Effect of Magnification Lenses on Student Operator Posture


Abstract: A distinct body of literature supports the association between clinical postures of the dental practitioner and work-related musculoskeletal disorders (WRMD). Several aids or devices have been tested to improve clinical posture in the interest of decreasing WRMD. The use of magnification lenses while performing dental procedures may increase the quality of work and decrease the likelihood of musculoskeletal problems. To date, only anecdotal and personal opinions had existed regarding the benefits of using magnification lenses, and no empirical evidence had authenticated the contention that use of magnification lenses exerts a positive change in operator posture. The objective of this study was to assess the effect magnification lenses had on the posture of dental hygiene students. Using a randomized crossover design, researchers videotaped nineteen senior dental hygiene students performing an intra-oral procedure with and without the use of magnification lenses. The tapes were then evaluated by a panel of five dental hygiene educators calibrated in the use of Branson’s Posture Assessment Instrument (PAI). Results of a paired t-test indicate that the posture of the students while wearing magnification lenses was more acceptable (p=.019) than when wearing traditional safety glasses. Results of this study indicate a quantifiable change in acceptability of posture for clinicians wearing magnification lenses and suggest that the use of such lenses in dental education may be warranted.

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A distinct body of literature exists supporting the association between clinical postures of the dental practitioner and work-related musculoskeletal disorders.1-17 Fixed working positions and repetitive motions over extended periods of time are attributed to musculoskeletal disorders.1,7,9,10,15,16 Assuming a more neutral and less stressful posture is reported to reduce the amount and severity of musculoskeletal disorders.18-20 The literature suggests that the use of magnification lenses while performing dental procedures may increase the quality of work and has the potential to decrease the likelihood of musculoskeletal problems, although indications of a physiological benefit are primarily based on anecdotal evidence.21-28

Systematic observations of posture require that dental operator posture be clearly defined. Basic instrumentation texts have sought to describe ideal posture for the clinician.29,30 However, the literature reveals no description of the limits for posture outside of the ideal ranges. Recently, Branson’s Posture Assessment Instrument (PAI) was developed based on expert opinion of a panel of clinical dental hygienists, physical therapists, occupational therapists, and educators. This instrument provides a reliable method to examine posture over a period of five minutes.31 During a five-minute period, the evaluator examines ten components of the body’s posture and then, using established criteria, rates the posture in one of three categories: 1) acceptable, 2) compromised, 3) harmful. A weighted composite score is then computed such that the final score represents posture impact over the five-minute time frame. This instrument provides a means for measuring posture outside of ideal ranges.

Two previous experimental studies have reported on dental students’ use of magnification lenses with respect to quality of work and satisfaction in lens use.32,33 However, neither provided any evidence of magnification lenses making a difference in posture. Lekinius et al., using a crossover design study, reported that the performance of dental students in a preclinical fixed prosthodontics laboratory wearing magnification lenses was superior to those students not wear-
ing magnification lenses when trimming dies and pre-
paring the facial surfaces of mandibular molars.  

Donaldson et al. reported results that conflicted
with those demonstrated by Lekinius et al. In this
study, dental students were randomly assigned to ei-
ther wear or not wear magnification lenses. To ob-
tain baseline performance values, students prepared
and self-evaluated a disto-occlusal preparation on
tooth L. The students continued in their respective
groups for eight weeks during a pediatric clinical
rotation. At the conclusion of this time period, all
participants prepared and evaluated an additional
disto-occlusal preparation on tooth L. No between-
group differences in product were found for either
the pre- or post-preparation. Donaldson et al.'s re-
results also included data obtained from a question-
aire sent to the fifty-five dental schools regarding
mandated purchase of magnification lenses by den-
tal students. Fifty schools responded, for a 91 per-
cent response rate. Results showed that five dental
schools require the purchase and use of magnifica-
tion lenses for all students and six others strongly
encourage such a purchase. These results found that
most schools cite faculty preference as the rationale
for student purchase of magnification lenses.

To date, while the literature suggests that mag-
nification may improve performance outcomes for
students, recommendations for the use of magnifi-
cation lenses to improve posture are based solely on
anecdotal and personal opinions. No clear evidence
was found in the literature regarding changes in pos-
ture while using magnification lenses. Therefore, the
overall objective of our study was to quantitatively
assess dental hygiene students’ posture with and with-
out the use of magnification lenses. Furthermore, the
study sought to examine the effect of operator stool
position on posture and address student perceptions
of the effectiveness of magnification lenses.

Materials and Methods

This study used a randomized crossover de-
sign to examine the relationship of clinical posture
with and without the use of magnification lenses. This
design allowed for the subjects to serve as their own
treatment and control groups. The protocol for the
study was reviewed and approved by the University
of Missouri-Kansas City Adult Health Sciences In-
stitutional Review Board (IRB).

A convenience sample of twenty-two dental
hygiene students was initially recruited for the study.
All students were at the same level of clinical ad-
vancement and were in the last semester of their den-
tal hygiene curriculum. Participants had successfully
completed all required process evaluations and were
deemed competent to complete intra-oral procedures.
Each student had an eye examination within twelve
months prior to participating in this study. The stu-
dents were measured for the correct fit of magnifi-
cation lenses, and informed consent was obtained.
In determining correct fit, each subject was measured
for focal distance, facial structure to determine size
of frame, and position of the pupils within the frame
(top to bottom and side to side). Students requiring
prescription correction were supplied with lenses
made to their prescription or used contact lenses un-
der the magnification lenses. Once custom-fitted,
subjects used the lenses while performing clinical
procedures during four clinical sessions to become
accustomed to the use of magnification.

The subjects were randomly divided into one
of two lens groups. The sequence of lens use was
randomized to control for potential sequence effect.
Initially the groups were equivalent with eleven stu-
dents in each group. However, after attrition, due to
videotape scheduling conflicts, the first group (Group
A) consisted of ten students, and the second group
(Group B) was made up of nine students. Student
clinicians were videotaped during two clinical ses-
sions: one while providing dental hygiene care with
magnification lenses, and one while wearing tradi-
tional safety lenses.

During videotaping, students sat on a modified
operator stool. The stool was modified with a plat-
form affixed to the back of the stool that held an over-
head video camera. The camera would continually
follow the clinician throughout all chairside proce-
dures, thus documenting posture.

The Orascoptic Research Company (Madison,
Wisconsin) provided eleven pairs of custom-fitted
magnification lenses for the study. These lenses had
a magnification power of 2.6 and are the typical
lenses used by dental hygienists. Lenses were
“through-the-lens” design with an angle of declina-
tion of twenty-five degrees.

While the students in Group A participated in
the adjustment period of four clinical sessions, stu-
dents in Group B participated in videotaping sessions
that recorded their posture while completing a full-
mouth probing procedure wearing traditional safety
glasses. Following this taping of Group B, Group A
was taped wearing the magnification lenses. The
study groups were then reversed so that Group B was
fitted for magnification lenses and given an adjustment period of four clinical sessions. During this time Group A, wearing traditional safety glasses, was videotaped. Subjects in Group B were then videotaped wearing the magnification lenses.

All videotaping took place in a quiet area of the clinic away from distractions. Students had full range of motion with the operator stool and were given the opportunity to adjust the patient chair to a comfortable working position. Necessary accommodations were made for the three left-handed clinicians who took part in the study. Each student wore a solid color scrub uniform to help the evaluators who viewed the videotapes. In order to provide orientation of the student’s change in space, reference markers were placed on the student’s shoulders. Additionally, a welder’s cap, modified to include reference markers, was worn by each student during the videotaping session. These markers made it easier for the evaluators to observe and assess posture. (See Figure 1.)

Students were instructed to complete a full-mouth probing procedure on an assigned patient. An assistant was provided to record the probing depths in order to maximize the student’s efficiency. Patients on whom the probing procedure was performed were of average height and weight and presented with no limitations in head movement. The taping of both groups was accomplished over a two-month period.

Following completion of data collection, students were asked to respond to a brief survey that assessed their perceptions of magnifying lenses. The survey contained three major categories regarding student perceptions of: 1) the adjustment period, 2) the impact on clinical skills, and 3) the impact on posture.

Examination of posture was performed using direct analysis of videotaped students, a method that the literature suggests is appropriate for assessing posture as it occurs. Basic instrumentation texts have sought to describe ideal posture for the clinician. Ideal posture is defined as the clinician in a neutral position throughout treatment, where neutral infers no rotations or tilt of the head and trunk. Only recently has there been an index available to objectively assess clinician posture. Branson’s Posture Assessment Instrument (PAI) has been shown to be a valid and reliable method to examine posture over a period of five minutes.

A panel of raters comprised of five dental hygiene educators was convened. These raters, colleagues of the principal investigator, were faculty members affiliated with the dental hygiene program in which the subjects were enrolled. Calibration sessions were held to orient the panel to Branson’s PAI. Specific objectives of the study design were not communicated to the raters. Panel members independently reviewed videotapes for a five-minute period and, using established criteria, rated posture components as: 1) acceptable, 2) compromised, or 3) harmful. A weighted composite score was then computed such that the final score represented posture impact over the five-minute time frame.

A preliminary analysis was conducted to examine whether there was a differential effect of rater on clinician posture with and without magnification lenses since it was not possible to blind raters during assessment of videotapes. A two-factor repeated measures ANOVA was conducted on PAI scores with magnification and rater as independent variables. This analysis showed that there was no interaction effect of rater and magnification (p=.892) nor main effect for rater (p=.123). Therefore, the decision was...
made to test the original hypothesis regarding the differential effect of magnification lens on pooled PAI scores using a dependent t-test with p<.05. PAI scores from all examiners were subsequently pooled to create a mean score for students under each magnification condition. The pooled PAI scores for magnification lens and no magnification lens conditions were compared using a dependent t-test.

Results

Means and standard error of the means (SEM) for PAI scores, with and without magnification lenses, are shown in Table 1. PAI scores for students wearing magnification lenses were significantly better (p=.019) when compared to PAI scores without magnification. The mean score for students using magnification lenses was 12.05 compared to 15.02 without lenses. PAI scores ranging from 10 to 40 represent an “acceptable” posture. The three-point lower PAI score represents less deviation from ideal posture. Additionally, the variance of PAI scores for students using magnification lenses was considerably less than when not using the lenses.

Table 2 shows summative data on students’ perceptions of magnification lenses and the 1) adjustment period, 2) impact on clinical skills, and 3) impact on posture. Overall, students reported they found the magnification lenses comfortable and indicated that they adapted easily to the lenses. Only one student reported difficulty in adjusting to the lenses during the study period, whereas 81 percent (n=17) adjusted to the lenses in two days or less. The only adverse effect reported by the students was the sense of vertigo during provision of care (43 percent) and eye soreness (5 percent).

The vast majority of student clinicians reported that the magnification lenses improved the quality of their clinical performance. This was also verified during outcome evaluation of the students’ performance using the standard clinical grading system. Of note, 95 percent reported that their visual clarity was improved by lens use; whereas slightly fewer reported improvement in skills and overall performance (67 percent and 76 percent, respectively). Subjects rated either increased performance of clinical skills or no noticeable affect.

Of particular note, 100 percent reported that their posture improved during magnification lens use, and 90 percent felt this would improve their effectiveness in private practice upon graduation.

Table 1. PAI mean scores (SEM) for student clinicians using and not using magnification lenses

<table>
<thead>
<tr>
<th>Condition</th>
<th>Mean</th>
<th>SEM</th>
</tr>
</thead>
<tbody>
<tr>
<td>With magnification lenses</td>
<td>12.05*</td>
<td>0.72</td>
</tr>
<tr>
<td>(Groups A and B combined)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Without magnification lenses</td>
<td>15.02</td>
<td>1.25</td>
</tr>
<tr>
<td>(Groups A and B combined)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>* Statistically significant p=.019</td>
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Discussions and Limitations

This study demonstrated a significant positive change in posture when students performed the intra-oral probing procedure wearing magnification lenses. On average, postural components while wearing these lenses were generally rated in the acceptable category using the PAI, with composite scores demonstrating a more acceptable level of posture than with traditional safety lenses. It is noteworthy that posture assessment when wearing traditional safety glasses, while less acceptable than with magnification, was on average in the acceptable category. This effect favoring the magnification lenses may have been somewhat attenuated since students were aware that they were being videotaped during provision of patient care. Subjects had signed informed consent forms that briefly described the nature of the study. Furthermore, the special equipment used could have altered students’ performance as they understood an evaluation was taking place. Additionally, in the educational environment, students are monitored more carefully for postural abnormalities and may have been more aware of their posture during videotaping. However, since students served as their own controls, the effect favoring magnification lenses on posture likely represents a real advantage.

The head and neck positions, as measured by the PAI, were noticeably improved with the use of the magnification lenses. Clinicians wearing lenses appeared more relaxed and upright in the upper body region when compared to upper body postures with safety glasses. The vast majority of students’ perceptions of magnification lenses reported that adaptation to and comfort with the lenses was good. Additionally, there was a perceived advantage to wearing lenses to improve students’ clinical skills. These results in general suggest that magnification lenses may have utility in the education environment for both comfort and quality of work. The long-term
The impact of improved posture and clinical performance with magnification lenses remains unknown; however, it is logical that fewer violations of postural parameters would be beneficial over time. This impact may be discernible during probing procedures and other intra-oral exercises.

The nature of capturing posture on videotapes created some limitations, in that occasionally elements of movement were obscured for brief intervals. Evaluators were not always able to rate every body part necessary for the PAI due to the limited vision caused by the fixed video camera. Future studies may have utility if the PAI is used in real time so that all movements can be better observed. On the other hand, videotapes are valuable in that scenes could be replayed.

A further limitation may have been created by the sample size. Nineteen subjects completed the study. The results may have been more powerful with a larger sample size. Additionally, more subjects would have tested a wider range of clinicians’ body types and operating styles.

The postures examined in this study occurred while students were conducting a full-mouth probing procedure, which requires minimal hand pressure and mental stress. Future investigations could use the PAI for assessment of a wider range of movements performed by dental and dental hygiene students that may put the clinician in a more strained posture. Other procedures could include crown preparation, scaling/root planing, and endodontic therapy.

Finally, the experience level of the student clinicians may have had an influence on the outcomes of this study. Although the dental hygiene clinicians were in the final semester of their curriculum, their habits and postures have not become habituated as occurs in private practice. Future studies should be designed to assess magnification lens use in private practice. In private practice, the pressure of time, productivity expectations, and other realities of the environment could affect outcomes.

The results of this study quantitatively support statements in the literature that report improved posture with the use of magnification lenses.21-28

### Table 2. Summary of students’ perception of magnification lenses’ comfort and utility

<table>
<thead>
<tr>
<th>Comfort and Adjustment</th>
<th>percent</th>
<th>(n)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Weight of the lenses</td>
<td>Heavy weight/hard to wear</td>
<td>5%</td>
</tr>
<tr>
<td></td>
<td>Moderate weight/adaptable</td>
<td>67%</td>
</tr>
<tr>
<td></td>
<td>Light weight/easy to wear</td>
<td>28%</td>
</tr>
<tr>
<td>Comfort</td>
<td>Comfortable</td>
<td>86%</td>
</tr>
<tr>
<td></td>
<td>Uncomfortable</td>
<td>9%</td>
</tr>
<tr>
<td></td>
<td>Both comfortable &amp; uncomfortable</td>
<td>5%</td>
</tr>
<tr>
<td>Time for adjustment</td>
<td>Less than a clinic day</td>
<td>57%</td>
</tr>
<tr>
<td></td>
<td>2 clinic days</td>
<td>24%</td>
</tr>
<tr>
<td></td>
<td>3-4 clinic days</td>
<td>5%</td>
</tr>
<tr>
<td></td>
<td>Never did adjust</td>
<td>5%</td>
</tr>
<tr>
<td>Physical symptoms experienced during adjustment</td>
<td>Vertigo that caused a pause in working</td>
<td>43%</td>
</tr>
<tr>
<td></td>
<td>Eye soreness</td>
<td>5%</td>
</tr>
</tbody>
</table>

### Impact on Clinical Skills

| Clarity of oral cavity | Increased | 95% | (20) |
|                        | No noticeable difference | 5% | (1) |
| Ability to adapt an instrument | Increased | 67% | (14) |
|                        | No noticeable impact | 33% | (7) |
| Impact on the quality of work | Increased | 76% | (16) |
|                        | No noticeable impact | 24% | (5) |

### Impact on Posture

| Positive change in head, neck, and trunk position | Yes | 100% | (21) |
| Magnification will allow longer time in private practice | Yes | 90% | (19) |
Conclusions

Results of this study indicate that the posture of dental hygiene students was more acceptable when they wore magnification lenses than when they wore traditional safety glasses. The outcomes suggest that the use of such lenses in dental education may be warranted, but further investigation is indicated.

REFERENCES