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ORIGINAL RESEARCH

Workday Arm Elevation Exposure: A Comparison Between Two Professions

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OCCUPATIONAL APPLICATIONS Results from this study indicate that dental hygienists spent a mean of 7% of their workday with their arms elevated above 60 of humeral elevation. The majority of their workday (71%) was spent working with their arms in static positions. Compared to a separate working population (office workers), dental hygienists had more than two times greater arm elevation exposure above 60 . Dental hygienists have a high incidence of shoulder injuries, which may be related to arm elevation exposure. Based on the present study, ergonomic interventions should be based on reducing the total arm elevation exposure in dental hygiene. Further, interventions should be designed to reduce the repetitive tasks performed by dental hygienists.

ÙoÎMethods:Bilateral, full workday arm elevation exposure was measured for bo dental hygienists and computer workers using a tri-axial accelerometer with a built in data logger (Virtual Corset

R, Microstrain, Inc., VT, USA). Exposures analyzed were the percent of the workday spent above 30 , 60 , and 90 of humeral elevation. Additionally, exposure to repetitive motion, or jerk, was estimated, specifically the percent time spent moving the arm in pseudo-static (< 10 /s) slow humeral motion (between 10 /s and 40 /s) and fast humeral motion (> 40 /s). ResultsÞDental hygienists had bilateral arm elevations above 60 for approximately 7% of their workday, more than two times the exposure of office workers for the same duration of work. Dental hygienists had a mean of 71% of their work time in pseudo-static postures, which is significantly less than computer workers (78%). Dental hygienists had slow and fast arm motion during 23% and 6% of their workday, respectively, significantly higher than those for computer workers (17% and 5%). Conclusions:

upper extremity injuries within this profession. In dental hygiene work, elevation exposure above 60 and dynamic arm motions above 10 /s may be specific contributors to the risk of upper extremity disorders bilaterally.

KEYWORDS Of ce ergonomics, dental hygiene, shoulder, posture, exposure assessment, biomechanics

INTRODUCTION

Exposure to work with arms in an elevated posture is believed to be related to degenerative changes of the rotator cuff tendons and may ultimately lead to such disorders as shoulder impingement syndrome (Armstrong et al., 1993). Occupations with high exposure to unsupported arm postures above 60 of elevation are considered injurious professions for the shoulder (Svendsen, Gelineck et al., 2004; Svendsen et al., 2005). In a study conducted by Bey et al. (2007), arm elevations were associated with geometric narrowing of the subacromial space; additionally, the subacromial distance was minimized when the arm reached 60 of humeral elevation. Narrowing of the subacromial space may be related to rotator cuff degeneration, shoulder pain, and subacromial impingement syndrome (Zuckerman JD, 1992; Nordt et al., 1999; Seitz et al., 2010). Narrowing of the subacromial space in combination with repetitive motion has been shown to accelerate rotator cuff tendon damage in a rat model (Soslowsky et al., 2002).

In the profession of dental hygiene, workers have a high estimated prevalence (64%–85% of active hygienists) of work-related shoulder pain (Akesson et al., 1999; Ylipaa et al., 2002). Constrained arm postures have been identified as potential risk factors for the development of occupational neck and shoulder disorders (Sartorio et al., 2005; Hayes et al., 2009; Morse et al., 2010). The incidence of shoulder injury in dental work may additionally be associated with the velocity of arm motion as well as the total amount of time the arm is exposed to elevated positions (Akesson et al., 1999; Marklin & Cherney, 2005). In addition to elevation exposure, greater generated muscle forces (intensity and duration) on the upper extremity during work are likely to lead to greater risk for injury (Bernard, 1997). Several factors may influence muscle force of the upper extremity in the workplace, such as external load (arms supported or unsupported during elevation), the degree of humeral elevation (where 90º elevation with respect to gravity results in maximal shoulder torque), the types of tools used during dental work, and the velocity of humeral movement.

Shoulder injuries are more commonly reported on the dominant arm of dental hygienists (Oberg T, 1993; Yee T & Harber, 2005). Marklin and Cherney (2005) evaluated bilateral arm elevations among dental workers using video recordings from 4-hour work sessions, and they found that dental hygienists maintain unsupported elevation of their left shoulder to a greater extent than their right (45% of workday left arm, 34% of workday right arm). Results from this study also suggested that exposure levels are greater in the non-dominant arm than the dominant arm of dental hygienists. However, previous work suggested that injury prevalence is greater on the dominant arm (Yee T & Harber, 2005). Based on the exposure analysis by Marklin and Cherney (2005), arm elevation exposure may not be sole factor in the development of shoulder injuries among dental hygienists. However, the aforementioned study did not compare arm elevation exposure by arm dominance, nor did it evaluate arm elevation exposure over

regarding full workday arm elevation exposures and female workers limits the ability to design and implement effective ergonomic interventions.

The aim of this study was to compare arm elevation exposure and dynamic exposure between female dental hygienists and a separate population of female workers. Office workers who work primarily with computers are predominantly female and have relatively low risk for shoulder injuries (Jensen, 2003; Gerr et al., 2006; Waersted et al., 2010). A comprehensive review of musculoskeletal disorders among office workers (22 studies, 26 articles) showed insufficient casual evidence between computer use and shoulder injuries (Waersted et al., 2010). In a prospective cohort study of 896 newly employed workers from 12 different occupational settings, 12% (107 workers) complained of new-onset musculoskeletal pain. From this study, mechanical loading of the shoulder, unsupported arm elevation exposure to work above shoulder level, and repetitive work with little day to day variability in tasks were significantly correlated to new onset pain (Harkness et al., 2004). A typical workday for dental hygienists consists of four highly repetitive tasks–scaling, flossing, instrumentation, and polishing–that all require the arms to be predominantly unsupported (Bramson et al., 1998;

Instrumentation

(Hess et al., 2010) pseudo-static (< 10

DISCUSSION

It was hypothesized that dental hygienists would have greater arm elevation exposure and would work with faster arm velocities than office workers. The inclusion of computer workers served as a basis for comparison, since this group has relatively low rates of occupational shoulder injury. Results indicate that dental hygienists may spend as much as 7% of their workday with their arm elevated above 60 (Table 1). When compared to office workers, dental hygienists experienced more than two times the exposure duration to elevated arm postures above 60 , thus supporting the hypothesis. These differences suggest that dental hygienists have greater exposure to shoulder torque, given the larger elevation angles of the arm. Results additionally indicate that dental work requires less static arm postures than office workers, with greater arm usage at both slow and fast velocities. This latter finding suggests that dental hygienists are exposed to greater repetitive motion than office workers. No significant difference was found between occupations, in terms of current arm disability (DASH scores), although the dental hygienists reported having experienced five-fold

Findings from the present study do not support the hypothesis with respect to arm dominance, since there were no arm dominance differences for full workday arm elevation, nor were there any significant dynamic arm usage differences between the dominant and non-dominant arms of dental hygienists. Existing evidence suggests that arm injury rates among dental hygienists are not evenly split between the dominant and non-dominant arms. For dental hygienists, injuries are 37% more common on the dominant side of right-handed dental hygienists and 94% more common on the dominant side of left-handed dental hygienists (Yee T & Harber, 2005). It is possible that other factors not measured in this study, such as external loads and instruments used for dental hygiene, may have an influence on shoulder injuries by arm dominance.

3c(ould)-731.8(h)0.2elp From the present study, dental hygienists had more shoulder injuries during their career and had greater arm elevation exposure levels than office workers. When compared with workers from other studies, dental hygienists have greater exposure levels than machinists but less exposure than car mechanics and house painters in terms of percent time above 30 , 60 , and 90 of humeral elevation (Svendsen, Bonde et al., 2004). Overall arm elevation exposure levels in female hairdressers was greater than exposure levels in dental hygienists (6.9% versus 13% of workday) for percent time above 60 ; however, dental hygienists had greater arm elevation exposure levels than hairdressers (2.6 versus 2.1% of workday) for percent time above 90 (Veiersted et al., 2008). When compared with several relevant reports, the prevalence of shoulder complaints was greatest for the current dental hygienists than other groups, where 38% of dental hygienists (8/21) had at least one prior injury within the past 12 months. House painters had the second highest number of shoulder injuries, with roughly 32% (241/758) of workers having a shoulder injury within the past 12 months (Svendsen, Bonde et al., 2004). Hairdressers had the lowest number of injuries reported, with roughly 24% of workers reporting an injury (84/350) (Veiersted et al., 2008).

The use of tri-axial accelerometers can accurately quantify shoulder elevation exposure levels in dental hygienists (Amasay et al., 2010). In the current study, full workday arm elevation exposure levels varied between the two occupations tested. Study limitations include only sampling from a single workday from both dental hygienists and office workers. Further, as with any skin mounted device, skin motion artifact is a potential limitation. Care should be taken to ensure that devices mounted on skin do not move with respect to the skin during the workday.

Exposure to arm elevation above 30 and 60 in dental hygiene may be related to the relatively high prevalence of shoulder injuries in this field. Based on the results of the jerk analysis as well as information from the literature, it is likely that dental hygiene requires repetitive and unsupported arm positions, which may be fatiguing (Akesson et al., 2000; Oberg T, 1993). From this study's questionnaire, 6531iene(t)-23romC2-1.27m

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