor spaces due to concerns regarding toxicity of ENDS emissions, creating confusion about compliance with smoke-free laws.^{49,73} Although no federal laws had been enacted July 1, 2018, there were 752 municipalities, 11 states, and two territories prohibiting ENDS use in 100% smoke-free environments.⁷³ In addition, the CDC September 2017 report identified 47 states, along with the District of Columbia, Guam, Puerto Rico, and the U.S. Virgin Islands have implemented restrictions on the sale of ENDS to minors.⁷⁴ The U.S. Food and Drug Administration (FDA) extended their authority to regulate all tobacco products, including ENDS as of August 8, 2016.⁷⁵ Under the final FDA rule, manufacturers of new products are now required to report the ingredients contained in their products and to undergo premarket review as a condition for receiving authorization for marketing and selling their products.⁷⁵ Regulation of ENDS products is essential in order for consumers to identify product ingredients and aerosol content.^{49,76}

Health Care Organization Policies

Multiple professional organizations have policies opposing ENDS use for tobacco cessation including the American Medical Association, the American Association for Respiratory Care, American Lung Association, and the World Health Organization, among others.⁹ With clearly developed policies regarding ENDS use, dental and other health care related organizations could be influential in providing appropriate guidance regarding evidence-based practices for tobacco cessation and for prevention strategies that address ENDS.^{9,13,16,68}

Future Research Needs

As a relatively new area of study, ENDS research regarding health effects is challenged with procedural problems in part due to the wide variety of brands and models limiting the transferability of study results.^{50,70} Studies of ENDS ingredients have taken place without any standardization of the evaluation process.^{49,50} Conditions where nicotine fluid is overheated in the laboratory can overestimate health consequences.⁵⁰ Human studies may have limited results due to short-term exposure study and potential harm from long-

term use may be underestimated.^{49,50} While animal study results may not be reliable, possibly determined under conditions of overexposure, human studies on long-term ENDS health effects may not generate the same results.^{49,50} Although less harm does not mean safe, the literature suggests the use of ENDS without use of other products is likely to be less harmful over the short-term when compared to combustible tobacco.^{14,49,50} More extensive evidence-based studies need to continue, since long-term consequences are unknown.^{14,47,48,50-52,66,67,77}

The Cochrane Addiction Group has been recognized as providing “gold standard evidence” in identifying the most effective methods to support smoking prevention and treatment.⁷⁸ Essential needs for research identified by this group includes identifying the ways all health care providers can be involved in providing patient treatment and determining the safety of ENDS.⁷⁸ Researchers are challenged with establishing the consistent risk measures for ENDS that are key to the development of best practices for the use of these products.^{49,50,54,79}

Implications for Dental Hygiene Practice

Remarkable progress in the area of tobacco dependence education has been made in dental education programs over the last 25 years. Evidence suggests that with appropriate education, dental hygienists are well-informed, effective health care providers and demonstrate greater engagement with patients regarding tobacco use.^{9,12,13,54,80-82} Dental hygienists have the potential to be the driving force behind patient education on tobacco, smoking and vaping products, including ENDS. With the increasing use of ENDS and the potential impact on oral health, dental hygienists have a unique opportunity and obligation to inform patients regarding the oral and systemic health concerns. Tobacco product use, as part of the health history and patient assessments, should include ENDS in the development of strategies for patient education.^{12,13,84} ENDS discussions with adults could be approached using a risks versus benefits format.^{3,11-13,36} Most studies suggest when providing tobacco cessation guidance, FDA approved medications with evidence supporting their efficacy should be recommended, thus ENDS products are not included at this time.¹² In general, patients should be advised to avoid all tobacco products, including ENDS; dual use of tobacco products should be discouraged.^{20,49,85} Guidance for discussions regarding ENDS in the clinical setting is shown in Table I.

Table I. Guidance for addressing ENDS use in the dental setting

<ul style="list-style-type: none"> • Seek professional development opportunities to become better informed regarding all tobacco and vaping/ENDS products.
<ul style="list-style-type: none"> • Ask all patients regarding tobacco, smoking and vaping/ENDS product use and advise users to quit.
<ul style="list-style-type: none"> • Guide patient quit attempts with scientific, evidence-based approaches to treatment utilizing FDA approved medications.
<ul style="list-style-type: none"> • Advise youth patients about ENDS dangers, including addiction to nicotine and harm to brain development and recommend abstinence from all tobacco and vaping/ENDS product use.
<ul style="list-style-type: none"> • Educate the dental patient with basic information on what is known and unknown about ENDS, to allow for informed decisions regarding use.
<ul style="list-style-type: none"> • Encourage dental professional organizations to establish clear policies for patient guidance on use of all tobacco and vaping/ENDS products.

Conclusion

Review of the literature suggests more thorough evidence-based studies are needed to establish the efficacy of ENDS for tobacco cessation, for the use of ENDS products in harm reduction efforts, and the health effects of ENDS use over time. Available research studies display inconsistencies and are lacking in number and quality. Evidence appears strong regarding the detrimental effects of youth ENDS use and guidance from health care professionals regarding ENDS is needed for youth as well as adults. Health care organization guidelines and recommendations are strongly encouraged, serving as reliable resources on ENDS for health care professionals. Dental hygienists are well positioned to advocate for change with greater awareness of the rapidly rising use of ENDS as a critical public health issue and should seek continuing education opportunities to increase their ENDS knowledge base. Using the current scientific evidence, dental hygienists can provide the appropriate educational strategies to assist adults and youth in making informed decisions regarding the use of ENDS.

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Efficacy, Safety and Patient Preference of Knotted Floss Technique in Type I Gingival Embrasures

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Abstract

Purpose: The purpose of this study was to evaluate the efficacy and safety of the knotted floss (KF) technique with respect to plaque biofilm accumulation, gingival inflammation, bleeding, trauma, and patient preference when used in Type I gingival embrasures, in a crossover-comparison with a conventional flossing (CF) technique.

Methods: Thirty healthy, non-flossing adults with at least one Type I gingival embrasure participated in this two-treatment-phase, crossover study. Each subject was randomly assigned to perform either KF or CF technique in the first 6-weeks, and the comparative technique in the second 6-weeks, with a 2-week washout phase in-between. Test-sites were scored at baseline, 2-weeks, 4-weeks, and 6-weeks using the Rustogi Modification of Navy Plaque Index (RMNPI), Modified Gingival Index (MGI), Modified Papillary Bleeding Index (MPBI), and the Carter- Hanson et al., scoring method for gingival trauma. A 3-factor analysis of variance was performed on the data to rule out treatment sequencing as a significant factor. Data was analyzed for differences between groups at respective time points using the student t-test and the paired t-test was used for changes within groups over time ($p \leq 0.05$).

Results: Analysis of data showed a statistically significant improvement in RMNPI, MGI and MPBI scores within both flossing groups over the period of 6-weeks from baseline. The RMNPI scores were significantly less in the KF group at 2, 4, and 6 weeks when compared to the scores between the KF and CF treatment groups. No significant gingival trauma was recorded in either treatment group. Seventy-five percent of the subjects completing the study, chose KF when asked about their preferred flossing technique with respect to its ability to clean interdentally, while 71% chose KF as the flossing technique that they were willing to continue to use.

Conclusion: KF is as effective and safe as an inter-dental oral hygiene technique for reducing plaque biofilm and gingival inflammation and bleeding, as compared to CF in Type I gingival embrasures, when both were used in conjunction with regular tooth-brushing. KF was shown to be better than CF in terms of improved plaque biofilm scores.

Keywords: flossing, interdental cleaning, dental plaque, gingivitis, oral hygiene

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Introduction

It has been well established in the literature that the origin of gingivitis and periodontitis occurs through the colonization, accumulation and subsequent maturation of a plaque biofilm. Variations to this inflammatory process are thought to be a consequence of differences in the quantity and composition of these microbial deposits in addition to being mediated by systemic and local inflammatory responses and other environmental factors.¹ Good oral hygiene practices are considered to be important in maintaining good oral health.²⁻⁴ Regular oral care, focused on controlling supra-gingival plaque,

can assist in slowing or reducing the tendency of plaque biofilm to shift to a pathogenic environment.⁵ Current preventive oral health care focuses on thorough removal of plaque biofilm to prevent, reduce or even reverse oral disease processes, such as gingivitis.⁶⁻¹⁰ Dentists and dental hygienists have commonly recommended daily mechanical plaque biofilm control, specifically tooth-brushing for thorough removal of plaque biofilm and prevention of further plaque accumulation.^{3,5,9,10}

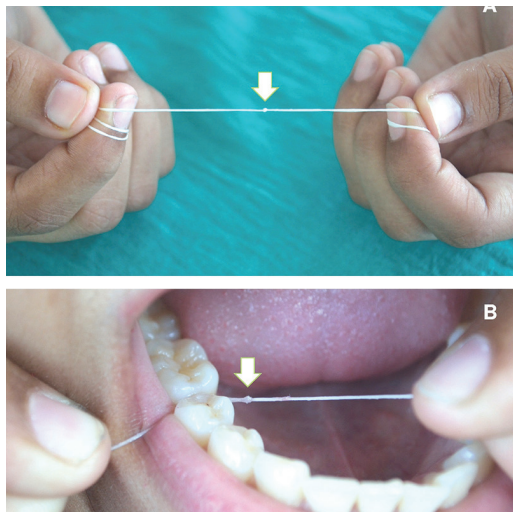
Toothbrushing as a means to mechanically remove plaque biofilm is extremely effective, however it has not been shown

to be thoroughly effective in cleaning interdental areas when used exclusively.^{4,6,10,11} Schmid¹² classified interdental embrasures, depending upon how much the interdental papilla fills the gingival embrasure and advised that dental floss be used in Type-I embrasures, and the incrementally wider interproximal and uni-tufted brushes be used in in Type-II and III, respectively.¹²

In a systematic review of twelve studies on flossing, Sambunjak et al.¹³ concluded that there is some evidence to support the theory that flossing, in addition to tooth-brushing, reduces gingivitis and plaque biofilm accumulation as compared to tooth-brushing alone. Routine use of dental floss in conjunction with tooth-brushing has been shown to reduce the amount of plaque biofilm accumulation especially in the proximal areas.^{5,6,14} Additionally, plaque biofilm reduction may not only prevent the onset and severity of gingivitis but may also lower the risk of cardiovascular disease.^{15,16} Flossing is also utilized to clear food impaction from interdental areas.¹⁷ However, in regards to compliance, patients frequently exhibit a reluctance or an inability to perform flossing on a regular basis.^{9,14}

Gomes et al.,¹⁸ have presented a modification in flossing called Knotted Floss (KF) technique and advocated its use in wider embrasure areas. The modification was made to increase the effective width of the floss, thus enabling it to be used in embrasures wider than those recommended for conventional floss. To modify the floss, a knot is tied at any distance in the middle third of the floss length. The floss can then be inserted past the interdental contact point by the conventional finger flossing (CF) technique in the non- knotted area and then during the “to and fro movement” on the tooth surface cervical to the contact, the knotted area is then engaged through the embrasure (Figure 1).¹⁸

Figure 1. Knotted Floss Technique



Make a simple knot (arrow) in the middle of the length of floss

Floss is inserted between teeth (non-knotted part) and then knotted area (arrow) is allowed to slide through embrasure

Asadoorian⁶ conducted a literature search and critical analysis of studies on the efficacy of manual finger flossing, flossing aids and devices, and other interproximal aids. However, no studies

have been identified in the literature that have evaluated either the efficacy, safety, or the patient preferences of the KF technique as an adjunct to tooth brushing.

To assess the efficacy of an interdental cleansing method, one must consider two reference points; theoretical efficacy of the method as determined by its clinical evidence and practical efficacy based upon the acceptability of the procedure, which in turn influences the long-term compliance.⁶ Theoretical efficacy can be determined by evaluating the effects of the test device or procedure on plaque biofilm accumulation scores and the presence of gingival inflammation and bleeding. The potential of the test device to cause gingival trauma during use must also be evaluated. The purpose of this study was to compare the changes in scores of plaque biofilm accumulation, gingival inflammation, sulcular bleeding and presence of gingival trauma due to flossing using the KF technique versus the CF technique, in Type-I gingival embrasures. Preferences between the two flossing techniques were also evaluated.

Methods

Sample Selection Criteria

A sample of 30 patients, aged 18 years and above, were randomly selected from the patients visiting Uttaranchal Dental and Medical Research Institute outpatient department, for a dual phase, examiner blinded, crossover clinical trial. A preliminary pilot study with six subjects was conducted in order to estimate the necessary variables required to determine the sample size according to the criteria of Chow et al.¹⁹ A sample size of 28 was calculated to achieve a sample power of 80%, and was increased to 30 to adjust for potential attrition.²⁰ Inclusion and exclusion criteria used for subject selection are shown in Table I. The trial was conducted as per the World Health Organization guidelines for good clinical practice²³ and was approved by the Uttaranchal Dental and Medical Research Institute Ethics Committee. This study was part of a larger study protocol involving different groups comparing the KF technique with the CF technique, along with the use of interdental brushes and uni-tufted brushes in Type-II and Type-III embrasures, respectively. No subjects overlapped amongst the sample groups of the larger study protocol.

Study Design

Each potential participant received written and verbal instructions on the two flossing techniques prior to starting in the study. The first and third investigator

Table I. Sample selection criteria

Inclusion Criteria	Exclusion criteria
<ul style="list-style-type: none">• One type-I embrasure in the premolar-first molar area, (only one type-I embrasure selected per subject)• Full mouth (Silness and Loe²¹) plaque index score ≥ 1.8• Full mouth (Loe and Silness²²) gingival index ≥ 1.0• Good general health• No missing teeth in the quadrant bearing the embrasure being tested, except for third molars• No missing teeth in the quadrant opposite to the embrasure being tested, except for third molars• No more than two teeth missing in each of the other two quadrants• Available for a 14-week study period• Willing to abide with the study criteria and follow study methodology with no personal alterations• Minimum education of higher secondary school certification	<ul style="list-style-type: none">• Use of other oral hygiene aids (besides tooth-brushing) such as dental flossing, mouthwashes and water jet irrigating systems in the previous 2 months• Any habit of unilateral mastication for ≥ 2 months• History of diabetes mellitus, hepatitis, and pregnancy or requiring any antibiotic prophylaxis• Drug history in preceding two months (and during study) of use of antibiotics, hormonal supplements, steroids, non-steroidal anti-inflammatory medications, oral contraceptives or any drug influencing gingival tissue• Participation in other clinical or drug trials including taking part in other studies related to evaluation of knotted floss technique• Physical handicaps limiting oral hygiene ability and the effective use of dental floss• Orthodontic treatment• Gross dental caries• Severe gingival inflammation requiring professional therapy• Advanced periodontitis (more than one pocket $\geq 6\text{mm}$)• Active periodontal therapy such as scaling, root planing, curettage, periodontal surgery in the previous 8 weeks,• Oral habits including smoking, tobacco chewing or self- gingival mutilation• History of trauma or jaw surgery• Proximal caries/gross occlusal caries or proximal restorations/ crowns/ onlays/inlays on teeth adjacent to the embrasure area selected

demonstrated both flossing techniques on typodonts in 30-minute educational sessions over three consecutive days. Each educational session had no more than ten participants. On the third day, the participant's proficiency in both techniques on typodonts was confirmed separately by both investigators, informed consent taken and the subject was enrolled into the fourteen-week study. Failure to perform the techniques as instructed required an additional 30-minute educational session or exclusion from the study.

In the first phase, half of the subjects were randomly assigned to use either the CF or the KF technique. Only the first investigator was responsible for this allocation and the other investigators were blind as to which technique the subject was assigned to. The treatment phase consisted of six weeks of daily use of the assigned technique and was followed by a 14-day washout period after which the second phase began and the subjects used the other flossing technique. Subjects were given their assigned floss products by the first investigator

exclusively at the baseline appointment for each phase. Subjects assigned to the CF technique received 90 pieces of waxed floss (Reach,[®] Johnson & Johnson Consumer Inc.; New Brunswick, NJ), each piece 15 centimeters in length, equally divided into three plastic bags. Subjects assigned to the KF group received the same bags of floss except that each floss strand had a simple knot tied at approximately the middle of the strand. All participants received a toothbrush (Oral-B[®] all-rounder soft; Procter & Gamble; India Ltd.) and dentifrice (Colgate[®] Strong Teeth; Colgate-Palmolive; New York, NY).

Participants were given detailed instructions regarding the oral hygiene study regimen (Table II). As in any 2x2 crossover study, trial phases must be separated by a washout phase sufficiently long enough to rule out any carryover effect of the first treatment procedure prior to proceeding to the second.^{19,24} Carter-Hanson et al.,¹⁴ used a 2-week washout period in their crossover study comparing a floss holding device to conventional finger-flossing procedure, while Torkzaban et

Table II. Subject instructions

1.	Brush the teeth twice a day using only the supplied toothbrush and dentifrice	
2.	Do not use any other oral hygiene aid except for the assigned floss	
3.	Use the assigned floss twice a day in the method previously instructed	
	CF Phase	Wrap the floss around the middle or index fingers. Hold the floss taut and gently slide the floss between the teeth and move it along the margin, curved into a “C” shape. Movement of the floss should be ‘up & down’ and ‘back & forth’ (in a push-pull motion) three to five times between each tooth without using excessive pressure. Finally allow the floss out through the embrasure by releasing the floss from one finger.
	KF Phase	Wrap the floss around the middle or index fingers. Hold the floss taut and gently slide the floss between the teeth in the portion that does not contain the knot. Move it along the margin, curved into a “C” shape. Movement of the floss should be ‘up & down’ and ‘back & forth’ (in a push-pull motion) three to five times between each tooth without using excessive pressure, such that the knotted area passes across the interdental area from buccal to lingual or vice-versa. Finally allow the floss out through the embrasure by releasing the floss from one finger.
	Washout Phase	Perform normal oral hygiene practices of tooth-brushing with dentifrice. Refrain from using any floss or other plaque biofilm control aids.
4.	Write in the diary (present in the sample kit) any flossing experience that you feel is significant, including missing a flossing activity, performing an extra oral hygiene procedure (like tooth picking), taking any medication or any gingival trauma, cut, etc..	
5.	Discuss queries regarding flossing only with the first and third investigator. Do not mention anything about your flossing experience to the second and fourth investigator.	
6.	Return all unused dental floss products to the first investigator at the end of each treatment phase.	

al.,²⁵ used a 7-day washout period in their crossover study comparing brushing and flossing sequencing. Data from the pilot study showed no significant intra-subject differences at the start of each treatment phase, when a 2-week washout period was used, while when a 1-week washout was employed, there was no conclusive evidence that the washout was effective. Hence, a washout of 2-weeks was selected between treatment phases allowing the participants time to return to their original oral status and establish parity in baseline clinical measurements, prior to starting the second treatment phase. Moreover, the same inclusion and exclusion criteria were applied to all participants at the start of each treatment phase. Subjects were instructed to perform their normal oral hygiene practices of tooth-brushing with dentifrice and refrain from using any floss or any additional plaque biofilm control aids during the washout period.

Clinical Evaluations

Clinical evaluations of all subjects were performed beginning with baseline, and at 2-weeks, 4-weeks, and 6-weeks of each treatment phase. Adjacent teeth and gingiva at the test sites were scored with the Rustogi Modification of Navy Plaque Index (RMNPI),²⁶ Lobene’s Modified Gingival Index (MGI),²⁷ and Barnett’s Modified Papillary Bleeding Index (MPBI).²⁸ Sequencing of the examination was specifically chosen as RMNPI, followed by MGI and MPBI, to avoid the possibility of plaque removal during the recording of the other two indices.^{14,29} A plaque disclosing agent was used to identify the location and quantity of plaque. Gingival trauma (GT) was assessed as the presence or absence of signs of trauma in the marginal and papillary gingiva of adjacent teeth according to methodology proposed by Carter-Hanson et al.¹⁴ Facial and lingual surfaces were visually examined for gingival trauma. Presence of lacerations, floss cuts, or demarcation line/indentation at the site was scored as one, while a score of zero was recorded in the absence of any signs of trauma. The score per subject was obtained by totaling all scores and dividing by the number of sites examined.¹⁴ Indices were recorded by the second and fourth investigators. Intra- and inter-examiner reliability was calculated prior to the commencement of the study, as well as at two weekly intervals over the duration of the study by utilizing nine additional subjects who were not part of the sample. The study schedule was organized so that no more than six subjects reported for examination on any given day of the week. The two investigators involved in the recording of data were blinded as to which technique the subject was using as well as the amount of unused floss, if any, at the end of the respective treatment phase.

Subject cCompliance

Each subject received a compliance diary at the baseline appointment of each treatment phase and the diaries were collected at the end of each phase by the first investigator. Participants recorded each flossing experience along with any other events he/she felt significant. Compliance was further established by dispensing a specific amount (90 pieces) of the assigned floss product per treatment phase. Subjects returned any unused portion of floss product to the first investigator at the end of each phase; thus, non-compliance was estimated. Additionally, a patient satisfaction questionnaire consisting of specific choice type questions, substantiated compliance. Questions did not require participants to compare specific techniques by name, rather by phase 1 versus phase 2, and were completed by all participants at the completion of study. The first investigator later decoded the sequence of choices as per the random allocation performed at start of study.

Validity and Reliability

Prior to beginning the study, a panel of three experts consisting of senior staff members (two in the field of oral health and one in clinical psychology) evaluated the questionnaire used in the initial pilot study and deemed it to be valid. Intra and inter- rater reliability was established through the collection of data from subjects who were not part of the sample during pilot testing. Inter- and intra- rater reliability was measured at two-week intervals, using a minimum of nine randomly selected volunteers from the outpatient clinic. These volunteers fulfilled the selection criteria but did not participate in the treatment phases. Reliability was assessed for the RMNPI and MGI.

Statistical Analysis

Data were analyzed using SPSS software version 17.0 (SPSS; Chicago, IL, USA). Gender wise distributions were compared and the mean age was calculated. A 3-factor analysis of variance (ANOVA) was conducted to examine the effects of sequence of the treatment phase and the possibility of any 'carry-over' of the effects of the first treatment phase into the second, in spite of the 2-week 'washout' phase. Following statistical confirmation that treatment sequencing was not a significant factor, data was further analyzed as at baseline and post intervention. For each of the outcome variables, intra-group differences were analyzed using a paired t-test; inter-group differences

were analyzed using the student's t-test. Direct comparisons were performed on the questionnaire responses between the two groups. All results were examined for statistical significance ($p \leq 0.05$).

Results

Inter-examiner reproducibility for exact agreement ($K = 0.76 \pm 0.07$, SE) was assessed for readings made between the second and fourth investigators, indicating an excellent level of agreement. An intra-examiner reproducibility for exact agreement ($K = 0.81 \pm 0.06$, SE) and (0.79 ± 0.08 , SE) for replicating the readings were recorded by the second and fourth investigators, respectively, also indicating an excellent level of agreement.

Data gathered from one subject was excluded due to non-compliance; the participant introduced a knot into the floss himself during phase-2 when the CF technique was to have been used. Another subject was withdrawn before the start of phase-2 as the plaque and gingival indices were below the sample selection requirements, even after the washout phase, and no longer met the inclusion/exclusion criteria. All clinical data is based on recordings from the twenty-eight subjects who successfully complied with, and completed both the treatment phases of study; no data was included from the two subjects that were withdrawn. Participant demographics are displayed in Table III. Each subject was scored in each of the two treatment phases at baseline, 2-weeks, 4-weeks and 6-weeks for RMNPI, MGI, and MPBI. Areas of GT were also assessed at 2- weeks, 4-weeks and 6-weeks in both treatment phases. Scores recorded from the subjects during use of the KF technique were grouped together and the means and standard deviation recorded. Similarly, scores recorded during use of the CF technique were grouped together, and means and the standard deviation were calculated.

Mean scores at baseline, 2 weeks, 4 weeks and 6 weeks for RMNPI,

Table III. Age / Gender Distribution of Subjects in Study (n=28)

	Phase 1		Phase 2		Total
	KF	CF	KF	CF	
Number	13	15	15	13	28
Males	4	5	5	4	9 (32%)
Females	9	10	10	9	19 (68%)
Age Range (years)	18 - 46		18 - 46		18 - 46
Mean Age (years)	31.3 (\pm 11.2)		31.3 (\pm 11.2)		31.3 (\pm 11.2)

CF = Conventional flossing KF = Knotted flossing

MGI, MPBI and GT are shown in Table IV. Baseline scores for the first three indices were similar. On comparison of RMNPI scores between the two groups, mean scores for the KF group were found to be significantly lower than those of the CF group at 2-weeks,

Table IV. Comparison of mean scores between treatment groups at various time intervals.

Index	Examination Period	CF*	KF**	p-value
Plaque Index (RMNPI ²⁶)	Baseline mean (SD)	2.57 (0.96)	2.61 (0.99)	0.813
	2 week mean (SD)	1.71 (0.66)	1.36 (0.69)	0.010
	4 week mean (SD)	1.21 (0.50)	0.96 (0.33)	0.017
	6 week mean (SD)	1.18 (0.60)	0.89 (0.40)	0.014
Gingival Index (MGI ²⁷)	Baseline mean (SD)	2.5 (0.69)	2.66 (0.65)	0.153
	2 Week mean (SD)	1.89 (0.52)	1.76 (0.42)	0.070
	4 week mean (SD)	1.79 (0.42)	1.73 (0.40)	0.326
	6 week mean (SD)	1.70 (0.48)	1.70 (0.48)	0.726
Bleeding Index (MPBI ²⁸)	Baseline mean (SD)	2.5 (0.79)	2.32 (0.72)	0.345
	2 Week mean (SD)	1.85 (0.65)	1.71 (0.46)	0.326
	4 week mean (SD)	1.75 (0.52)	1.68 (0.48)	0.573
	6 week mean (SD)	1.71 (0.48)	1.61 (0.52)	0.413
Gingival Trauma Index (GTI ¹⁴)	Baseline mean (SD)	-	-	-
	2 Week mean (SD)	0.71 (0.26)	0.11 (0.31)	0.663
	4 week mean (SD)	0.00 (0.00)	0.00 (0.00)	-
	6 week mean (SD)	0.00 (0.00)	0.00 (0.00)	-

*CF = Conventional flossing **KF = Knotted flossing SD = Standard Deviation

4-weeks and 6-weeks. Comparison of MGI and MPBI mean scores did not reveal any statistically significant difference between both the groups at all the time points.

When comparing within respective group the mean difference in RMNPI scores, the differences in scores between baseline and 2-weeks, 2-weeks and 4-weeks, as well as scores between baseline and 6-weeks, were statistically significant for both treatment groups ($p = 0.05$). There was no significant difference between the mean RMNPI at 4-weeks and 6-weeks for either group (Table V).

When comparing mean differences in MGI within each treatment group, it was noted that the differences within groups at baseline and 2-weeks, as well as baseline and 6-weeks, for both the CF and the KF treatment groups, were statistically significant ($p \leq 0.05$). The mean difference between MGI at 2-weeks and 4-weeks was also significant for the CF group but not for the KF group (Table V). No significant differences were found between MGI at 4-weeks and 6-weeks for either group.

Mean differences within groups between MPBI at baseline and 2-weeks and baseline and 6-weeks were statistically significant within both treatment groups ($p \leq 0.05$). No significant differences were identified between MPBI at 2-weeks and 4-weeks, and 4-weeks and 6-week intervals for either treatment group (Table V). Patient

compliance and satisfaction were estimated by way of the entries made in the compliance diaries, the amount of unused floss and the questionnaire completed at the end of final phase. Over 93% of the subjects reported flossing twice a day, 7 days a week. Participant responses and preferences identified in the questionnaire are seen in Table VI.

Over half of the subjects (54%) completing the study felt that the KF technique was easier to use than the CF technique, while 46% felt that CF was easier to use. An equal number said it took less time to use the CF technique. Three-fourths (75%) subjects were of the opinion that they were able to clean interproximal areas better when using the KF and 71% of the participants expressed a desire to continue using KF as their flossing method of choice in their future oral hygiene practices.

Discussion

Dental flossing is still one of the most effective means for the removal of interproximal plaque biofilm and cleansing of interdental areas post food-impaction.^{13,30-32} However, investigators have reported that people, in general, do not use dental floss routinely,^{9,14} creating a need for alternative methods and interdental cleaning aids, to improve acceptability and compliance. In such an endeavor, Gomes et al¹⁸ in 2016, proposed a KF technique which helped dislodge plaque biofilm and food debris from wider interdental areas, and therefore probably increased its acceptability. Results from the current 98 day, 2-phase, clinical study indicate a similar ability of the KF technique as compared to CF with respect to removing interdental plaque, decreased gingival inflammation and bleeding. There were no statistically significant signs of gingival trauma arising from

Table V. Mean differences of scores within each treatment groups between various time intervals for Type 1 embrasure group

Index	Examination Period	CF	p-value	KF	p-value
Plaque Index (RMNPI ²⁶)	Baseline – 2weeks	0.86 (0.58)	<0.001	1.25 (0.57)	<0.001
	2weeks – 4weeks	0.50 (0.57)	<0.001	0.39 (0.49)	<0.001
	4weeks – 6 weeks	0.04 (0.19)	0.309	0.07 (0.26)	0.146
	Baseline – 6weeks	1.39 (0.98)	<0.001	1.71 (0.88)	<0.001
Gingival Index (MGI ²⁷)	Baseline – 2weeks	0.61 (0.59)	<0.001	0.89 (0.71)	<0.001
	2weeks – 4weeks	0.11 (0.24)	0.026	0.04 (0.13)	0.146
	4weeks – 6 weeks	0.09 (0.27)	0.085	0.04 (0.19)	0.309
	Baseline – 6weeks	0.80 (0.62)	<0.001	0.96 (0.72)	<0.001
Bleeding Index (MPBI ²⁸)	Baseline – 2weeks	0.64 (0.67)	<0.001	0.61 (0.77)	<0.001
	2weeks – 4weeks	0.11 (0.31)	0.073	0.04 (0.19)	0.309
	4weeks – 6 weeks	0.04 (0.19)	0.309	0.07 (0.26)	0.146
	Baseline – 6weeks	0.79 (0.67)	<0.001	0.71 (0.75)	<0.001

*CF = Conventional flossing

**KF = Knotted flossing

Table VI. Patient satisfaction questionnaire (n=28)

Questions	CF* n (%)	KF** n (%)
Which floss did you find easier to use?	13 (46.4%)	15 (53.6%)
Which floss was faster to use?	15 (53.6%)	13 (46.4%)
With which floss did you have more pain and sensitivity?	16 (57.1%)	12 (42.9%)
Which floss did you feel cleans better between teeth?	7 (25.0%)	21 (75.0%)
If given a choice which floss would you continue to use?	8 (28.6%)	20 (71.4%)

*CF = conventional flossing

**KF = knotted flossing

either flossing technique. Additionally, the subjects at the end of the study stated a preference towards the KF technique and wished to continue to use it in the future.

In order to obtain an effective level of interdental plaque biofilm removal, the use of a dental floss or any other interdental device should be combined with a good brushing technique.^{25,33,34} The present trial evaluated the use of brushing combined with each of two techniques of flossing and not of dental floss technique exclusively.

Numerous studies in the literature compare the CF with mechanical flossing devices and other interdental aids.^{14,33,34} These studies have shown that flossing devices hold no

clinical advantage in the reduction of plaque and improved gingival index scores when compared to CF. A study by Carter- Hanson et al.,¹⁴ is most comparable to the present study with its two-phase, single blind, crossover clinical design, although it was only 74 days in comparison to 98 days of the present study. Carter- Hanson et al.,¹⁴ reported a significant decrease in plaque, gingival inflammation and bleeding scores over the period of their study with the use of CF and a floss holder. Patients preferred the floss devices in spite of the increased cost in comparison to use of CF.¹⁴ In the present study, the KF technique did not involve any increased expenditures by the patient, unlike the floss devices used in previous studies.^{14,33,35} Carter-Hanson et al.,¹⁴ had expressed the opinion that such preference for a floss product could increase a patient's compliance to incorporate flossing into their daily oral care routine.

Cronin et al.,³³ compared the safety and efficacy of a battery-operated interdental cleaning device fitted with either a fork-like floss holder or a pick attachment, versus CF in the reduction of plaque biofilm scores and gingival inflammation when combined with manual tooth brushing over a 30-day period. Participants were split equally into three parallel groups. All three groups showed similar scores at baseline but showed statistically significant reductions after 30 days in gingival inflammation and bleeding scores, while plaque scores reduced significantly in the floss holder device group and the CF group only. Plaque biofilm reduction was reported to be better for the floss holder device group as compared to the pick-attachment group. The present trial has similar results, with the statistically

significant reductions seen in scores of plaque biofilm, gingival inflammation and gingival bleeding over a 6-week period after using either the CF or KF technique. The KF group had significantly more reduction in plaque biofilm indices from baseline scores and at time points from 2 weeks, 4 weeks and 6 weeks in comparison with reductions seen in the CF group at identical time-points. Subjects selected for the study had moderate amount of plaque biofilm, gingival inflammation and gingival bleeding, as inferred by their baseline scores. Madan et al.,³⁶ concluded that most dental patients do not have an awareness about flossing and hence in this study, patients were chosen who were not regular flossers and didn't have any advanced periodontal disease. Hence, the sample was reflective of a standard population of relatively healthy individuals with gingivitis.

The presence of high compliance in this trial can be attributed to the subject's psychological effect of impending study or the Hawthorne effect.^{14,37,38} The fact that observance of gingival trauma was negligible may be because of the proper flossing instructions at the start of the study. However, although the subjects demonstrated the flossing technique on typodonts to the satisfaction of the instructors, the actual flossing by the subjects was done unsupervised and with no interference by the instructors. During the time of oral examinations, the subjects were oblivious to the scores and were not given any instructions as to how to modify their flossing habits. Hence, the inference that the KF technique can be used safely for interdental cleansing of Type-1 gingival embrasures, albeit only after proper flossing instructions have been given.

A meta-analysis by Berchier et al.,³⁹ explored the impact of adding flossing as an adjunct to brushing, and its effect on the indices of plaque biofilm and gingival health. They failed to find statistically significant improvement in these scores, but at the same time suggested that one has to have proper instructions to achieve a goal of high-quality flossing. In addition, there has been recent press coverage calling into question the recommendation for daily flossing.⁴⁰ However, even though the average benefit of CF and modified techniques like the KF technique is probably small, there are no documented harms nor increased costs to the patient. Since more than half of all Americans are said to be affected by periodontal disease,⁴¹ even a small benefit to their oral hygiene may prove beneficial.³²

In the present study, no preference was given to the selection criteria for choosing the test area (upper or lower jaws, left or right sides). Similarly, there was no criteria for inclusion of only left-handed (LH) or right-handed subjects

(RH). In a study of 40 subjects, Kadkhodazadeh et al.,⁴² reported that LH subjects have lower plaque biofilm scores in the right quadrants and RH subjects have lower plaque biofilm indices in the left quadrants. Cakur et al.,⁴³ studied forty-six adolescents and reported that RH subjects have lower oral hygiene scores and a lower incidence of caries, possibly because of their better manual dexterity and brushing efficiency. These confounding variables do not necessarily affect the present crossover study, as these variables were common during both trial phases.

Limitations

This trial was limited to the evaluation of the KF technique in type 1 embrasures in subjects who otherwise were not regular users of interdental oral hygiene aids and oral irrigators. The sample consisted of individuals of both sexes, different socioeconomic strata, and varied dietary habits. A crossover study on flossing by Torkzaban et al.,²⁵ found that there was a significant influence of gender on the plaque scores and bleeding points index. The present trial did not compare the scores between different genders. Similarly, this evaluation of the KF technique was not performed in cohorts comprised of different types of embrasures, a variety of socioeconomic groups, and groups with different kinds of eating habits. Hence, there is a need for a larger sample size such that all confounding variables are identified, their influences evaluated and compared. Volunteers who enrolled into the study were given instructions in flossing technique and were thus extra-motivated in diligently performing the procedure as required. It is uncertain whether favorable results in the efficacy of both flossing techniques were achieved by cognitive behavioral intervention, or by the Hawthorne effect.³⁷ This limitation may be diminished in a long-term study. Moreover, it cannot be guaranteed that a recommendation of twice a day flossing as performed in this study, will not have a negative compliance in the lay public. Hujoel et al.,⁴⁴ have cautioned against the extrapolation of results obtained from professionally supervised flossing, to typical floss users since unsupervised self-flossers didn't show any significant reduction in incidence of interdental caries. Conversely, the fact that the subjects were not directly supervised during the flossing procedure per se, meant that the verification of their compliance depended only on their honesty.⁴⁵ It is possible that the presence of a knot in an otherwise smooth dental floss has the increased potential to cause gingival trauma. For ethical reasons, this study excluded subjects with severe inflammatory gingival disease needing urgent professional care. Since severely inflamed gingival tissues are more prone to injury, it is probable such subjects would have had more cases of gingival trauma.

Conclusion

Results from this two-phase, single blinded clinical trial demonstrate that KF is a safe and effective inter-dental oral hygiene cleansing technique for reducing plaque biofilm accumulation, gingival inflammation and bleeding, as compared to CF techniques in Type I gingival embrasures, when used in conjunction with regular tooth-brushing over an 6-week period. The KF technique is an effective alternative to CF provided proper instructions are given regarding its use and the procedure is performed in conjunction with tooth-brushing. Patient preference for the KF technique indicate that it can be a viable alternative to CF in assisting patients in establishing regular and cost-effective interdental cleaning habits in Type I gingival embrasures.

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