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ABSTRACT

A joint study was conducted by a manufacturer of dental stools in the Midwest of the United States and Marquette University to measure the occupational postures of dentists and dental hygienists. The postures of 10 dentists and 10 dental hygienists were assessed using work sampling and video techniques. Postural data of the neck, shoulders and lower back were recorded from video and categorized into 30-degree intervals: 0 (neutral posture of respective joint), 30, 60 and 90 degrees. Each subject's postures were observed while they were treating patients during a four-hour period, during which 100 observations of postures were recorded at random times. Compared to standing, dentists and dental hygienists were seated 78 percent and 66 percent of the time, respectively. Dentists and dental hygienists flexed their trunk at least 30 degrees more than 50 percent of the time. They flexed their neck at least 30 degrees 85 percent of the time during the four-hour duration, and their shoulders were elevated to the side of their trunk (abducted) at least 30 degrees more half of the time. The postures of the trunk, shoulders, and neck were primarily static. This database of postures can be used by dental professionals and ergonomists to assess the risk dentists and dental hygienists are exposed to musculoskeletal disorders, such as low back pain or shoulder tenosynovitis, from deviated joint postures. They could use these data to select dental furniture or dental devices that promote good body posture, i.e., reduce the magnitude and duration of deviated joint postures, which, in theory, would decrease the risk of musculoskeletal disorders.

Numerous studies, including an exhaustive review of the literature,[1] have shown that dentists and dental hygienists work in postures that make them susceptible to musculoskeletal disorders.[2-4] Dentists and dental hygienists work in postures that expose them to long-duration static muscle loads that can cause musculoskeletal disorders and pain. Examples of musculoskeletal disorders are low back pain and shoulder tendinitis. Prolonged exertions of the muscles of the neck, back and shoulders have been reported as the greatest number of complaints from both dentists and hygienists,[5-6] and these prolonged exertions could pose dental professionals to risk of musculoskeletal disorders. To the authors' knowledge, no detailed task analysis of the magnitude and duration of joint postures have been conducted. Results from a detailed task analysis would enable dental professionals and ergonomists to determine which joints have the most non-neutral (deviated) postures, and thus, where to direct their efforts to reduce the deviated postures.

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New office furniture or dental devices that promote more neutral joint postures could be implemented in operatories, which in theory would reduce the risk of musculoskeletal disorders.

In response to reports of dental workers' pain from static postural loading and the lack of documentation of magnitude and duration of dental professional's body postures, a task analysis consisting of work sampling techniques and video analysis was conducted to collect postural data of dentists and hygienists.

Method

Approach

There are many dental procedures that demand dentists and hygienists to maintain working postures that put them at risk of musculoskeletal disorders. Previous studies have shown there is a high frequency of musculoskeletal problems among both dentists and dental hygienists.[2,3,5] In 1987, the annual income lost due to musculoskeletal complaints in dentistry was $41 million; the present amount in annual income would be much greater than $41 million, given the effect of inflation.[6] While statistics have been recorded for the incidence of musculoskeletal disorders in the dental profession, there is a lack of data concerning the working postures of dentists and hygienists.[1] Quantitative data on the working postures of dental professionals could be used to design dental equipment in order to improve postures and reduce the risk of musculoskeletal disorders.

The approach of the task analysis was to use work sampling techniques in order to collect postural data from dentists and dental hygienists at work. Preliminary data collection and analysis were conducted at the Marquette University Dental School in order to develop the appropriate procedures and protocol. After this was completed, four

Milwaukee-area dental practices were selected as sites for data collection. The dentists and dental hygienists were monitored in their normal work areas (operatories) while performing their tasks in a typical manner. Each dentist, hygienist, and the patient being worked on were informed that the work sampling data were being collected.

Subjects

Working postures of 10 dentists and 10 dental hygienists at four different dental practices in the Milwaukee area were observed.

Apparatus

The equipment used in the task analysis was a video recorder and a chronograph. The video recorder was placed in the best available location in the operatory to observe the working postures of the dentists and hygienists. It was set for continuous recording during a four-hour work sampling period, with the video tapes being changed at the two-hour mark. The chronograph was used to keep track of the scheduled observation times, which were generated randomly throughout the four-hour session.

Experimental Protocol

A work sampling packet was created for each of the 10 dentists and 10 dental hygienists during the data collection phase of the task analysis. This packet was developed from a preliminary analysis conducted at the Marquette University Dental School. Using the postural analysis protocol, the analyst recorded the following data at 100 randomly generated times during a four-hour session.[7] At each observation time, the analyst estimated the angles of the major joints of the dentists or hygienists.

Operator Status

P = working on the patient

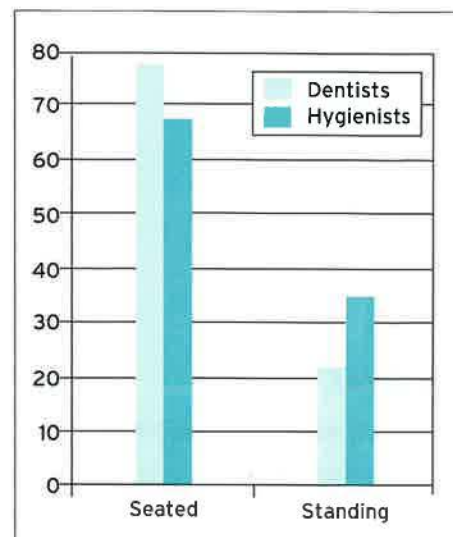W = working on something other than the patient

Figure 1. Percentage of time dentists and hygienists spent sitting vs. standing.

T = talking to the patient while not doing P or W

0 = out of the room

Seated or Standing

Marked one column if seated and another column if standing

Trunk Posture

0 = 0-degree trunk flexion (trunk vertical)

30 = 30-degree trunk flexion (trunk bent forward 30 degrees from vertical)

60 = 60-degree trunk flexion (trunk bent forward 60 degrees from vertical)

Neck Posture

0 = 0-degree neck flexion (neck in line with the axis of trunk)

30 = 30-degree neck flexion (neck bent 30 degrees forward from axis of trunk)

60 = 60-degree neck flexion (neck bent 60 degrees forward from axis of trunk)

Shoulder Posture

0 = 0-degree shoulder abduction (arms at the side of the trunk)
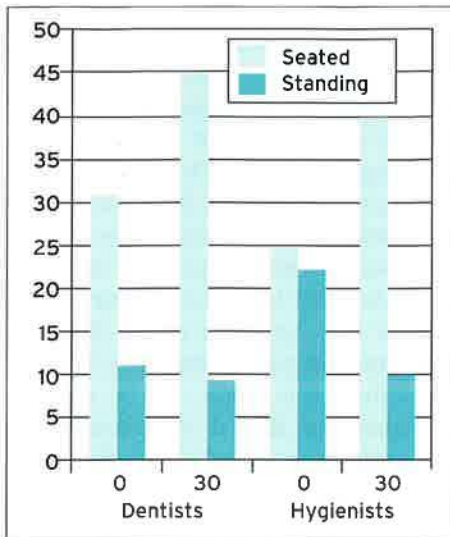
30 = 30-degree shoulder abduction

Figure 2. Percentage of time dentists and hygienists worked with different angles (in degree) of trunk flexion (from vertical). The percentage of time spent in a posture greater than 60 degrees was less than 3 percent.
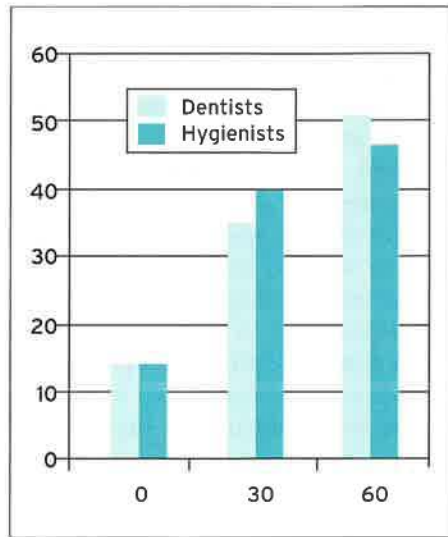

Figure 3. Percentage of time dentists and hygienists worked with different angles (in degrees) of neck flexion. Zero-degree neck posture was the posture when the neck was in line with the trunk.
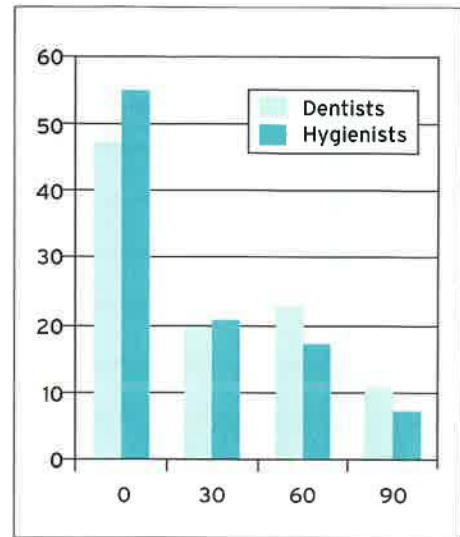

Figure 4. Percentage of time dentists and hygienists worked with different angles (in degrees) of left shoulder elevation (abduction). Zero-degree shoulder elevation was the posture when the arm was at the side of the trunk.

(arms elevated 30 degrees to side of trunk)

60 = 60-degree shoulder abduction (arms elevated 60 degrees to side of trunk)

90 = 90-degree shoulder abduction (arms horizontal to the side of trunk)

The information recorded above formed the basis of the task analysis. The video camera was set up inconspicuously in a corner of the room, and the analyst minimized his presence by making the observations from outside the working area. At the beginning of the four-hour period, the camera was turned on and observations were recorded whether the dentist or hygienist began working on a patient or not. Each patient during that period was told what type of study was being conducted and then asked for his/her permission to be filmed during the procedure. The session was filmed for four hours, during which time the 100 observations were made. In addition to the data collected on the work sampling charts, other valuable information was gained during the task analysis simply by speaking with each of the subjects and

finding out their personal opinions on their posture, the dental stools currently in use, and what improvements they would like to see.

Results

Operator status reveals the percentage of time actually spent working in the operatory where the work sampling and video taping was taking place. The dentists were in the room approximately 70 percent of the time and the hygienists were in the room 80 percent of the time. The percentages on joint posture were based on the time spent working in the operatory. For instance, as shown in **Figure 3a**, the dentists flexed their neck approximately 30 degrees 35 percent of the time while they were actually observed in the room, not 35 percent of the entire four-hour observation period.

As shown in **Figure 1**, the seated vs. standing data showed that the dentists spent about 78 percent of their working time seated and only 22 percent standing. (Note: working time is the time spent in the operatory, which is equal

to P+W+T in the Experimental Protocol section.) The hygienists spent 66 percent of working time in a seated position. The main reason for this difference is that the hygienists spent a portion of their working time cleaning the room and equipment between patients, while the dentists had their assistants clean and prepare the room for the next patient. The trunk posture data provided in **Figure 2** reveals that the dentists spend almost 58 percent of their working time in some degree of trunk flexion, whether seated or standing. A trunk flexion of approximately 30 degrees is most prevalent, occurring almost 45 percent of the time. The postural results for the hygienists are quite similar to that of the dentists. As shown in **Figure 2**, the hygienists flexed their trunk 30 degrees about 50 percent, similar to the 53 percent for dentists.

Figure 3 provides the neck posture data for the dentists, which indicate dentists exhibited at least 30 degrees of neck flexion 86 percent of the time while working in the room, 35 percent of the time at 30 degrees and 51 percent of the
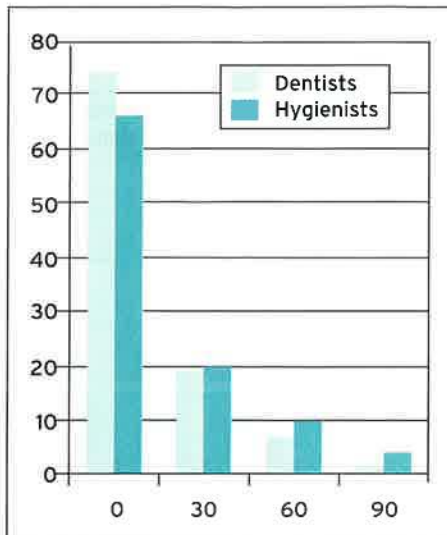
Figure 5. Percentage of time dentists and hygienists worked with different angles (in degrees) of right shoulder elevation (abduction). Zero-degree shoulder elevation was the posture when the arm was at the side of the trunk.

time at 60 degrees. The hygienists exhibited results similar to those of the dentists in that hygienists had at least 30 degrees of neck flexion 86 percent of the time, the same percentage as the dentists.

The shoulder posture data shows the dentists had some degree of elevation (abduction) more than 50 percent of the time in the left shoulder, as seen in **Figure 4**, but only about 25 percent of the time in the right shoulder, as shown in **Figure 5**. The hygienists' left shoulders were abducted 45 percent of the time, while their right shoulders were abducted 34 percent of the time.

Discussion

In this study, the analyst estimated the postural angles in discrete 30-degree increments for ease of observation and analysis. Although this technique has been used previously to record upper extremity posture in a poultry processing plant, this method does have limitations due to the low resolution of the measurement intervals.[7] Therefore, the results from this study must be interpreted to show only patterns of trunk

and upper extremity postures and not exact angles.

The data from this task analysis agree well with postural data and incidence of musculoskeletal disorders reported in the published literature. The seated vs. standing data showed that the dentists spent about 78 percent of their working time seated and only 22 percent standing, which agrees with the literature.[5] A trunk flexion of approximately 30 degrees is most prevalent, occurring almost 45 percent of the time, which may explain why pain is often reported in the lower back of dentists.[2,3,5] The dentists spent more than half of their working time with their neck flexed approximately 60 degrees, which agrees with the results found previously in the literature that the neck is an area of primary concern.[2,3,5] The reason for the difference in the abduction angle between the right and left shoulders is due to the right-handed dominance of all the dentists and hygienists surveyed. The typical working position for right-handed dentists and hygienists is to abduct the left shoulder and hold the right arm close to the trunk.

The postural data from the task analysis of both dentists and dental hygienists show that they spent at least half of their time working with their necks flexed 60 degrees or greater, their trunks flexed 30 degrees or greater, and one of their shoulders abducted. Because of the mechanical disadvantage of the muscles with respect to their joints, flexed and abducted joint postures require high muscle forces to hold these static postures. The high muscle forces then produce high compression loads on the joint. The postures assumed by dentists and dental hygienists can require sizeable muscle forces, and concomitantly, high compression loads on the joint. Except for the weight of small instruments, and an occasional push or pull from the hand, the only

external forces acting on dentists' and hygienists' joints are from the weights of their body segments, which have to be maintained at flexed and abducted angles at least half of the time spent working on patients. The clinical consequences of prolonged, flexed or abducted postures of the joints can be numerous, such as muscle pain in the neck, shoulder, and lower back musculature; rotator cuff syndrome in the shoulder, and low back pain or disorders. Postural data from this study can be used by designers of dental equipment and instruments as a baseline to either modify existing or design new equipment and instruments that would promote more neutral joint postures. Reductions in back and neck flexion and shoulder abduction would, in theory, improve the occupational health of dentists and dental hygienists. CDA

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