

The effect of loupes on neck pain and disability among dental hygienists

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Abstract.

BACKGROUND: Musculoskeletal disorders represent a significant occupational health issue in dental hygiene, with high prevalence rates documented. Despite this fact, there have been few advancements in the application of ergonomic principles in the dental hygiene profession. While the use of loupes is often promoted as an ergonomic solution, there is little published research to support this claim.

OBJECTIVES: The aim of the present study, therefore, was to investigate the effect of the use of loupes on neck pain and disability in dental hygienists.

METHODS: The study was conducted using an exploratory pre-test post-test design, comparing musculoskeletal measures in dental hygienists wearing loupes with final year dental hygiene students who do not wear loupes. Pre- and post-test measures included the Neck Pain and Disability Scale and a standardised physical assessment using previously validated measures. Statistical analysis was conducted as a series of mixed ANOVAs with time and treatment as the independent variables.

RESULTS: While the analyses revealed no significant interactions between time and treatment ($p < 0.05$), there were general trends of improvement or deterioration for outcome measures. Improvements over time were noted in the treatment group for cervical range of motion and deep neck muscle endurance; however deteriorations were noted for forward head posture and cervical kinaesthetic sense.

CONCLUSIONS: Overall, despite no statistically significant differences being detected, this study suggests that wearing loupes appears to have both positive and negative outcomes with regards to physical well-being. As such, further studies are required to more precisely determine the effects of loupes on MSD among dental hygienists, particularly long-term. Dental hygienists with existing neck pain exploring ergonomic equipment may reflect on the findings and consider the potential benefits and risks of wearing loupes.

Keywords: Musculoskeletal disorders, risk factors, magnification

1. Background

1.1. *Musculoskeletal disorders in the dental hygiene profession*

Musculoskeletal disorders (MSD) represent a significant and costly occupational health issue for the dental profession [1–4]. Work related MSD include injury, trauma and pain to both the soft and hard

tissues of the body, and frequently develop over time [3]. As a preventive dental practitioner, the physical burden of performing repetitive and precise tasks such as scaling and debriding teeth places dental hygienists at a high risk of work related MSD [3, 5]. Recent research supports this observation, with the prevalence of MSD in the profession reported at rates between 64% and 93% [3]. Hygienists are more likely to suffer neck, shoulder and wrist pain than other dental professionals [6–8]. Hygienists are also exposed to a number of other identifiable risk factors, such as a large number of occupation related computer usage hours, psychosocial stress

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and being predominately of female gender [3, 9–13]. This occupational health issue leads to lost work time, diminished work performance, medical attention and possible early retirement [14, 15]. The economic ramifications of this situation are substantial, with lost earnings in the United States of America due to MSD in the dental profession reported at over \$40 million some years ago [5]. With a considerable proportion of the profession reporting MSD, and the consequent effects and impacts of this, research into the prevention of this problem is imperative.

Neck pain specifically has been identified as a common complaint of dental hygienists, with the 12 month prevalence reported at between 54% and 69% [6, 16, 17]. Work-related tasks such as scaling teeth appear to predict reported neck pain among Australian and Swedish dental hygienists, as does the stress of balancing work with family commitments [18, 19]. Dental hygienists suffering from neck pain are more likely to have time off work or are considering reducing their working hours [18], affecting productivity and career longevity.

It is evident that the problem is widely acknowledged, however much of the information regarding prevention of MSD among dental hygienists appears to be anecdotal [3]. Developing an ergonomic solution has been limited by attention bias when examining postural improvements [20, 21], and participants completing undemanding simulated tasks during the intervention [20, 22, 23]. As a result, there has been little development or progression in ergonomics for the dental hygiene profession.

1.2. Loupes as a preventive measure against MSD

New technologies, such as loupes [surgical magnification] for the dental hygienist are being promoted as a preventive measure for MSD in the profession. Loupes are an eyewear system of telescopes attached to lenses (Fig. 1), which magnify the viewing field; in the case of dental clinicians, this means the teeth and the gingiva [24]. However, there appears to be no longitudinal studies or research using objective measures to support this innovation. The use of surgical magnification when providing dental treatment allows the clinician to maintain their natural posture, which in turn is believed to reduce the risk of musculoskeletal pain or discomfort [25]. It has been suggested that loupes may reduce the physical stresses on the body [26]. While the use of loupes amongst hygienists is not commonplace, it is never-



Fig. 1. Dental hygienist wearing loupes.

theless, a tool that hygienists may choose to use in their daily practice. At the current time loupes are not considered to be essential for workplace safety and sound ergonomics.

Current research into the effect of loupes appears to have been limited to self-reported measures of MSD through the use of questionnaires [18, 27, 28], or a single case study reporting a student's experiences [24]. To our knowledge, there is no contemporary research in the literature that has utilised triangulation methods to assess the effectiveness of using loupes on MSD in practising dental hygienists. The use of both self-reporting and objective outcome measures would provide a clearer insight into the potential benefits and limitations to wearing loupes during clinical patient care. The aim of the present study is to investigate the effect of the use of loupes on neck pain and disability in dental hygienists, using triangulation methods.

2. Methods

The study was conducted as an exploratory pre-test post-test design with a non-equivalent control group, comparing musculoskeletal measures in dental hygienists wearing loupes, with final year dental hygiene students who do not wear loupes. The research project was approved by the University of Newcastle Human Research and Ethics Committee.

2.1. *The intervention: Loupes*

Subjects in the treatment group were issued with flip-up Galilean loupes in 2.5x magnification. This level of magnification offers the widest field of view and longest depth of focus when compared to higher powers. The flip up function allows the magnification lenses to be adjusted during treatment or flipped out of sight when talking with patients or writing notes. Participants in the treatment group were individually fitted for loupes, measuring the working distance for appropriate fit. Working distance is the distance between the eyes and the oral cavity, and is often crudely proportionate to height. These measurements are crucial for the hygienist to have a clear view of the oral cavity and work in a balanced working position. It has been suggested that poorly fitting loupes can actually exacerbate MSD, given that they may require the clinician to place themselves in an awkward position for optimal vision [25]. The intervention involved subjects wearing the loupes during all clinical care provided to their patients in practice for a period of six months.

2.2. *Outcome measures*

Both self-reported and objective measures of musculoskeletal pain in the neck region were collected. Self-reported measures of neck pain and dysfunction were evaluated by the Neck Pain and Disability Scale (NPDS). The objective measures of upper body musculoskeletal symptoms were evaluated by a physical assessment, following a standardised protocol. The physical assessment included measures of cervical range of movement (CROM), low load craniocervical flexion, cervical proprioception, and craniocervical angle. Each of these measures are published in protocols elsewhere, and have been established as reliable and reproducible [29–34]. The characteristics of these measures are described in Table 1.

2.3. *Recruitment*

All full members of the New South Wales branch of the Dental Hygienists Association of Australia were contacted via post, and final year dental hygiene students at the University of Newcastle were also approached at the beginning of a clinical session on campus by a person not involved with the project. All those invited received a participant information statement, consent form and self-addressed reply-paid envelope. Interested participants who met the

inclusion criteria and did not meet any of the exclusion criteria (Table 2), and who voluntarily returned the signed consent form were considered eligible for the study. The minimum sample size required to determine a statistical difference in outcomes was 12 participants in each group, based on the minimal important change of 12 points difference in NPDS scores, a type I error of $\alpha = 0.05$ and 80% power.

2.4. *Procedure*

All participants were required to travel to The University of Newcastle (Ourimbah campus) to complete baseline demographic data collection, the NPDS survey and undergo the physical assessment. At this stage, participants in the treatment group were also personally fitted for loupes. Participants allocated to the treatment group were required to wear loupes during clinical treatment of patients, for the next six months. Participants allocated to the control group were required to work as usual, that is without the use of surgical magnification, for the next six months. Participants in the control group were also required to agree not to use loupes during the study period. At the end of the six month period, participants would again be required to complete the NPDS outcome measure as well as attend The University of Newcastle for a post-test physical assessment.

2.5. *Analysis*

An intention-to-treat analysis was adhered to throughout the study. Tabular summaries of demographic characteristics summarised responses using descriptive statistics, while comparison of the survey data pre- and post-test were performed using mixed ANOVAs. The primary outcome factor was change in neck pain and/or disability.

3. **Results**

A total of 12 practising dental hygienists and 17 final year dental hygiene students consented to participate in the study. The dental hygienists had a mean age of 31.8 (SD, 7.8) years and worked an average of 33.9 (SD, 8.2) hours per week, while the students on average were 25.1 (SD, 4.4) years and completed 28.1 (SD, 11.7) clinical hours per week. Both groups were predominantly non-smoking females. The descriptive statistics of participants are displayed in Table 3.

Table 1
Outcome measures

Measure	Description	Subjects	ICC	Reliability coefficient	Author
NPDS	This survey measures neck pain and/or dysfunction. It consists of 20 questions which require the subject to respond on a visual analogue scale.		0.97	0.93	Goolkasian [29]
Cervical range of motion	This testing is performed as per the protocol described by Youdas et al [30]. Cervical range of motion will be measured using a gravity goniometer; active range of cervical spine motion in the directions of flexion, lateral flexion and rotation to either direction will be ascertained. This test can be used to evaluate neck disorders.	Orthopaedic disorders	0.84 – 0.95		Youdas [30]
Low load cervical vertebral flexion	This test is performed as described by Jull et al. [31]. Pressure biofeedback will be used to measure deep cervical flexor muscle endurance using a low load, to reflect the tonic function of this muscle group. This test can be used to assess neck disorders.	Whiplash associated disorders	0.65, 0.89		Jull [31]
Cervical joint position test	Evaluation of neck proprioceptive activities will be assessed using the cervical joint position test as described by Treleaven et al. [32], following instructions developed by Revel et al. [33]. This test may be a predictor of impaired cervical kinaesthetic sense.	Young healthy adults	0.81		Treleaven et al. [32]
Craniovertebral angle	The natural head posture of subjects will be assessed by taking photographs of the subjects in seated positions, using markers to identify the craniovertebral angle, as per the protocol described by Watson and Trott [34]. It has been suggested that a smaller craniovertebral angle (ie forward head posture) may be a predictor of headaches and neck pain.	Females 25–40 yrs		0.973	Watson and Trott [34]

Table 2
Inclusion and exclusion criteria for the study

Inclusion criteria – dental hygienists	Inclusion criteria – dental hygiene students	Exclusion criteria
1. Registration as a dental hygienist with the Dental Board	1. Enrolled full-time in the third year of the Bachelor of Oral Health Program	1. Chronic neck or shoulder pain (persistent pain for at least three months)
2. Working as a dental hygienist for a minimum of 24 hours per week	2. Completing at minimum of 24 hours of clinical experience per week	2. Pre-existing musculoskeletal disease/disorder unrelated to occupational factors (eg Rheumatoid arthritis, fibromyalgia)
		3. Currently wearing loupes

Table 4 summarises the neck related self-report and physical measures for the treatment and control groups at baseline and following the intervention. A series of mixed ANOVAs were conducted with time (baseline vs. post-intervention) and treatment (intervention vs. control) as the independent variables. The analyses revealed no significant interactions between

time and treatment ($p < 0.05$), which indicates that the loupes created no significant differences in outcomes. There was no change in mean NPDS scores between baseline and follow-up for the treatment group, while the control group reported an increase in perceived neck pain at follow-up. Although not statistically significant, improvements over time were noted in the

Table 3
Baseline characteristics of study participants

	Treatment	Control
Age Mean years (SD)	31.8 (7.8)	25.1 (4.4)
Clinical hours per week Mean (SD)	33.9 (8.2)	28.1 (11.7)
Height Mean (SD)	166.0 (6.1)	163.3 (9.4)
Gender (%)		
Female	100	82.4
Male	0	17.6
Have children (%)		
Yes	33.3	5.8
No	66.6	94.1
Regular tobacco smoker (%)		
Yes	16.7	5.8
No	83.3	94.1

treatment group for the tests examining cervical range of motion and low load cervical vertebral flexion; whereas these measures declined over time for the control group. Deteriorations were noted in treatment group participants for forward head posture and joint position sense, while there were improvements in the control group for the same measures.

4. Discussion

This study appears to be the first to objectively assess the impact of wearing loupes on neck pain and disability among practising dental hygienists. Development of a standardised protocol, with reliable and repeatable measures ensures a high validity with the study outcomes. Unlike previous research, this study combined objective measures with validated self-reported measures in both pre- and post-test phases. This triangulation method of evaluation is vital for providing solid evidence on the effect of the preventive measures under investigation.

Overall, the dental hygienists wearing loupes in this study did not perceive any improvements, based on the results of the self-reported measure of neck pain and disability. On the other hand, we should

consider it encouraging that they did not report deterioration in musculoskeletal health. The students who did not wear loupes noted a worsening in their neck pain symptoms; this is unsurprising, given that many studies have found that increasing time spent practicing correlates with reported MSD [16–18]. Improvements were noted for cervical range of motion and low load craniovertebral flexion in the treatment group. Interestingly, these markers deteriorated in the student group which again, may indicate that time practising as a hygienist is a risk factor and that the intervention may have the potential to mitigate deterioration in these measures.

Observed increases in neck extension, flexion, lateral flexion and rotation for those wearing loupes suggest that the muscle activity in this area is not impaired, and as such, injuries to the soft tissues of the neck are less likely. It is also likely that global muscle overactivity and concomitant tightness were reduced, a finding that is consistent with the cranio-cervical flexion results. Noted improvements in low load cervical vertebral flexion for the treatment group reflect the tonic function of the deep cervical flexor muscles, suggesting less inhibition due to neck pain and greater fine motor control of the cervical spine and its lordosis in the neutral position [35, 36]. It has been suggested that a neutral posture adopted whilst wearing loupes reduces neck muscle activation [37]. It might also be considered that simply by participating in the study that the hygienists were inherently more aware of their neck positioning, contributing to this positive change.

Wearing loupes appeared to impair the subject's ability to sense the position, orientation and movement of the head and neck [cervical joint position sense]. While wearing loupes, the eyes move between the magnified and unmagnified fields, which can be disconcerting [25]; this perhaps disturbs sensorimotor function though the provision of varying or discordant sensorimotor inputs. It is widely

Table 4
Self reported and physical measures of neck related performance for each participant group

	Loupes wearing group <i>N</i> = 12			Control group <i>N</i> = 17		
	Baseline Mean (SD)	Post intervention Mean (SD)	Change	Baseline Mean (SD)	Post intervention Mean (SD)	Change
Neck Pain Disability Scale	14.00 (12.49)	14.00 (11.05)	0	14.97 (16.91)	13.90 (13.54)	–
Low Load Cranio-cervical flexion (score/100)	51.83 (34.05)	54.17 (33.57)	+	57.88 (33.88)	52.18 (29.45)	–
Cervical flexion/extension (degrees)	51.11 (8.09)	52.47 (5.45)	+	56.78 (5.88)	54.42 (4.82)	–
Craniovertebral Angle (degrees)	49.69 (6.05)	46.91 (4.57)	–	47.86 (7.55)	48.65 (4.63)	+
Lateral Flexion (degrees)	42.50 (11.15)	46.33 (7.67)	+	49.76 (6.49)	48.39 (6.21)	–
Rotation (degrees)	63.33 (8.21)	65.83 (5.97)	+	68.71 (8.49)	65.79 (6.34)	–
Joint Position Error (centimetres)	11.71 (4.69)	13.22 (5.74)	–	16.00 (6.44)	12.11 (3.87)	+

acknowledged that wearing loupes requires an adjustment period [25], and while it has been suggested that two to three weeks may be sufficient, perhaps the true adjustment period is longer than this. Conversely, the students' joint position sense was improved in the follow up assessment; this is not surprising, as muscle memory and hand-eye co-ordination should improve for students as they gain experience and transition into their professional careers.

The decline in craniovertebral angle measurement for the hygienists indicates that following the use of loupes, they adopted a more forward head posture. However, it should be noted that in the current study, the mean change was less than 1° ; perhaps this change is too small to be considered meaningful, and may be within the error of the measurement method. Interestingly, while the test itself is reliable and widely used, an analysis of studies comparing forward head posture between subjects with pain and asymptomatic subjects concluded that its use in determining health gains should be re-appraised [38]. In the current study, there was no discernible difference in perceived neck pain and baseline and post-intervention for the hygienists [as measured by the NPDS], however the students perceived an increase in neck pain while their forward head posture improved; this contradictory result may lend support to the conclusions of the aforementioned analysis.

The findings from this study compel us to consider that no single intervention may be effective in preventing or limiting MSD among dental hygienists. Rather, as numerous risk factors contribute to MSD, the solution too may be multi-factorial. This has been suggested elsewhere [3, 39], and in a review of interventions to reduce work-related MSD, multi-component interventions found to be more efficacious than single interventions [40]. The lack of statistically significant findings should also lead us to question the value of the self-reported and physical measures used, in measuring MSD in a population with sub-clinical levels of pain. While all measures have demonstrated reliability, they may not be sensitive enough to detect a change when MSD is slight or intermittent.

4.1. *Strengths of the study*

This research is unique, in that it utilised triangulation methods in a longitudinal study to measure loupes as a preventive measure or intervention for MSD. The use of physical measures to assess dental hygienists has been underutilised and in the few studies which attempt this, explicit standardised pro-

ocols have not been reported. In a five-year follow up of female dental personnel, it is claimed that a standardised protocol was adhered to for the physical assessment [6]. However, it seems only broad criteria for pain and palpable tenderness was stated rather than explicit and reproducible techniques. Similarly, a physical examination protocol examining the prevalence of carpal tunnel syndrome and upper extremity tendonitis among American hygienists did not report specific methodologies [41]. Furthermore, repeated physical measures have not been used previously when investigating MSD among dental hygienists. Previous studies have used physical examinations as a measure of real time muscle activities (electromyography) [22, 37, 42] and positions (goniometry) [42, 43] or sensory perception ability (vibrometry) [44]. However, these studies fail to record changes in musculoskeletal symptoms over time.

4.2. *Limitations*

In Australia, while the dental hygiene profession is rapidly growing, it nevertheless remains a small and relatively young cohort when considered from an international perspective. As such, the recruitment of participants for this study was challenging, given the small numbers in the profession and the geographic distances required to travel for the physical assessments. At the current time it also remains unclear exactly how many practising hygienists are already wearing loupes, a situation which was a clear exclusion criteria in the current study. Another factor was the potential for confounding variables, such as the type of operator chair used, the type of practice worked in, and patient scheduling including breaks. However, as previously noted recruitment of participants was difficult, and further limiting the inclusion and exclusion criteria may have resulted in even fewer participants, and the study would not have been viable. Despite the risk of potential confounders, this study allowed participants to work in their usual clinical settings over an extended period, which ensures authenticity.

5. **Conclusions**

This study investigated the effect of loupes on MSD in dental hygienists, using previously validated objective measures, for what appears to be the first time. Overall, no differences were detected between wearing loupes and the control group, or from base-

line to follow-up. Despite this, the findings do suggest that wearing loupes probably has both positive and negative outcomes in regards to physical well-being. As such, further studies are required to definitively determine the effects of loupes on MSD among dental hygienists, particularly in the long-term.

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Conflict of interest

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