

Experience and attitudes regarding requirements for magnification and coaxial illumination among dental hygiene students

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Abstract

Purpose: Dental professionals are at elevated risks for the development of musculoskeletal disorders due to the occupational demands of static postures and precision movements required for instrumentation. The purpose of this study was to evaluate the experiences and attitudes regarding the requirements of purchasing and utilizing magnification loupes and coaxial illumination for patient care among dental hygiene students with the state of Ohio.

Methods: A cross-sectional, web-based, anonymous survey was sent via the dental hygiene program directors to dental hygiene students in the state of Ohio. Descriptive statistics were used to describe the dental hygiene students' experience with magnification loupes and coaxial illumination.

Results: A total of 123 students ($n=123$) participated in the study representing a response rate of 36.2%. Most respondents used magnification loupes (89.4%, $n=110$) and coaxial illumination (84.5%, $n=105$) while delivering patient care. Respondents who were required to purchase magnification loupes were more likely to feel that dental hygiene students ($X^2(1)=37.735$, $p<.001$) and dental hygiene faculty ($X^2(1)=38.256$, $p<.001$) should be required to purchase magnification loupes. Respondents who were not required to purchase their magnification loupes felt that loupes increased the accuracy of assessments and procedures ($U=1376.00$, $p<.01$) and increased the efficiency of providing care ($U=1327.00$, $p<.001$). Students who were required to purchase coaxial illumination were more likely to feel that dental hygiene students ($X^2(1)=10.809$, $p<.001$) and dental hygiene faculty ($X^2(1)=6.796$, $p<.01$) should be required to purchase illumination.

Conclusion: When considering student purchasing requirements for magnification loupes and coaxial illumination, the attitudes of dental hygiene students towards their utilization and benefits should be considered.

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

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Introduction

Dental professionals are at elevated risks for the development of musculoskeletal disorders due to the occupational demands of static postures and precision movements required for instrumentation.¹⁻⁷ Surveys conducted among dental professionals have shown that a majority of clinicians, (74%) reported musculoskeletal pain,³ particularly in the shoulders, neck, upper back, lower back, and wrists.^{8,9} In populations of dental hygiene professionals, the main cause of the pain was identified as the forward flexion of the neck and anterior carriage of the head.⁹⁻¹¹ However, musculoskeletal pain has also been identified during entry-level clinical training by dental hygiene

students^{5,12} and may serve a precursor to the development of musculoskeletal disorders as practicing clinicians.¹¹⁻¹³

Ergonomics is defined as the science of designing equipment and maximizing working spaces to increase productivity and minimize operator fatigue and pain.^{14,15} Magnification loupes have been shown to provide both positive and negative ergonomic aspects for clinicians.^{1,5,10,11,16} More acceptable postures can result with the proper use of magnification loupes; however formative feedback from faculty also plays a role in helping students achieve those acceptable postures.^{1,17,18} Although students may report self-perceived improvement in

postures using indirect vision with magnification, accuracy and efficiency do not necessarily change with the use of magnification.¹⁹ To supplement the beneficial effects of magnification, the use of coaxial illumination, or light sources aligned with the sight line, may be associated with improved postures and clinical benefits.²⁰⁻²³ Designed to supplement the overhead dental operatory light, headlights using light-emitting diode (LED) technology provide shadow-free illumination using corded or cordless batteries. Coaxial illumination provides shadow-free lighting to the working area in alignment with the magnification loupes to the working area. Used in conjunction with magnification loupes, coaxial illumination provides operators with ergonomic benefits by eliminating the need for overhead light adjustment.^{20,22} The combination of LED light and low-powered magnification (2.5 power) has also been shown to enhance caries detection in primary dentition.²⁴ Although ocular hazards may exist with the use of LED lights, most headlight manufacturers use LED beams within the safe zone spectrum and settings are recommended at minimum levels to reduce glare and maintain optimal visual acuity.²⁵

Experiences and opinions regarding the use of magnification loupes vary among dental professional students and practicing clinicians. However, trends towards requiring the use of magnification loupes in dental hygiene education programs are increasing. A national survey conducted in 2012 indicated that one-fourth of dental hygiene programs required students to purchase magnification loupes and less than ten percent of dental hygiene programs mandated that their clinical faculty purchase magnification loupes.²⁶ Within five years a little less than one-half (44%) of dental hygiene programs required students to purchase magnification loupes. However, only 9% of the programs mandated students to purchase coaxial illumination.²³ In spite of the increasing trend of requiring students to purchase magnification loupes, no studies have been reported in the literature regarding the attitudes of dental hygiene students towards the use of magnification loupes and coaxial illumination. The purpose of this study was to evaluate the experiences and attitudes regarding the requirements of purchasing and utilizing magnification loupes and coaxial illumination for patient care among dental hygiene students with the state of Ohio.

Methods

This study involved a cross-sectional, web-based, anonymous survey of dental hygiene students in the state of Ohio and was determined to be exempt from Institutional Board Review from The Ohio State University (2015EO344).

E-mails were sent to the twelve dental hygiene program directors in the state of Ohio to invite all dental hygiene students enrolled in their entry-level programs to participate in the study. Informed consent was implied through completion of the survey.

The 25 item survey was originally created with questions patterned after two existing surveys.^{27,28} Questions included demographic information; respondents' experience with magnification loupes and coaxial illumination; and attitudes about program purchasing and utilization requirements for magnification loupes and coaxial illumination. The majority of the items required yes/no responses and Likert-style responses ranging from 1- strongly disagree to 5- strongly agree. Two open ended questions required responses from participants who did not use magnification loupes and/or coaxial illumination.

A panel of 4 dental hygiene faculty experts reviewed the questions for content validity. The survey was pilot tested on 30 dental hygiene students for validity and reliability. Following revisions, the survey was finalized by the panel of dental hygiene experts.

Qualtrics web-based survey software (Provo, UT, USA) was used to construct and administer the survey. The invitation e-mail was sent to the 12 dental hygiene program directors in Ohio to inform them of the study followed by an additional e-mail was sent for the program directors to directly to the dental hygiene students enrolled in their programs. After 2-weeks, a reminder e-mail and separate forwarding e-mail was sent to the program directors. The survey was closed after a total time of 28 days.

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

Results

Eight of the twelve dental hygiene program directors in Ohio agreed to invite their enrolled dental hygiene students to participate in the survey. While the program directors were not asked how many students were e-mailed the survey, it was estimated that approximately 42 students were enrolled in each of the eight programs totaling 340 students (n=340). A total of 123 students (n=123) participated in the study

representing a response rate of 36.2%. Nearly three-quarters of the respondents (72%) were enrolled in an associate degree program, while the remaining 28% were enrolled in a baccalaureate degree program. A little more than one-half (55%) were in their 1st year and 45% were in their 2nd year of study. Respondent demographics are shown in Table I.

Table I. Demographic characteristics of the respondents (n=123)

College structure	Associate degree program 72.4% (n=89)		Baccalaureate degree program 27.6% (n=34)	
Year in program	1 st year 55.3% (n=68)		2 nd year 44.7% (n=55)	
Gender	Female 96.7% (n=119)	Male 1.6% (n=2)		Declined to state 1.6% (n=2)
Age group	20-29 years 75.6% (n=91)	30-39 years 17.1% (n=23)	40-49 years 4.9% (n=6)	Other 2.4% (n=3)

The first aim of the study was to determine the experiences of dental hygiene students using magnification loupes and coaxial illumination for patient care (Table II & III). A majority of respondents used magnification loupes when providing patient care (89.4%, n=110). Of the minority who were not using magnification loupes (10.6%, n=13) the following reasons were cited: cost, possible dependence on loupes, and possible effects on vision.

For the respondents using loupes, the following beliefs/ attitudes were identified as consequences to not using magnification loupes: compromised ergonomics (52.0%, n=64), compromised patient care (32.5%, n=40), inability to provide patient care (3.3%, n=4). A little more than half of the participants (56.1%, n=69) were required to purchase their magnification loupes, felt that dental hygiene instructors should be required to purchase loupes (53.7%, n=66), and believed that magnification loupes should be purchased by the time of their preclinical instruction course (52.8%, n=68).

Most respondents used coaxial illumination while delivering patient care (84.5%, n=105). Of those not using coaxial illumination (13.8%, n=17), cost, inconvenience with the cord, and lack of perceived need were given as reasons for not using illumination. Respondents using coaxial illumination identified that barriers to coaxial illumination use would lead to feeling uncomfortable while providing patient care (33.1%, n=53), compromised ergonomics (19.5%, n=24), inability to provide patient care (2.4%, n=3). Nearly one-fifth (19.5%, n=24) of the participants felt that a barrier to using coaxial illumination would not result in any differences in the provision of patient care. A majority of the participants (82.9%, n=102) were not required to purchase coaxial illumination, did not feel that students should be required to purchase coaxial illumination (49.6%, n=61), and did not feel that dental hygiene instructors should be required to purchase coaxial illumination (66.7%, n=82). Respondents' magnification loupe and coaxial illumination experiences and attitudes are shown in Tables II and III.

The second aim of the study was to explore the attitudes of dental hygiene students towards the use of magnification based on the dental hygiene program requirement to purchase magnification loupes (Table IV). Chi-square tests of independence were calculated comparing the student requirement for magnification loupes and wearing loupes while providing patient care, attitudes about whether magnification loupes should be required for dental hygiene students, and attitudes about whether magnification loupes should be required

for dental hygiene instructors. Significant interactions were identified. Dental hygiene students who were required to purchase magnification loupes were more likely to wear loupes when providing patient care ($\chi^2(1)=18.574, p<.001$); more likely to feel that dental hygiene students should be required to purchase magnification loupes ($\chi^2(1)=37.735, p<.001$); and more likely to feel that dental hygiene instructors should also be required to purchase magnification loupes ($\chi^2(1)=38.256, p<.001$).

Mann-Whitney *U*-tests were used to examine the relationships between the student requirements to purchase magnification loupes and student attitudes of whether magnification loupes increase the use of proper ergonomics, increase the accuracy of assessments and procedures, and increase the efficiency of providing care (Table V). No significant differences were found in regards to whether student attitudes towards magnification loupes increased the use of proper ergonomics among students who were required or not required to purchase magnification loupes ($U=1780.00, p>.05$). Dental hygiene students who were not required to purchase magnification loupes but used them in the clinic felt that magnification loupes increased the accuracy of assessments and procedures (M place=71.02; $U=1376.00, p<.01$) and increased the efficiency of providing care (M place=71.93; $U=13277.00, p<.01$).

The third aim of the study was to evaluate the attitudes of dental hygiene students regard-

Table II. Respondents experiences and attitudes towards magnification loupes (n=123)

Questions for Magnification Loupes					
Do you currently use magnification loupes while providing patient care?	Yes 89.4% (n=110)			No 10.6% (n=13)	
If magnification loupes is not used, why not?	Too expensive (n=7)	Concerns about dependence on magnification (n=2)	Concerns about effects on vision (n=1)	Plan to purchase (n=2)	
If yes, which best describes how you would feel if you were unable to use magnification during patient care?	I would feel comfortable providing patient care 4.1% (n=5)	I would feel I was compromising my ergonomics 52.0% (n=64)	I would feel unsure about providing adequate patient care 32.5% (n=40)	I would feel unable to provide care 3.3% (n=4)	No answer 8.1% (n=10)
Does your school require the students to purchase magnification loupes for patient care?	Yes 56.1% (n=69)			No 43.9% (n=54)	
Do you feel that dental and dental hygiene students should be required to use magnification while providing patient care?	Yes 65.0% (n=80)			No 35.0% (n=43)	
If yes, how soon should magnification loupes be purchased and worn?	During pre-clinical instruction 52.8% (n=68)	At the start of patient care experiences 7.3% (n=9)	At the end of first year of patient care experiences 4.9% (n=6)	No answer 35.0% (n=43)	
Do you feel that dental and dental hygiene clinical faculty members should be required to use magnification while providing patient care?	Yes 53.7% (n=66)			No 43.6% (n=57)	
Using magnification loupes increases the use of proper ergonomics by the practitioner.	Strongly agree 63.4% (n=78)	Agree 34.1% (n=42)	Neutral 1.6% (n=2)	Disagree 0.0% (n=0)	No answer 0.8% (n=1)
Using magnification loupes enhances the accuracy of assessments and procedures.	Strongly agree 67.5% (n=83)	Agree 26.8% (n=33)	Neutral 4.9% (n=6)	Disagree 0.8% (n=1)	No answer 0.0% (n=0)
Using magnification loupes improves the efficiency of providing patient care.	Strongly agree 61.0% (n=75)	Agree 30.1% (n=37)	Neutral 7.3% (n=9)	Disagree 1.6% (n=2)	No answer 0.0% (n=0)

ing illumination based on the requirement to purchase coaxial illumination (Table VI). Chi-square tests of independence were calculated comparing the student requirement for coaxial illumination and wearing coaxial illumination while providing patient care, attitudes about whether coaxial illumination should be required for dental hygiene students, and attitudes about whether coaxial illumination should be required for dental hygiene instructors. No significant interaction was found between dental hygiene students who were required to purchase coaxial illumination and dental hygiene students using coaxial illumination when providing patient care ($\chi^2(1)=1.272, p>.05$). Dental hygiene students who were required to purchase coaxial illumination themselves were more likely to feel that dental hygiene students should be required to purchase coaxial

illumination ($\chi^2(1)=10.809, p<.001$) and were more likely to feel that dental hygiene instructors should also be required to purchase coaxial illumination ($\chi^2(1)=6.796, p<.01$).

Mann-Whitney *U*-tests were used to examine the relationships between the student requirements to purchase coaxial illumination and attitudes of whether coaxial illumination increased the use of proper ergonomics, increased accuracy of assessments and procedures, and increased the efficiency of providing care (Table VII). No significant differences were found in the attitudes of whether coaxial illumination increased the use of proper ergonomics ($U=952.50, p>.05$), increased accuracy of assessments and procedures ($U=898.50, p>.05$), and increased the efficiency of providing care ($U=950.50, p>.05$) among dental hygiene

Table III. Respondents experiences and attitudes towards coaxial illumination (n-123)

Questions for coaxial illumination					
Do you use a headlight (coaxial illumination) while providing patient care?	Yes 84.5% (n=105)	No 13.8% (n=17)			No answer 0.8% (n=1)
If a headlight (coaxial illumination) is not used, why not?	Too expensive (n=10)	Not needed for patient care (n=1)	Inconvenience of light/wire (n=2)		Other (n=5)
If yes, which best describes how you would feel if you were unable to use a headlight during patient care?	I would feel comfortable providing patient care 19.5% (n=24)	I would feel I was compromising my ergonomics 19.5% (n=24)	I would feel unsure about providing adequate patient care 43.1% (n=53)	I would feel unable to provide patient care 2.4% (n=3)	No answer 15.4% (n=19)
Does your school require the students to purchase a headlight for patient care?	Yes 15.4% (n=19)	No 82.9% (n=102)			No answer 1.6% (n=2)
Do you feel that dental and dental hygiene students should be required to wear a headlight while providing patient care?	Yes 48.8% (n=60)	No 49.6% (n=61)			No answer 1.6% (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 31.7% (n=39)	No 66.7% (n=82)			No answer 1.6% (n=2)
The use of a headlight during patient care increases the use of proper ergonomics by the practitioner.	Strongly agree 43.9% (n=54)	Agree 35.8% (n=44)	Neutral 17.1% (n=21)	Disagree 1.6% (n=2)	No answer 1.6% (n=2)
The use of a headlight during patient care enhances the accuracy of assessments and procedures.	Strongly agree 56.9% (n=70)	Agree 33.3% (n=41)	Neutral 8.1% (n=10)	Disagree 0.0% (n=0)	No answer 1.6% (n=2)
The use of a headlight during patient care improves the efficiency of providing patient care.	Strongly agree 52.0% (n=64)	Agree 37.4% (n=46)	Neutral 8.1% (n=10)	Disagree 0.8% (n=1)	No answer 1.6% (n=2)

students who were required or not required to purchase coaxial illumination.

Discussion

The origins of musculoskeletal disorders may occur during dental hygiene clinical education^{12,13} and efforts are being instituted to reduce the risks for future oral health care professionals. The growing trend in dental hygiene programs is to mandate all students to purchase magnification loupes with the intent to improve overall ergonomics and reduce risks for musculoskeletal disorders.^{23,26} However, limited evidence exists with respect to the experiences and attitudes of dental hygiene students regarding the requirement for purchasing and using magnification loupes and coaxial illumination. Results from this study may provide support to the trending

changes in educational policies requiring the purchase and use of magnification and/or coaxial illumination by dental hygiene students.

The purpose of this study was to evaluate the experiences and attitudes regarding the requirement of magnification loupes and coaxial illumination among dental hygiene students in Ohio. In regards to magnification loupes, 89.4% of respondents used loupes even though only 56.1% were required to purchase loupes. Regarding coaxial illumination, 84.5% of respondents used coaxial illumination even though only 15.4% were required to purchase coaxial illumination. Students who were required to purchase magnification loupes felt that dental hygiene students and dental hygiene faculty should all be required to purchase loupes. Students who were not required to purchase loupes felt more strongly about the

Table IV. Relationships between magnification loupe requirements, experience, and attitudes

Magnification loupe experience and attitudes	Magnification loupe requirements			
	Does your school require students to purchase magnification loupes for patient care?		X ²	p-value
	Yes	No		
Do you currently use magnification loupes while providing patient care?	62.7%	22.2%	18.574	<.001
Do you feel that dental and dental hygiene students should be required to use magnification while providing patient care?	88.4%	64.8%	37.735	<.001
Do you feel that dental and dental hygiene clinical faculty members should be required to use magnification while providing patient care?	78.3%	77.8%	38.256	<.001

Table V. Relationship between magnification loupe beliefs and requirements

Question	All respondents			Are you required to wear magnification loupes when providing patient care?		p-value
	n	Median	IQR	Yes	No	
Loupes increase the use of proper ergonomics	122	1.0	1.0-2.0	60.68 n=68	62.54 n=54	>.05
Loupes increase the accuracy of assessments and procedures	123	1.0	1.0-2.0	54.94 n=69	71.02 n=54	<.01
Loupes increase the efficiency of providing care	123	1.0	1.0-2.0	54.23 n=69	71.93 n=54	<.01

Table VI. Relationship between coaxial illumination requirements, experience, and attitudes

Coaxial illumination experience and attitudes	Coaxial illumination requirements			
	Does your school require students to purchase coaxial illumination for patient care?		X ²	p-value
	Yes	No		
Do you currently use coaxial illumination while providing patient care to your own patients?	17.3%	14.9%	1.272	p>.05
Do you feel that dental and dental hygiene students should be required to use coaxial illumination while providing patient care?	26.7%	56.9%	10.809	<.001
Do you feel that dental and dental hygiene clinical faculty members should be required to use coaxial illumination while providing patient care?	28.2%	72.5%	6.796	<.01

Table VII. Relationship between coaxial illumination requirements and beliefs

Question	All respondents			Does your school require students to purchase coaxial illumination for patient care?		p-value
	n	Median	IQR	Yes	No	
Coaxial illumination increases the use of proper ergonomics	121	1.0	1.0-2.0	61.87 n=19	60.84 n=102	>.05
Coaxial illumination increases the accuracy of assessment and procedure	121	1.0	1.0-2.0	57.29 n=19	61.69 n=102	>.05
Coaxial illumination increases the efficiency of providing care	121	1.0	1.0-2.0	60.03 n=19	61.18 n=102	>.05

benefits of using loupes regarding accuracy of assessments and procedures and the efficiency of providing care. Students required to purchase coaxial illumination felt that all dental hygiene students and dental hygiene faculty should be required to purchase coaxial illumination. However, the requirement for coaxial illumination had no effect on the perceived benefits of using coaxial illumination.

Although dental hygiene student respondents agreed with perceived benefits of both magnification loupes and coaxial illumination, they perceived more benefits from using loupes versus coaxial illumination. The main perceived benefits among dental hygiene students for the use of magnification loupes and coaxial illumination when providing care are increased use of proper ergonomics, increased accuracy of assessments and procedures, and increased efficiency of providing care. These findings are consistent with the attitudes of dental hygiene program directors and practicing clinicians regarding the benefits of using magnification loupes.^{23,26,27} In this study, if the respondents were unable to use their magnification loupes, the top two detrimental effects cited were compromised ergonomics and compromised patient care. In regards to coaxial illumination, the top two detrimental effects included discomfort when providing patient care and compromised ergonomics. However, a greater number of respondents seemed to feel that there would be no difference in the provision of patient care with with the lack of coaxial illumination than with the lack of magnification.

Differing views exist about the requirement to purchase magnification loupes and coaxial illumination by students who were required to purchase them versus those who were not required. Students who were required to purchase loupes were more in favor of an overall requirement for hygiene students and faculty to purchase magnification loupes. These respondents may view magnification loupes as the standard of care in the

delivery of dental hygiene services. However, the students who were not required to purchase their magnification loupes felt more strongly about the benefits of magnification loupes regarding the accuracy of assessments and increased efficiency. This finding seems to imply that students who choose to purchase loupes may value the investment more than those who were required to purchase them with their clinic kit. Students who were required to purchase coaxial illumination also felt that all dental hygiene students and faculty should be required to purchase coaxial illumination. This may be due to the perceived standard of care achieved with the use of coaxial illumination. Future studies should further explore the attitudes and beliefs resulting from the purchasing and utilization requirements of magnification loupes and coaxial illumination.

Limited evidence exists regarding the student and faculty requirement of magnification loupes and coaxial illumination. Previous research has shown that dental educators using magnification loupes were not entirely convinced about student and clinical faculty requirements regarding magnification loupes.^{23,28} Practicing dental hygienists who have always used magnification loupes have been shown to support the required use of loupes.²⁷ However, occasional and nonusers of magnification loupes stated they may have benefited from the use of loupes during their educational programs and favored magnification loupes as an option, not a student requirement.²⁷ If clinical faculty members do not conform to the same requirements for magnification loupes and coaxial illumination, enforcing student requirements may become problematic. Since cost has been identified as a challenge, financial support from dental hygiene programs may help increase the use of magnification and coaxial illumination among dental hygiene faculty.

There were limitations to this study. With survey research, no causal relationships can be established with this type of

design. The survey relied on the respondents' self-reported data, and their interpretation of the questions. Because the distribution of the survey relied on program directors to forward the survey to their dental hygiene students, the exact representativeness of the sample could not be calculated and the generalizability of the results could not be determined. Future studies should include a national survey of dental hygiene programs and students to determine whether the student requirement of magnification loupes and/or coaxial illumination is a predictor of musculoskeletal disorders.

Conclusion

Student users of magnification loupes believed in the perceived ergonomic benefits of using loupes, however, students who were not required to purchase loupes felt more strongly about the overall benefits of using loupes. Purchasing requirements for coaxial illumination had no effect on the perceived benefits of using coaxial illumination. Student attitudes should be considered when considering student purchasing requirements for magnification loupes and coaxial illumination.

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