Effects of Dental Magnification Lenses on Indirect Vision: A Pilot Study

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Introduction

Dental hygienists are required to perform very fine precise movements within the small parameters of the oral cavity. The use of direct vision throughout the entire oral cavity combined with a balanced posture is not always feasible. Published studies have found a relationship between the use of indirect vision and a balanced clinical posture.[1–4] The head position is considered balanced when it is tilted no more than 20 degrees forward.[5] Ninety percent of the time, a typical clinician's head is tilted forward to angles ranging from 17 degrees to 39 degrees and at angles greater than 40 degrees during 10% of the time.[4] These extreme positions are not reflective of a balanced, comfortable clinical posture. A clinician is at risk for musculoskeletal trauma when a posture remains outside the balanced parameters for long periods of time.

Clarity of vision plays an important role in the ease at which a clinician can maintain a balanced posture. Posture, clarity of vision and musculoskeletal discomfort are all related in a viscous cycle. The discomfort of musculoskeletal disorders may impact the efficiency and accuracy of the clinician. Likewise, diminished clarity of vision can impact musculoskeletal discomfort. Research demonstrates a correlation between visual acuity and maintaining a balanced posture.[1–4] A survey of 868 practicing dental hygienists revealed 91.5% of the dental hygienists agree an advantage of using magnification lenses is better posture.[3] Magnification lenses, which produce a clear, larger image, combined with indirect vision, allows the clinician to maintain this balanced clinical posture.

Abstract

Purpose: The purpose of this pilot study was to evaluate the effect of magnification lenses on the indirect vision skills of dental hygiene students.

Methods: This pilot study examined the accuracy and efficiency of dental hygiene students' indirect vision skills while using traditional safety lenses and magnification lenses. The sample was comprised of 14 students in their final semester of a dental hygiene program. A crossover study approach was utilized, with each participant randomly assigned to a specific order of eyewear. The study included evaluation of each participant taking part in 2 separate clinical sessions. During the first session, each participant completed a clinical exercise on a dental manikin marked with 15 dots throughout the oral cavity while wearing the randomly assigned eyewear, and then completed a similar exercise on a differently marked dental manikin while wearing the randomly assigned eyewear. This procedure was repeated at a second clinical session, however, the dental manikin and eyewear pairings were reversed. Accuracy was measured on the number of correctly identified dots and efficiency was measured by the time it took to identify the dots. Perceptions of the participants' use of magnification lenses and the participants' opinion of the use of magnification lenses in a dental hygiene curriculum were evaluated using a questionnaire.

Results: Comparing the mean of the efficiency scores, students are more efficient at identifying indirect vision points with the use of magnification lenses (3 minutes, 36 seconds) than with traditional safety lenses (3 minutes, 56 seconds). Comparing the measurement of accuracy, students are more accurate at identifying indirect vision points with traditional safety lenses (84%) as compared to magnification lenses (79%). Overall, the students reported an increased quality of dental hygiene treatment provided in the clinical setting and an improved clinical posture while treating patients with the use of magnification lenses.

Conclusion: This study did not produce statistically significant data to support the use of magnification lenses to enhance indirect vision skills among dental hygiene students, however, students perceived that their indirect vision skills were enhanced by the use of magnification lenses.

Keywords: Magnification lenses, indirect vision, dental hygiene students, clinician posture

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Properly utilizing indirect vision and maintaining a balanced clinical posture while viewing the oral cavity minimizes a clinician's musculoskeletal discomfort. Dental professionals who regularly utilize their dental mouth mirror to view areas of the mouth indirectly have shown to have fewer headaches and reduced neck/shoulder discomfort.[6] Although most studies of training and utilizing indirect vision with the use of a dental mouth mirror were conducted in the 1980s, the skills and techniques remain common practice.[6,7] Boyd et al observed that, "When students are taught psychomotor skills in the mandibular arch and transfer to the maxillary arch, there is a continued desire to depend upon direct vision, which results in early acquisition of poor postural habits."[8] Results from a student questionnaire following the study indicate the students who began with direct vision skill exercises on the mandibular arch perceived they were not progressing as fast, now working on the maxillary arch due to loss of visualization. In contrast, the students who began with indirect vision skill exercises on the maxillary arch felt they were progressing faster, visualizing better, maintaining correct posture and producing better dentistry.[8] This study found no statistical significance between the performance of students who began with indirect vision skill exercises compared to direct vision skill exercises. Skills learned from indirect vision build confidence in the clinicians as well as promote a balanced clinical posture.

Dental hygienists are required to perform the meticulous tasks of scaling and root planing, assessing the periodontal health with the aid of a millimeter marked periodontal probe and a screening of the oral cavity for oral cancer. Magnification lenses allow the clinician to see greater detail than that of traditional safety lenses. Literature suggests the use of magnification lenses will improve the precision in instrumentation and facilitate optimal visualization of the oral cavity, however, minimal clinical studies have been conducted in dental hygiene.[6,9] To better understand the effect magnification has on human movement and control in operating a tool via indirect vision, medical researchers performed clinical experiments with 10 study participants. Each participant manipulated a computer mouse to direct a pointer from Target A to Target B, viewed indirectly on a magnified display. It was found that greater magnification resulted in more precision in movement.[9] Bohan et al summarizes, "The role of magnification can thus be understood as amplifying the particular skill level afforded by the effecting limb."[9]

While several authors suggest magnification lenses improve posture, the empirical evidence is very limited. Two comparable dental hygiene clinical studies were conducted assessing dental hygiene student posture while performing 2 different clinical procedures – an intra–oral full mouth probing and hand scaling. Both of these procedures required detailed manipulation of dental instruments within the oral cavity and utilized the Branson's Posture Assessment Instrument (BPAI) to examine the students' posture.[1,2,10] Branson et al assessed the effect of magnification lenses on dental hygiene students' posture while performing an intra–oral procedure of full mouth probing with and without the use of magnification lenses.[11] Results showed the posture of the students was more balanced while wearing magnification lenses as compared to wearing traditional safety lenses.[1] It was also noted that all of the participants felt their posture improved while utilizing magnification lenses, and 90% felt magnification lenses would improve their effectiveness in private practice after graduation.[1]

Maillet et al reported significant improvement in posture while using magnification lenses in the task of hand scaling.[2] Results were more pronounced in students who used magnification lenses when entering the dental hygiene program as compared to the students who delayed starting the use of magnification lenses. This study sought to incorporate magnification lenses into the dental hygiene curriculum as early as possible.

Branson et al conducted a clinical case study documenting the experience of a dental hygiene student during a 4 week adjustment period to magnification lenses.[4] The BPAI was also utilized in this study for postural measurements.[4,10] Overall, the case study indicated the use of magnification lenses created postural improvement according to the BPAI and the dental hygiene student perceived postural improvements in 12 out of 15 reflective journal entries. In many of the journal entries, clarity of the oral cavity and better overall perception of quality of work were documented. This case study supports the idea that the use of magnification lenses can create a more balanced posture and provide greater clarity of the oral cavity. The above studies all involved dental hygiene students and all resulted in a perceived or documented measurement of improved posture.

Clinical studies have been conducted exploring the relationship of magnification lenses to posture while performing clinical procedures.[1–3] The reported study operates on the premise that increased skill with indirect vision will results in an improved clinical posture. The purpose of this pilot study was to evaluate the effect of magnification lenses on the indirect vision skills of dental hygiene students. This impact will be measured against 4 parameters: the accuracy of the student clinicians, the efficiency of the student clinicians, the perceptions of the student clinicians and the recommendations of the student clinicians.

Methods and Materials

Participants

A convenience sample of 14 dental hygiene students from the 2011 dental hygiene program at Rochester Community and Technical College were invited to participate in the study. These participants had 3 prior semesters of dental hygiene education and were in the final semester of the curriculum. Participation was optional and written informed consent was obtained from each participant.

Data Collection

Prior to data collection, the study was approved by the University of Missouri–Kansas City Social Sciences Institutional Review Board. All dental hygiene student participants were fitted by a representative from Designs for Vision (Ronkonkoma, NY) for through–the–lens magnification lenses. None of the participants had prior experience with magnification lenses and were allowed a 1 month adjustment period prior to beginning the study. The company was chosen out of convenience in that the representative was available to measure and fit all students in the time frame necessary to complete the study and was willing to allow the students to utilize the magnification lenses at no cost throughout the duration of the study. At the completion of the study, the students had to either return the magnification lenses or had the option to purchase them at a discounted price.

Each participant was evaluated by 2 investigators while completing indirect vision exercises during 2 separate clinical sessions. The clinical sessions were conducted with the clinician wearing the same personal protective barriers that would be used during patient treatment. These included: gloves, mask, gown and either magnification lenses or traditional safety lenses. The clinical exercises were conducted with the manikin fitted into a dental chair, serving as a reasonable representation of human positioning (Figure 1). The manikin was marked with 15 red dots made with permanent marker and randomly placed throughout the oral cavity (Figure 2). The majority of the dots (10) were on tooth structures. However, 4 dots were placed on gingival tissue. Red dots were differently positioned on Manikin A as compared to Manikin B.

The study utilized a crossover design in which each participant served as their own control. All participants utilized both magnification lenses and traditional safety lenses on both Manikin A and Manikin B. The order of utilizing magnification lenses versus traditional safety lenses was determined by the flip of a coin. Therefore, some participants utilized magnification lenses first on Manikin A during the first clinical session, followed by traditional safety lenses 1 month later on Manikin A. Others utilized traditional safety lenses first on Manikin A during the first clinical session, followed by magnification lenses 1 month later on Manikin A. The same method of randomization was utilized to determine the eyewear pairings for Manikin B.

Figure 1: Photo of dental manikin used for clinical exercises

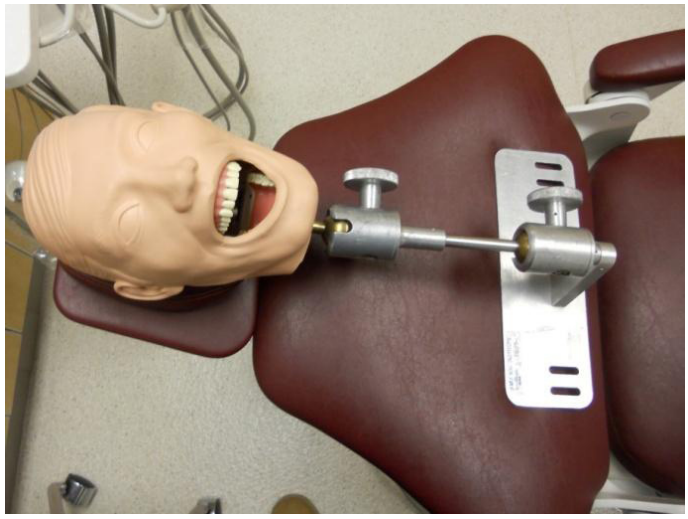


Figure 2: Photo showing a representation of the red dots placed indirectly throughout the oral cavity

Prior to each clinical exercise, verbal directions were given to each participant by the same examiner. The participants were given a maximum of 5 minutes to complete each exercise. If the participant had located all 15 intra–oral dots prior to the 5 minute time frame, the participant was instructed to stop. If the participant felt they had located as many of the 15 intra–oral dots as possible, they stated they were done. Participants could only verbalize tooth numbers or intra–oral locations during the clinical exercises.

Performance was measured for accuracy as based on the number of correctly identified red dots within the oral cavity and efficiency was measured by the time it took to identify the intra–oral dots. Perceptions of the participants' regarding the use of magnification lenses and recommendations of the introduction of magnification lenses into the dental hygiene curriculum were measured using a questionnaire distributed by an online survey engine, www.zoomerang.com. The survey instrument was developed by the investigators, mimicking the perception based surveys administered by Branson et al[1] and Maillet et al.[2] It was pilot tested via paper to a group of dental hygiene students at the University of Missouri–Kansas City at a similar level of education as the study participants. Based on the feedback from the students, the survey was revised to capture the desired information. The revised survey was then converted into an internet survey form.

Table I: Summary of dental hygiene students' perceptions of dental magnification lenses (n=14)

Impact on Clinical Skills	
Increased quality of treatment provided	• Yes – 79% • No – 14% • Undecided – 7%
Enhanced indirect vision skills	• Yes – 72% • No – 21% • Undecided – 7%
Increased efficiency	• Yes – 42% • No – 29% • Undecided – 29%
Increased accuracy	• Yes – 42% • No – 29% • Undecided – 29%
Impact on Clinical Posture	
Improved posture	• Yes – 86% • No – 14%
Comfort and Adjustment	
Time for adjustment	• 1 day or less – 14% • 2–4 clinic days – 50% • 5 or more clinic days – 36%
Symptoms	• Vertigo – 14% • Headaches – 50% • None – 36%
Weight of the lenses	• Heavy – 0% • Moderate – 14% • Light – 86%
Recommendations	
Magnification lenses should be a requirement for dental hygiene students?	• Yes – 21% • No – 79%
When would you recommend novice clinicians begin using magnification lenses?	• 1st yr dental hygiene – 29% • 2nd yr dental hygiene – 71% • Start of private practice – 0% • After a few year of private practice – 0% • Not at all – 0%

Analysis

To determine if participants were more efficient at locating indirect vision points in the oral cavity with magnification lenses, a 2–tailed paired t–test with an alpha level of 0.05 was utilized. This test analyzed the difference in means between the times it took to identify the indirect vision points with magnification lenses versus the times it took to identify the indirect vision points with traditional safety lenses.

The Wilcoxon Rank Signed Test was applied to determine if the participants were more accurate at locating indirect vision points in the oral cavity with magnification lenses. This test merged the number of correctly identified dots displayed with the use of magnification lenses and traditional safety lenses and ranked them from highest to lowest. The test determined if accuracy is the same between the eye wear pairings or different.

A follow up survey was conducted of the participants' perception of their experience with magnification lenses when viewing objects indirectly within the oral cavity. Furthermore, the survey sought to identify the students' recommendations regarding the use of magnification lenses as part of the dental hygiene curriculum. Results of this survey are reported as descriptive findings using percentages (Table I).

Results

Mean and standard deviation scores, with and without the use of magnification lenses, are shown in Table II and III. Study findings indicate a difference in efficiency with the use of magnification lenses as compared to traditional safety lenses. When comparing the combined data from Manikin A and Manikin B (n=28), 54% of participants were more efficient with magnification lenses, and 25% were more efficient with traditional safety lenses. There was no difference in time between the use of magnification lenses and traditional safety lenses 21% of the time. The average time to complete the clinical exercise with magnification lenses was 3 minutes and 36 seconds, which increased to 3 minutes and 56 seconds with traditional safety lenses. A 2–tailed t–test resulted in a p value of 0.07. This difference was not of statistical significance at the established level of $p \leq 0.05$ (Figure 4).

Study findings also indicate a difference in accuracy with the use of magnification lenses as compared to traditional safety lenses. When comparing the combined data from Manikin A and Manikin B (n=28), 57% of participants were more accurate with traditional safety lenses, and 25% were more accurate with magnification lenses. There was no difference in accuracy 18% of the time. Accuracy scores were an average of 79% with the use of magnification lenses and 84% with the use of traditional safety lenses. This difference was not of statistical significance when analyzing accuracy with a Wilcoxon Signed Rank Test ($p \leq 0.05$) (Figure 5).

Figure 3 displays the complete online survey used to identify how the participants perceive their experience with magnification lenses. All 14 participants completed the questionnaire for a 100% response rate. Examining the demographics of the survey responses indicated all of the participants were female, with an age range from 21 to 31 years. Twelve respondents were Caucasian, 1 respondent was African American and 1 respondent was Somali. Table I displays summative data on the dental hygiene students' perceptions of magnification lenses. Overall, students reported an improved clinical posture, increased quality of dental hygiene treatment provision and enhanced indirect vision skills. All participants recommended use of magnification lenses within the dental hygiene curriculum, with 71% recommending that magnification lenses be used during the second year of the dental hygiene curriculum, and 29% recommending that they be used during the first year of dental hygiene curriculum. The majority (79%) do not feel magnification lenses should be a requirement for dental hygiene students.

Table II: Summary statistics for efficiency (time) of indirect vision exercises – includes combined data from Manikin A and Manikin B

Variable	Observations	Mean (seconds)	Standard Deviation
Magnification Lenses	28	216.53	56.85
Traditional Safety Lenses	28	236.25	54.63

Table III: Summary statistics for accuracy (percent correct) of indirect vision exercises – includes combined data from Clinical Session I and II

Variable	Observations	Mean	Standard Deviation
Magnification Lenses	28	79%	0.15
Traditional Safety Lenses	28	84%	0.14

Half of the students felt it only took 2 to 4 clinic days to adjust to the use of magnification lenses. During this time period, half of the students experienced headaches and 14% of the students experienced vertigo. In contrast, 36% did not experience any vertigo, headaches, eye soreness or any other symptoms. When asked about the weight of the magnification lenses, the majority of the students (86%) felt the lenses were light weight, whereas the remaining 14% felt they were moderate weight.

Discussion

This study was conducted to determine if magnification lenses lead to any improvement in indirect vision skills. While the results of the accuracy and efficiency data analysis indicated no statistical significance, the majority of the dental hygiene students (72%) perceived magnification lenses enhanced their indirect vision skills. This finding supports the literature of perceived improvements with the use of magnification lenses.[1–3]

The adjustment period to the magnification lenses may have had an influence on the outcomes of this study. Each student was given 1 month to adjust to the lenses, with each student setting their own time frame for this adjustment. Some students invested more time into this process than others. It could be that the students intending to purchase

Figure 4: Line graph displaying efficiency in locating the red dots (time in seconds), n=28 observations

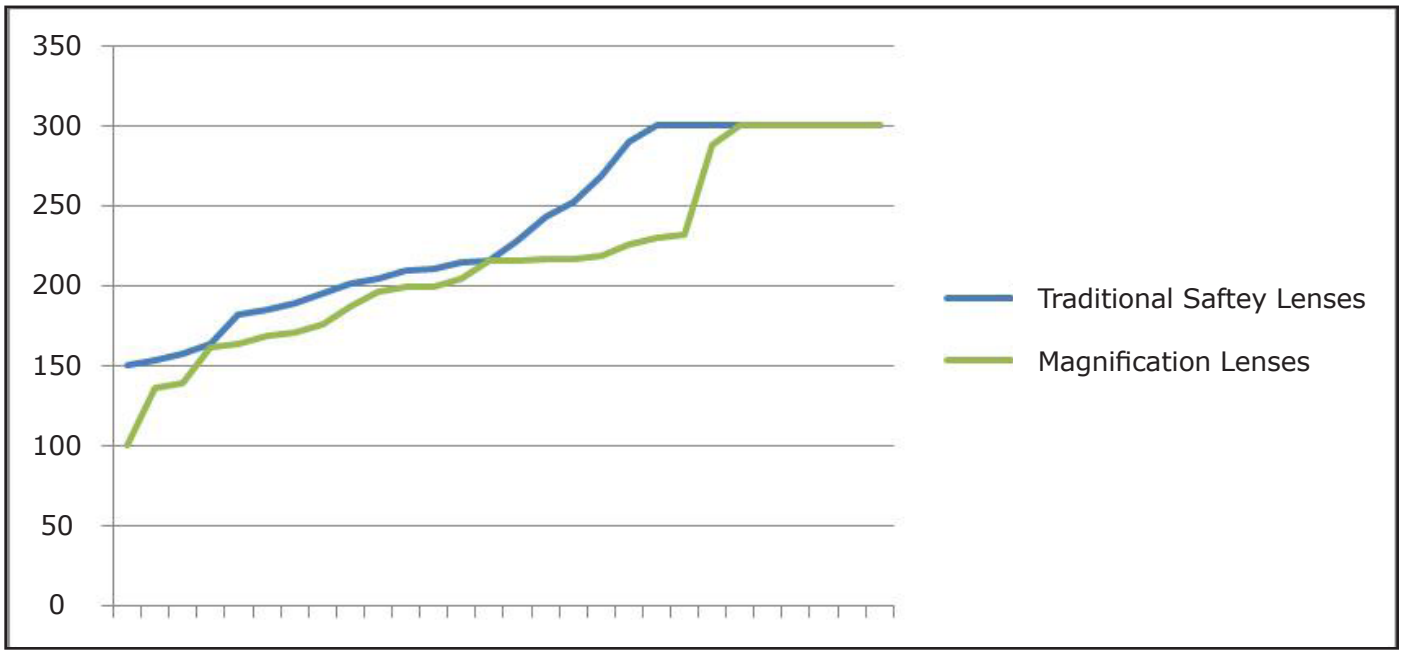
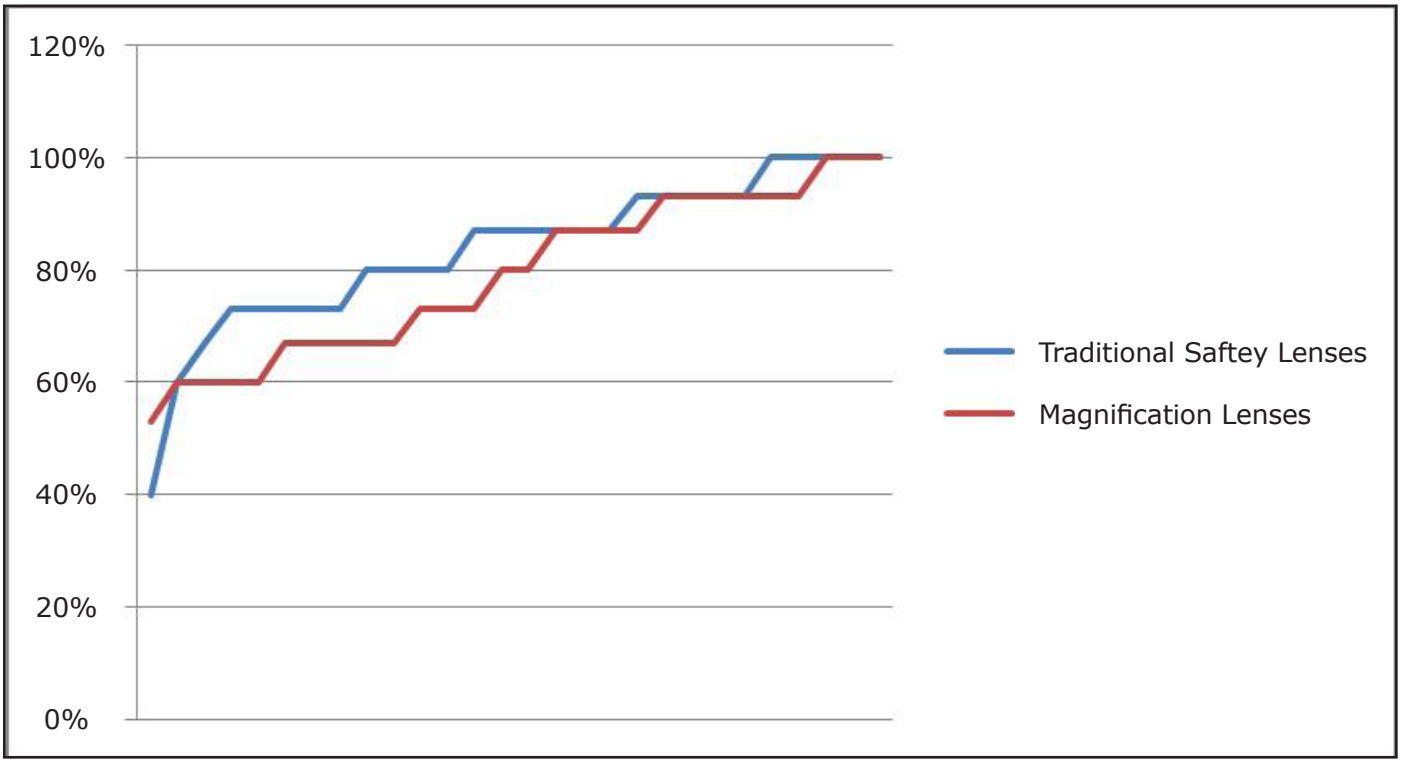


Figure 5: Line graph displaying accuracy in locating the red dots (percent correct), n=28 observations



the magnification lenses at the end of the study invested more time into the adjustment process than those students who intended to return the magnification lenses at the end of the study. Another factor could have been the cost of the magnification lenses. Eight of the dental hygiene students decided to purchase the magnification lenses at the completion of the study, whereas 6 of the dental hygiene students returned the magnification lenses at the completion of the study.

The outcome of this study may have also been influenced by the students' choice of eyewear to utilize during the 1 month period between Clinical Ses-

sion I and Clinical Session II. If the students went back to traditional safety lenses, this allowed them to perfect their proficiency with this modality. Conversely, if they continued to use magnification lenses, it perfected that modality, skewing their ability to use one modality or the other during the second phase of the study.

The sample size used in this study was small and therefore skewed the results. Fourteen dental hygiene students completed the study. Therefore, the results cannot be generalized. The results may have been significant with a larger sample size. However, the methods of this study may serve as a pilot for future research with larger samples.

The study population, second year dental hygiene students, may have had a technical bias on the study as this population had already had 3 semesters of prior experience with indirect vision using traditional safety lenses. Therefore, it did not allow for an equal assessment of magnification lenses compared to traditional safety lenses. However, since traditional safety lenses are the current form of eyewear protection for all clinicians, this will always be a bias for any study population.

The indirect vision points may have had an influence on the outcomes of the study. Each indirect vision point was represented with a red dot, which was easy to visualize on the tooth structure with the unaided eye. Future studies should be designed to locate indirect vision points that appear more neutral in color to represent calculus formation or composite restorations. More students missed locating the red dots on the gingival tissue due to the camouflaging of the red dots against the tissue as compared to the red dots against the white tooth structure.

Finally, the experience level of the dental hygiene students may have had an influence on the outcomes of this study. Even though the students were in their final semester of their curriculum, they have not mastered their clinical skills. There were several incidences where the student verbalized the wrong tooth number to the examiner. Future studies should address the experienced graduate dental hygiene clinician who does not currently utilize any form of magnification lenses.

Conclusion

This study did not produce statistically significant data to support the use of magnification lenses to enhance indirect vision skills among dental hygiene students. However, the students perceived the use of magnification lenses enhanced their indirect vision skills, improved their clinical posture and increased the quality of dental hygiene treatment provided. It is suggested that future studies utilize this research design as a model and incorporate a larger sample size and utilize a more realistic intra–oral color for indirect vision points.

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