

REDUCING MUSCULOSKELETAL STRAIN WITH THE USE OF MOVABLE GEL ELBOW RESTS IN A DENTAL CLINIC

PROTEAU ROSE-ANGE

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Abstract

The work of dental hygienists imposes prolonged static muscle load on the upper limbs. To date, few solutions have been studied to reduce this load. Our study was designed to see if the use of new movable gel elbow rests reduced static stress on the shoulders under usual working conditions. Ten volunteer hygienists in the Montreal area took part in the study. The muscular activity of eight muscles was measured by surface electromyography (EMG) before and after one month's use of the new elbow rests. The results showed a significant reduction in upper trapezius muscle load. The hygienists were all right-handed and the reduction was more significant on the left side. Most of the hygienists observed succeeded in changing their position with respect to the patient's head, to reduce the frequency and range of arm abduction. Use of the elbow rests did not lead to any increase in muscle load on the wrists.

Keywords: Dental hygienist, movable elbow rests, static work

DIMINUTION DES CONTRAINTES MUSCULO-SQUELETTIQUES PAR L'UTILISATION
D'APPUIE-COUCDES MOBILES EN GEL EN CLINIQUE DENTAIRE

Résumé

Le travail des hygiénistes dentaires impose une charge musculaire statique prolongée au niveau des membres supérieurs. À ce jour, peu de solutions ont été étudiées pour réduire cette charge. L'étude visait à vérifier si l'utilisation des appuie-coudes mobiles en gel permettait d'alléger la contrainte statique aux épaules en situation réelle de travail. Dix hygiénistes volontaires de la région de Montréal ont participé au projet. L'activité musculaire de huit muscles a été mesurée par électromyographie de surface (EMG) avant et après un mois d'utilisation des nouveaux appuis. Les résultats ont démontré une réduction significative de la charge musculaire des trapèzes supérieurs. Les hygiénistes étaient toutes droitrières et la réduction a été plus importante du côté gauche. La plupart des hygiénistes observées ont réussi à changer leur position par rapport à la tête du patient pour réduire la fréquence et l'amplitude de l'abduction des bras. L'utilisation des appuis n'a pas entraîné d'augmentation de la charge des muscles responsables des mouvements des poignets.

Mots clés : Hygiénistes dentaires, appuis-coudes mobiles, travail statique

INTRODUCTION

Over the past four years (1997-2001), a number of dental hygienists consulted the *Association pour la santé et la sécurité du travail secteur affaires sociales* (ASSTSAS) about various physical problems they had developed in their shoulders, elbows, wrists, hands and fingers. These problems had forced them to stop working for an extended period of time. Some hygienists had found it difficult to return to work, while others had had to change careers. The work of dental hygienists imposes tremendous static load on the muscles responsible for mobilizing the shoulder girdle, shoulder and elbow (Oberg, 1993). This load is mainly associated with positioning and stabilizing the joints responsible for the precise hand and finger movements used when performing operations related to cleaning teeth (scaling, ultrasound, etc.). In dental clinics, hygienists in particular must frequently keep their arms in a position of significant abduction (*arms held away from the body*). The right arm is placed in a position of abduction above the patient's chest, while the left arm is in abduction above the patient's head (see figure 1).



Figure 1. Both arms in abduction at the same time when the hygienist is positioned beside the patient's head (left). Arms are closer to the body when using movable gel elbow rests (center and right).

An earlier study (5) showed that the introduction of telescopic pivoting arm rests (designed for office workers) and weekly monitoring of working positions for two months had helped hygienists reduce the amount of time spent in abduction for both arms. During this same period, the time spent working behind the patient's head increased. In 1998, EMG measurements of one hygienist who had been using these arm rests for more than a year revealed a significant reduction in the percentage of maximum voluntary contraction (MVC) in the upper trapezius muscles, dropping from more than 10% to less than 5% (2). This study showed a slight increase in forearm muscle contractions when using vibrating tools (ultrasound and polishing).

Recently, ASSTSAS was involved in developing a new movable gel elbow rest. The purpose of this project was to increase the comfort and function of the elbow rest and to reduce the effects of vibrations produced by certain tools (polishing and ultrasound). The equipment had to support the hygienist's elbows while maintaining freedom of horizontal movement. Since the elbow is somewhat moulded into the gel, the elbow rest follows the arm movement more easily than a rigid support system.

The purpose of this study was to evaluate the physical impact of using these new movable gel elbow rests and their potential for fostering the adoption of safer working positions and methods. More specifically, it also aimed to see if the elbow rests helped reduce static muscle load under actual working conditions, with monitoring and basic training on ergonomic concepts, in order to prevent musculoskeletal disorders.

1- METHODOLOGY

Ten dental hygienists volunteered to participate in this study at six dental clinics in the Greater Montreal area. Their work experience ranged from 1 to 22 years. Assessment of physical workload was performed on two occasions. On the first measurement day, the hygienists used their usual stool and working methods. Over the next few days, an ASSTSAS ergonomics counsellor met with each hygienist during the workday to observe her working methods and to give her advice about working techniques that could reduce musculoskeletal strain. A prevention handbook for dental hygienists was provided at the end of the meeting (4). The hygienists were then given one month to familiarize themselves with the new gel elbow rests and to implement the advice they had been given. After this period of adaptation, muscle load was reassessed.

On each of the two evaluation days, data was collected on an average of four clients who had come in to have their teeth cleaned. Muscle workload was measured by surface EMG (ME3000P8) with a sampling frequency of 1000 Hz, averaged and recorded every 0.1 seconds. The eight muscles evaluated were: bilateral upper trapezius and bilateral anterior deltoids, first right radial, right anterior cubital and bilateral spinal erectors. The EMG (μV) results were then converted into a percentage of maximum voluntary contractions using the highest maximum voluntary effort achieved for each muscle. The EMG was synchronized with video monitoring using a temporal marker. The use of three miniature cameras made it possible to view the hygienist's work on three planes and to classify the tasks being performed. These measurements were then compiled to compare the muscle load associated with each step of the procedure, with and without the elbow rests.

RESULTS

Muscle analysis

For the hygienists' principal work activities, the results of the variance analyses (ANOVA) show that using the elbow rests causes a significant reduction ($p < 0.05$)** in the use of the muscles responsible for stabilizing the arms. Scaling, ultrasound and polishing are the three activities which present a significant decrease in the use of muscles responsible to stabilize the shoulders. Figure 2 shows the decrease recorded in the use of the right and left **upper trapezius** muscles. For the left upper trapezius, use of the elbow rests led to an average reduction of 38% to 50% and made it possible to approach a safer level of static load, of 5% or less, as suggested by the works of Bjöksten & Jonsson (1). For the right upper trapezius, there was less reduction, i.e. an average of 8% to 23%, but the elbow rests also made it possible to approach safe levels when using curets and ultrasound. When using dental floss, it seems that the majority of the hygienists made little use of the elbow rests, but a statistically significant effect was observed nevertheless.

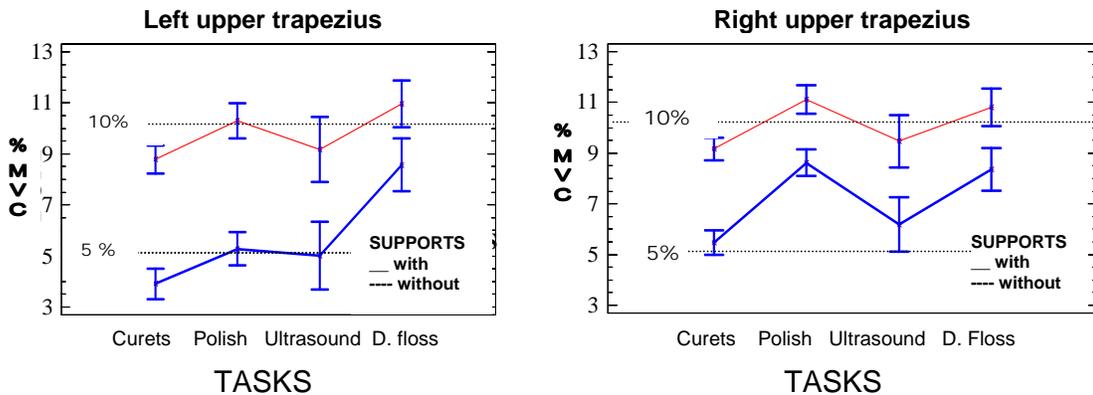


Figure 2. Average percentage of maximum voluntary contraction (MVC) with and without movable gel elbow rests (*SUPPORTS*), for the upper trapezius muscles when performing four cleaning tasks: using curets, polishing, ultrasounds and dental floss.

Despite a predictable reduction in the load on the shoulder girdle and shoulder muscles, the study aimed to show that use of the elbow rests did not result in overloading the muscles responsible for mobilizing the hands. As indicated in figure 3, the use of the movable gel elbow rests did not result in an increase in the load on the first right radial and the right anterior cubital. The mobility of the elbow rests and the changes in working methods probably contributed to this result. The first radial is responsible for the extension and radial deviation movements of the hand and the anterior cubital is responsible for ulnar flexion and deviation. These movements are frequently used for cleaning procedures.

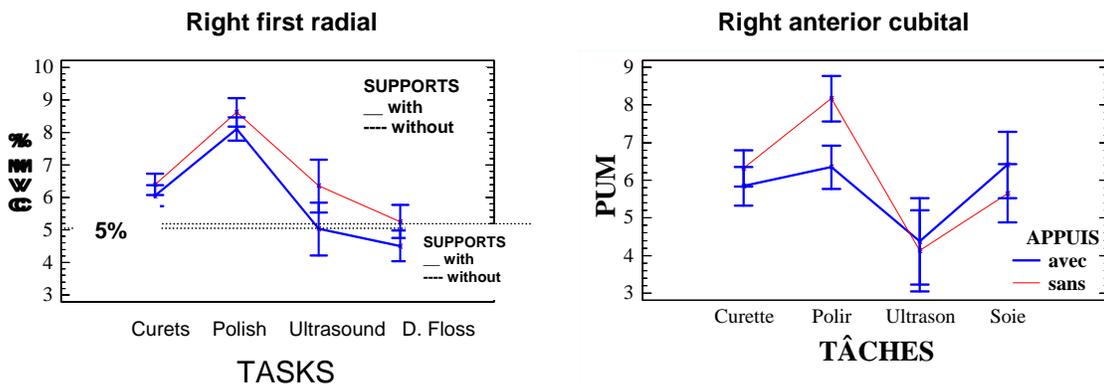


Figure 3. Average percentage of maximum voluntary contraction (MVC) with and without movable gel elbow rests (*SUPPORTS*), for the first right radial and the right anterior cubital when performing four tasks: using curets, polishing, ultrasounds and dental floss.

Impact on working postures in relation to the patient's head

The elbow rests and training are designed to reduce the use of postures with the arms maintained in a position of abduction above the client's chest and head. These postures, frequently observed when the hygienist is working beside the patient's head (8:00, 9:00 and 10:00 clock positions) are less common when she is positioned behind the patient's head (11:00 and 12:00 positions). An analysis of the percentage of time spent beside and behind the patient's head gives an indication of the impact of using the elbow rests and education about working methods. The posture analyses revealed that the percentage of time spent working behind the patient's head increased to 32% by the time of the second evaluation ($p < 0.05$). In addition to providing arm support, use of the movable gel elbow rests seems to facilitate the adoption of safer working methods by dental hygienists.

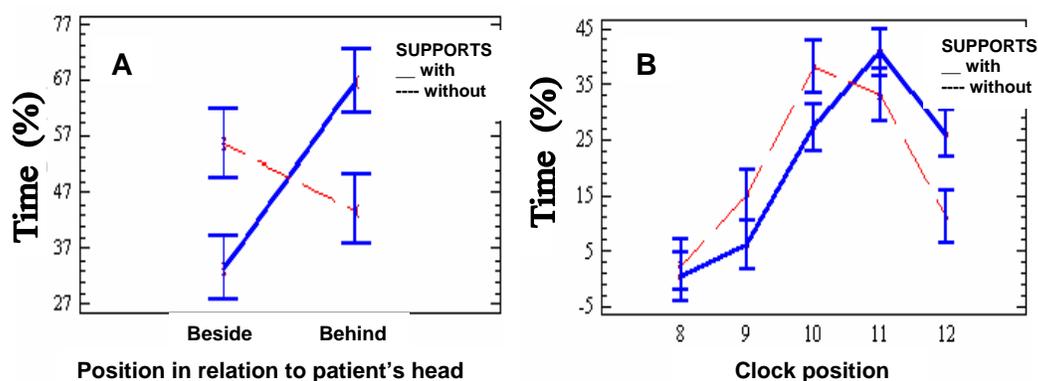


Figure 4. Percentage of time spent beside and behind the patient's head (A) and in different clock positions (B), with and without movable gel elbow rests

CONCLUSION

According to the results of the study, the use of movable gel elbow rests seems to be an interesting solution for reducing discomfort related to maintaining certain static postures. These elbow rests lead to a significant reduction in MVC when performing three demanding tasks. A more significant reduction was observed in the muscles that stabilize the left shoulder (the side that holds the mirror and suction). Without support, this activity is most often performed with the arm in pronounced abduction. According to observations, this reduction in static workload is associated with the combined effect of using the movable gel elbow rests and changes in working methods. The hygienists observed changed their working positions with respect to the patient's head, positioning themselves behind the patient's head more frequently. The elbow rests probably helped them make this change.

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REFERENCES

- (1) Bjöksten, M. & Jonsson, B. (1977). *Endurance Limit of Force in Long-Term Intermittent Static Contractions*. Scandinavian Journal of Work Environment and Health 3, pp 23-27.
- (2) Marchand, D. (1999). *L'utilisation des mesures quantitatives pour mesurer la charge de travail physique en situation réelle de travail*, Actes du 21^e Congrès de l'Association québécoise pour l'hygiène, la santé et la sécurité du travail (AQHSST), May 1999, p. 96-99.
- (3) Oberg, T., Oberg, U., (1993). *Musculoskeletal Complaints in Dental Hygiene: a Survey Study from a Swedish County*, Journal of Dental Hygiene, 67, 257-261.
- (4) Proteau, R.-A. (1999). *Guide de prévention des troubles musculo-squelettiques chez les hygiénistes dentaires*, ASSTSAS, 75 p.
- (4) Proteau, R.-A. (1997). *Étude ergonomique en clinique dentaire*, Université du Québec à Montréal and ASSTSAS, 105 p.