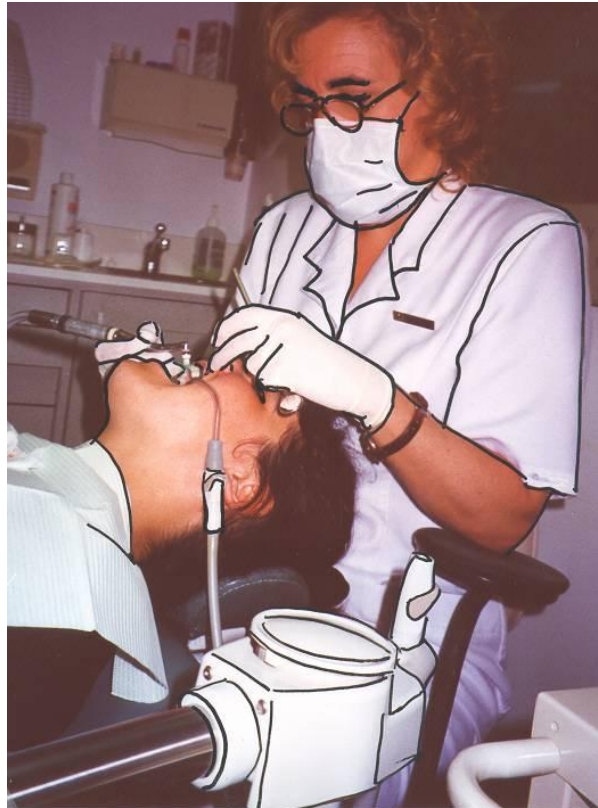


Prevention of Work-Related Musculoskeletal Disorders (MSDs) in Dental Clinics



Rose-Ange Proteau



ASSTSAS
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*ensemble **en** prévention*

**ASSOCIATION PARITAIRE POUR LA SANTÉ ET LA SÉCURITÉ DU TRAVAIL
DU SECTEUR AFFAIRES SOCIALES**

2009

**L'Association paritaire pour la santé et la sécurité du travail
du secteur affaires sociales (ASSTSAS)**

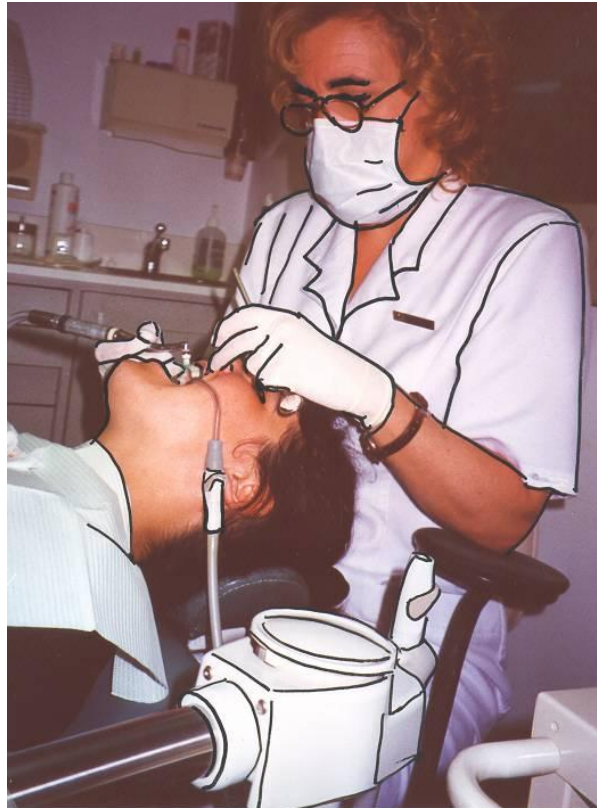
Mission

To promote prevention in occupational health and safety and to support its clientele in a joint labour/management context, by providing information, training, consulting, and research and development services and by implementing preventive actions while striving for work process efficiency and taking into account the safety of clients in the institutions.

Joint sector-based structure and funding

The ASSTSAS is a non-profit organization, managed by a general assembly and a board of directors consisting of an equal number of representatives from trade union associations and sector employer organizations. It is funded mainly through premiums collected from all employers in the health and social service sector.

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This document is a translation of excerpts from the French manual “*Guide de prévention des troubles musculo-squelettiques (TMS) en clinique dentaire,*” 2007 (276 pages).

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INTRODUCTION

“An ounce of prevention is worth a pound of cure.” That’s what dental health workers spend their days telling their patients (“*Brush your teeth, use dental floss...*”). It also applies to working conditions that can cause neck, shoulder, elbow, wrist, and lower back pain in dental health workers.

In dental clinics, there are very few activities that can cause sudden injuries or pain. Rather, it is an accumulation of seemingly innocuous or harmless working positions and small gestures that, over the course of months and years, are repeated so often that they may end up causing injuries. These injuries can make life and work difficult, and may even lead to permanent disability.

Did you know that although most dental health workers are right-handed, many have left shoulder pain? Simply holding a mirror can cause injuries that make work uncomfortable, or even painful, requiring treatment and sometimes forcing people to stop working. It's not just holding the mirror that places a load on the shoulder, but holding the mirror while keeping your left arm elevated for many minutes at a time, several times a day.

Louise had to leave her job as a dental hygienist after 18 years, because of the destruction of the supraspinatus tendon (rotator cuff) in her right shoulder. Sylvie, a 40 year-old hygienist, works only 20 hours a week now instead of full time. Albert, a 50 year-old dentist had to sell half of his practice, because he was no longer able to work fulltime. Is it possible to work in dentistry without risking one’s health?

For the past five years, the *Association pour la santé et la sécurité du travail, secteur affaires sociales* (ASSTSAS) has been studying the working conditions of hygienists, dental assistants and dentists with serious shoulder, neck, lower back, upper back, elbow, wrist and hand pain. At the *Journées dentaires internationales du Québec*, held in Montreal in May 2002, ASSTSAS launched its new manual *Prévention des troubles musculo-squelettiques en clinique dentaire* (Prevention of Musculoskeletal Disorders (MSDs) in Dental Clinics), available in French only. This guide was updated in 2007. The 276-page manual is fully illustrated (200 illustrations and 250 photos) and covers the following topics:

- Status of the situation
- Risk factors for MSDs in dental clinics
- Anatomy, physiology and pathologies relating to shoulder, neck, upper and lower back MSDs, and proposed solutions
- Anatomy, physiology and pathologies relating to elbow, wrist and hand MSDs, and proposed solutions
- Results of a study on reducing musculoskeletal strain with the use of free-motion elbow rests in a dental clinic.

This document presents excerpts from this manual, mainly sections related to shoulder, neck, and upper and lower back MSDs.

PART ONE: PROBLEMS INVOLVING THE SHOULDER, NECK, UPPER AND LOWER BACK

1. STATUS OF THE SITUATION

1.1 Literature review

A number of studies have looked at musculoskeletal problems in dental hygienists and dentists (Oberg, 1993, Osborn, 1990, Rundcrantz et al., 1991, etc.). Symptoms may only appear after a few years of practice, but seem to get worse after 10 years. According to Osborn (1990), 68% of hygienists experienced musculoskeletal (MS) pain in the past year and this pain affected their professional life in nearly one-third. MS pain seems to be more common among hygienists than among dentists because of their scaling activities. Letho (1991) pointed out that female dentists suffer more neck and shoulder pain than their male counterparts, as indicated in the following table.

Table 1		
Incidence of MSDs in male and female dentists*		
	Male Dentists	Female Dentists
Neck pain	45%	67%
Shoulder pain	50%	72%

*Letho et al. "Musculoskeletal symptoms of dentists assessed by a multidisciplinary approach," *Community Dent Oral Epidemiol.* 1991; 19: 38-44.

In Ontario, Liss and Jesin (1998) analysed the incidence of pain in 951 hygienists and 109 dental assistants who had filled out a questionnaire. The results are presented in the table below.

Table 2		
Incidence of MSDs in dental hygienists and assistants in the past 12 months*		
Region affected	Dental hygienists	Dental assistants
Neck	69%	57%
Shoulders	50%	27%
Lower back	65%	67%
Wrists/ hands	47%	27%

* Liss, Gary M. and Evie Jesin, "Musculoskeletal Problems among Dental Hygienists: a Canadian Study," *Ergonomics and the Dental Care Worker*, American Public Health Association, 1998, Chap. 6, p. 151.

In the literature, few strategies have been proposed to solve these problems. Some authors have suggested approaches relating mainly to postural hygiene (Murizio, S et al., 1995; Pollack, 1996; Freedman, 1997). Others have suggested making some equipment changes. For instance, Oberg (1993) tested an armrest attached to the back of the patient's chair.

1.2 Injuries compensated by the CSST in the province of Quebec (2001-2005)

Statistics from the *Commission de la santé et de la sécurité du travail (CSST) (Quebec Worker's Compensation Board)* data base provide information about the number of injuries in dental clinics that have been recognized and compensated, involving the following professions: dental hygienists, dental assistants, dental technicians, denturists and a few dentists (the majority of dentists are covered by private insurance). Since dental hygienists and dental assistants make up the majority of this group, the total number of injuries is probably quite representative for these two groups, but they cannot be looked at separately. The data presented cover five years, i.e. 2001 to 2005. Table 3 outlines the number of injuries per body area, along with the average number of days lost per injury and the amount of compensation.

The cost of musculoskeletal disorders (MSDs) in dental clinics was about five million dollars (\$5,181,679) between 2001 and 2005 (five years). About 75% of these injuries affect five main sites and account for 80% of the cost. Table 3 presents these injuries according to average cost per injury (wages lost and treatments).

Table 3
Percentage of injuries in dental clinics compensated by the CSST,
average number of days lost and cost according to site of the injury
in Quebec from 2001-2005

Body area	Injuries		Number of days	Average cost per injury (wages lost and treatments)			Total cost per body area	
	Number	%	Average per injury	Wages lost (WL)	Treatment (T)**	TOTAL (WL+T)	Per site	%
Cervical area	51	18%	323	\$19,709	\$5,654	\$25,363	\$1,293,513	25%
Shoulders	43	15%	276	\$17,472	\$4,965	\$22,437	\$964,791	19%
Wrists	38	13%	276	\$14,761	\$5,101	\$19,862	\$754,756	15%
Elbows	21	7%	251	\$13,064	\$6,839	\$19,903	\$417,963	8%
Lower back	63	22%	145	\$8,108	\$3,586	\$11,694	\$736,722	14%
Subtotal	216	75%	254	\$14,623	\$5,229	\$19,852	\$4,167,745	80%
Others	71	25%	n/a	n/a	n/a	\$14,281	\$1,013,934	20%
TOTAL MSDs	287	100%	233	\$9,388	\$4,626	\$18,055	\$5,181,679	100%

Source: CSST statistics for employers from SciAn Services classification codes 621210 and 621390.

*Data as at Dec. 31, 2005 for 2001, Dec. 31, 2006 for 2002, January 31, 2007 for 2003 to 2005

**Treatment includes cost to adapt the workstation.

The average cost of compensation (wage loss disability payment) plus payment for the treatment of cervical neck injuries alone was over \$25,000 per injury for a total of \$1.3 million. The average number of days lost is 323 days, which is neatly a year ! The average cost for shoulder injuries was \$22,437. Even though there are more lower back injuries, the cost and the number of days lost per injury is lower, i.e. \$11,697, averaging 145 days.

The average of 233 lost days per MSD injury in the dental field is three times higher than the cost of MSDs in the entire health and social services sector (hospitals, nursing homes, home care, etc.), which was 52 days in 2005.

1.3 Compensation from insurance companies for prolonged disabilities

It is difficult to find detailed information on disabilities covered by group insurance plans. For dentists, we were able to obtain a breakdown of the causes of prolonged disability from the Canadian Dentist Services Plans Inc. for 2000. Musculoskeletal problems (back and joints) account for more than one-third (39%) of the claims related to prolonged absences. All of the causes are presented in the following table.

Back and musculoskeletal	39%
Mental and nervous (e.g. depression)	12%
Cancer	10%
Heart	8%
Pregnancy	9%
Digestive tract	4 %
Stroke/CVA	3%
Accidents	3%
Other diseases	12%

Source: Canadian Dentist Services Plans Inc. for Canada, except for the province of Quebec.

For dental hygienists and assistants, the breakdown of insurance claims from one Quebec insurance company, for leaves of undetermined duration is as follows:

Primary cause	Musculoskeletal problems (shoulders, arms)
Other causes	Carpal tunnel syndrome Depression Cancer Allergies

1.4 History of the hygienists, dental assistants and dentists evaluated by ASSTSAS

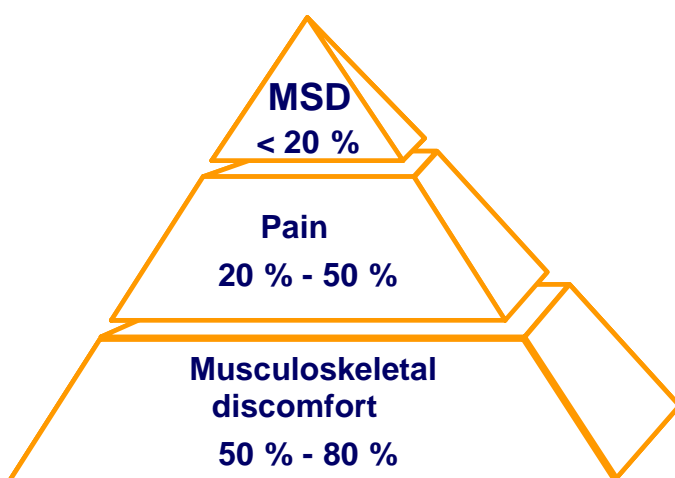
Of the hygienists, dental assistants and dentists who consulted ASSTSAS over the past twelve years, all had pain. While the majority had not stopped working, others were on leave, receiving either worker's compensation or benefits from an insurance plan or were staying at home with no pay. They were waiting for the pain to go away so that they could return to work. Their characteristics were as follows:

- History of mild to severe pain for one to 10 years.
- Numerous therapy sessions (osteopath, acupuncture, physiotherapy, etc.).
- Significant disruption in their day-to-day activities.
- For some, absences ranging from 2 weeks to a year.
- History of recurrence after their return to work.
- Cessation of employment and professional reorientation.

1.5 Questionnaire to screen for symptoms in dental care workers

The number of workers who take sick leave for recognized occupational injuries or disabilities usually accounts for just a small percentage compared to the number of workers who continue to work with aches and pains and those who suffer from musculoskeletal discomfort.

As a complement to CSST and insurance company statistics, it is helpful to look at the data on pain and discomfort in certain parts of the body, even if they have not resulted in disability leave. Injuries reported to the CSST are at the top of the pyramid in figure 1 below. A large number of people experience pain and discomfort, but this does not keep them from working.



At the top of the pyramid, MSDs reported to the CSST and treated medically, affecting the smallest number of workers.

In the middle, workers whose discomfort has developed into pain. If nothing changes in the work situation, this may lead to more severe pain and MSDs.

At the bottom, discomfort affecting a large number of people, but which does not keep them from working.

Figure 1. Pain pyramid in the absence of prevention.

Source: Adapted from Hedge, American Public Health Association, 1998, p.21

Self-administered questionnaires can be used to screen for various levels of MSDs ranging from discomfort to serious pain that disrupts a person's activities. They give a more accurate idea of the worker's condition and the existence of working conditions that may lead to MSDs.

Regardless of the person's sector of activity, changes from one level to another in the pyramid follow the same pattern. Work accidents (unexpected or sudden events) cause sudden pain. But **pain associated with MSDs**, which come on gradually, at first **take the form of discomfort**. If nothing is done to correct the discomfort, it may turn into more serious and more frequent pain, leading to MSDs.

Given the cumulative and gradual nature of MSDs, screening for the frequency of discomfort can be a way to identify the risk of developing MSDs in a given workplace. When several workers in the same group experience similar musculoskeletal problems, there is a strong likelihood that these problems are caused by shared working conditions, but, generally speaking, people are unlikely to experience exactly the same symptoms, with the same intensity.

This does not exclude the possibility, however, that symptoms may be experienced by just one person, and that they may be related to specific or unique working conditions.

1.6 Survey of serious pain among Quebec dental care workers (2003-2004)

In 2003-2004, the *Association des chirurgiens dentistes du Québec* [Quebec Association of Dental Surgeons] asked ASSTSAS to organize a continuing education activity on the prevention of musculoskeletal disorders in dental clinics for its members in 15 Quebec regions. This course was recognized by the *Ordre des dentistes du Québec* [Quebec Order of Dentists] for six credit hours of continuing education. In some parts of the province, dentists invited their staff to the sessions, while in others, such as the Greater Montreal and Quebec City areas, they did not.

Participants were asked to fill out a questionnaire before the meeting started and to return it before they left. The three-page questionnaire included a schematic drawing of the body indicating the various problem areas to be identified. Of the 1,138 participants, 687 (60%) handed in a completed questionnaire.

To help determine work-related pain, a question from the standardized Quebec Health and Social Survey (*ESSQ-1998*) questionnaire was used:

“In the past 12 months, have you experienced serious pain in any part of your body that interfered with your usual activities?”

The choice of responses was also the same, i.e. ***“never, sometimes, quite often, all the time”***. The questionnaire asked if the respondents were right- or left-handed and, for each area of the body, if they had serious pain, ***“on which side?”***

Of the respondents, 258 were male dentists, 201 were female dentists, 108 were female dental hygienists, and 77 were female dental assistants. The respondents in all job categories worked an average of 32 hours a week.

Since the sample of respondents was not randomly selected, we cannot draw any conclusions about how representative they are for the entire population of dental workers. In the sample, however, the respondents had the same average age as their respective groups. Also, depending on the Quebec region, dentists invited all or none of their staff to attend the conference.

1.6.1 Serious pain is twice as frequent in female dentists as in male dentists

Female dentists have approximately twice as much pain as **male dentists** in the neck, shoulders and upper back (statistically significant $p < 0.001$, when compared with *chi square*) (figure 2). Male dentists had a higher incidence of serious pain than Quebec male workers, but the same incidence as Quebec female workers (see figure 3).

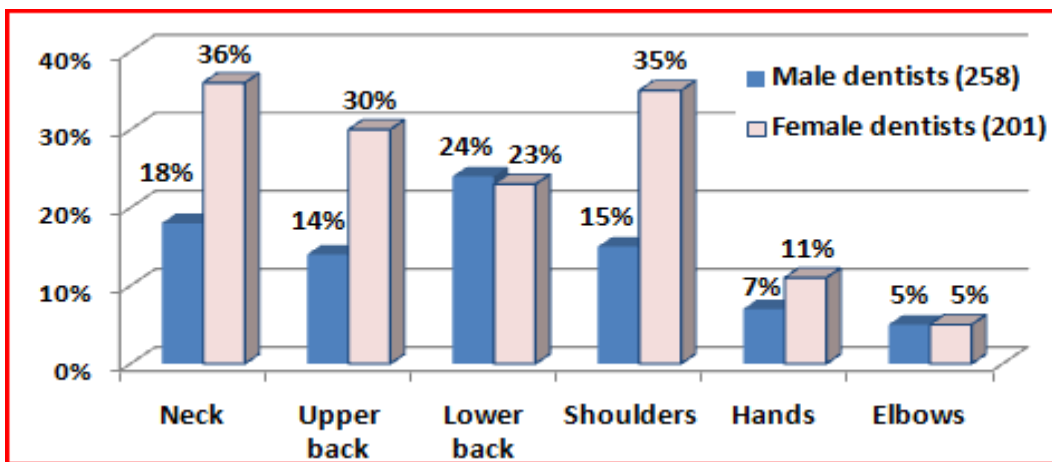


Figure 2. Percentage of male dentists (258) and female dentists (201) who experienced serious pain “quite often” or “all the time” that interfered with their usual activities in the past 12 months.

a) Results for the neck, upper back and shoulder area

These results show that for the neck, upper back and shoulders, male dentists experience fewer MSDs than their female colleagues. In the course of our ergonomic studies, we did not notice any significant difference between the methods and equipment used by male dentists and female dentists.

b) Results for the lower back area

The frequency of lower back pain is the same for male and female dentists (figure 2) and is similar to that of other workers, around 25% (figure 3).

c) Results for other parts of the body

As for other parts of the body (elbows, wrists/hands, hips/thighs, knees, ankles/feet), women in dental clinics indicated an incidence of pain that was the same as or less than that of other workers.

1.6.2 Quebec male and female workers

To analyse the results of the dental worker questionnaire, the responses were compared to those of the 5,500 men and 4,000 women, working 25 hours or more per week, who had responded to the ESSQ-1998 survey and who had checked off “*quite often*” or “*all the time*” for frequency of serious pain in any part of the body.

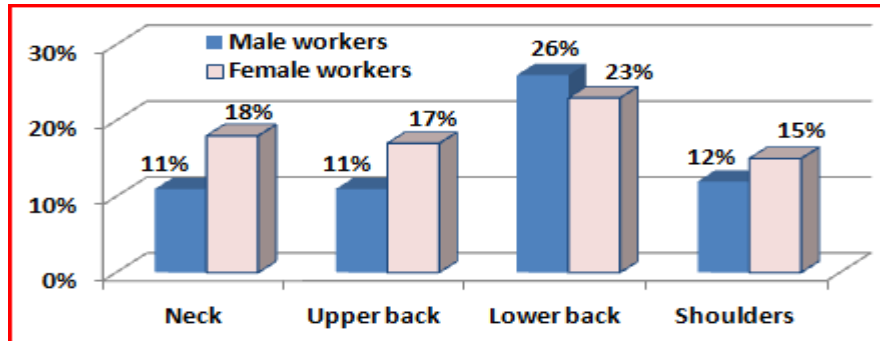


Figure 3. Percentage of Quebec male (5,500) and female workers (4,000), working more than 25 hours/week, who experienced serious pain “*quite often*” or “*all the time*” that interfered with their usual activities in the past 12 months.

The ESSQ-1998 survey showed that women have a slightly higher incidence of pain than men. However, everyone had a lower incidence of pain than female workers in the dental sector.

1.6.3 Results for dental hygienists

Hygienists have the highest incidence of serious pain for many areas of the body of all dental health workers except for the lower back. This incidence is much higher than for other Quebec female workers.

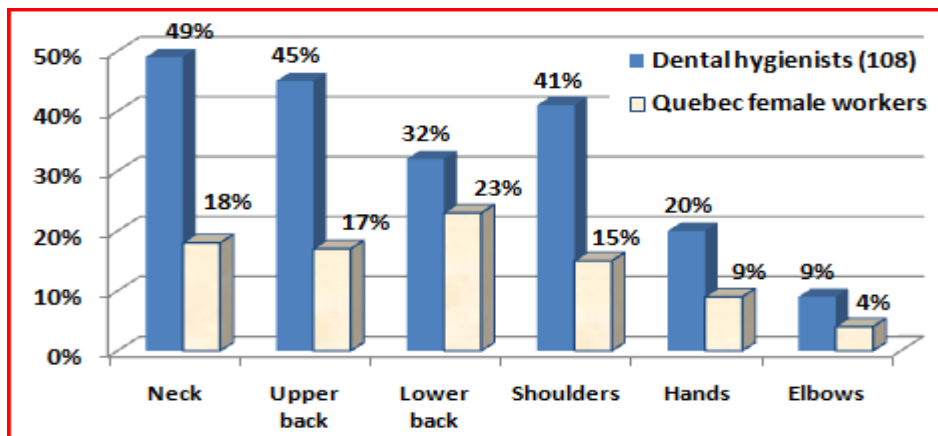


Figure 4. Percentage of dental hygienists (108) and Quebec female workers (4,000) who experienced serious pain “*quite often*” or “*all the time*” that interfered with their usual activities in the past 12 months.

1.6.4 Results for dental assistants

Female assistants have the highest incidence of serious lower back pain (statistically significant $p < 0.005$) of all dental health workers and Quebec female workers. For the other areas of the body, this incidence is similar to that of female dentists.

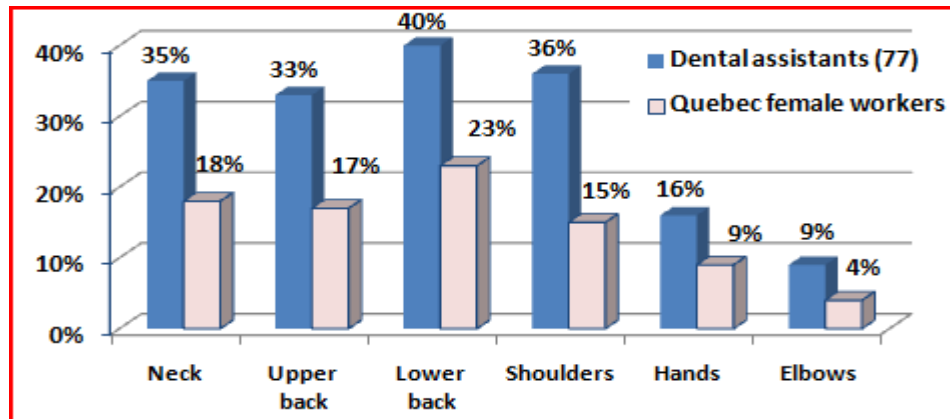


Figure 5. Percentage of dental assistants (77) and Quebec female workers (4,000) who experienced serious pain “quite often” or “all the time” that interfered with their usual activities in the past 12 months.

1.6.5 Results according to dominant hand

Although 90% of the respondents were right-handed and technical procedures are performed by the dominant hand, the right side shows only a slightly higher incidence than the left side (2-6% more), for the neck, shoulders, upper back and elbows. Only the wrist/hand area showed a higher difference of frequency on the right, i.e. 12%. This situation can be attributed to the fact that holding the mirror to pull away the cheek is more static than the work done by the dominant hand. Approximately 20% of the participants had pain on both sides for the neck and upper back, and 13% in the shoulders.

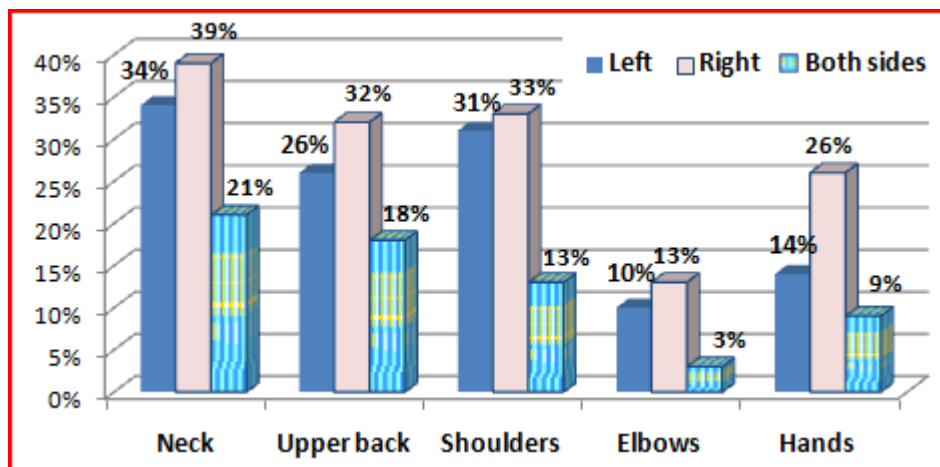


Figure 6. Percentage of dental personnel (687) who experienced serious pain “quite often” or “all the time” that interfered with their usual activities in the past 12 months, on the left side, the right side or both (90% were right-handed).

1.6.7 Why does static work cause more pain in female than in male workers?

According to several studies, mean muscle strength in women for the torso and upper limb muscles is approximately 2/3 that of men's (Laubach, 1969, Webbs Associates, 1978). The fact that men have greater strength probably allows them to reduce the percentage of maximum force required to hold the arms and neck in a static position.

A study of dental hygienists (Proteau *et al.*, 2001) showed that under regular working conditions, the upper trapezius muscles were contracted at approximately 10% of their maximum strength. Reducing static load on the shoulder girdle seems to be particularly important for female dentists and dental hygienists. These values dropped to approximately 5% with the use of *free-motion elbow supports* (Posiflex). This level is considered safe for static work of long duration (Bjoksten *et al.*, 1977). The use of *free-motion elbow supports* is an effective way to achieve these goals.

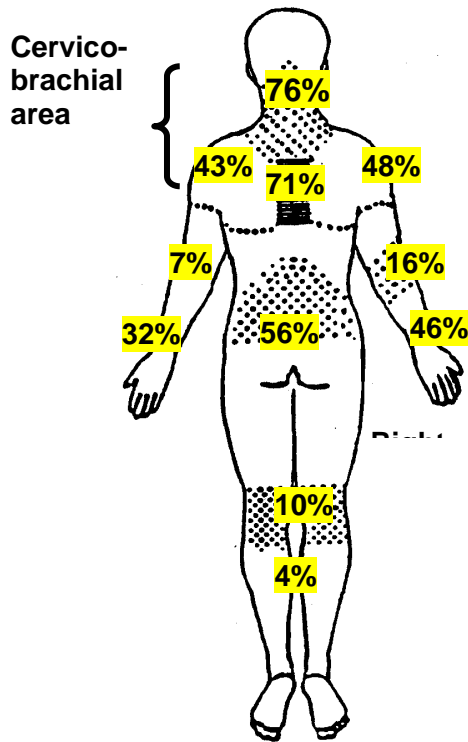
1.7 Survey of pain among Quebec dental hygienists (1998)

At its annual meeting in October 1998, the *Ordre des hygiénistes dentaires du Québec* included a lecture on the prevention of musculoskeletal problems and pain in dental hygienists as part of its program. At this meeting, ASSTSAS distributed a questionnaire to determine which parts of the body were being affected and what type of problems were being experienced. The questionnaire was longer and asked questions about type of treatment, course of pain after onset, medical diagnosis, leave of absence and reduced working hours.

The 125 hygienists who answered the questionnaire had varying amounts of work experience. Since the sample of respondents was not randomly selected, we cannot draw any conclusions about how representative they may be for the entire population of hygienists. In the sample, however, 39% of the respondents had more than 10 years of experience. This is quite representative of the Quebec hygienist population, who had an average of 9.8 years of experience in 1998.

The questionnaire asked about any type of pain, as opposed to the one presented above (in section 1.5) which asked about "serious pain that interfered with your usual activities." This explains why dental hygienists indicate with a greater frequency of pain.

1.7.1 Parts of the body affected by discomfort or pain



Only one of the hygienists had not experienced any symptoms in the past 12 months, while **79% of the respondents** indicated that they had experienced pain in three or more parts of the body. The incidence of the pain by area is indicated in figure 7. Many hygienists had experienced pain on both sides. So in all, the percentages of pain in the various parts of the body were as follows:

- 76% neck and upper back
- 56% lower back
- 54% shoulders (both sides)
- 52% wrists/hands (both sides)
- 23% elbows (both sides)
- 19% legs (both sides)

For 50% of the respondents, the pain interfered with their day-to-day activities (eating, writing, sports, hobbies, etc.) or woke them up at night. For three-quarters of the respondents, the pain had developed gradually.

Figure 7. Percentage of dental hygienists with pain in specific parts of the body, in the past 12 months (124 respondents).

1.7.2 Treatment received for cervico brachial pain

One of the major indications of the seriousness of the pain in the above-mentioned areas is pursuing treatment to try to solve the problem. **Seventy-nine percent of the hygienists** who indicated that they had experienced pain stated that they had sought help at least once. More than half of the respondents tried more than one type of therapy and 28% had tried three or more. Forty-seven percent had seen a doctor and 47% had seen a chiropractor. Thirty-six percent had seen a specialist and 34% had seen an alternative practitioner: massage therapist, orthotherapist or osteopath.

1.7.3 Course of the pain after onset

Pain was not a one-time event for the majority of the hygienists; rather it was a persistent problem with variations from one site to another. Regardless of their number of years of experience, about 60% mentioned that their pain returned periodically.

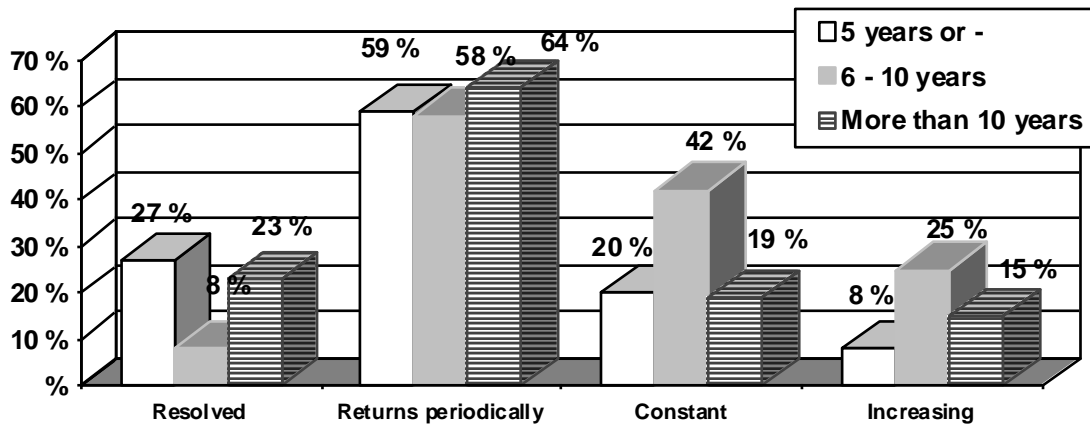


Figure 8. Course of cervico brachial area pain in dental hygienists after onset by years of experience (120 respondents).

1.7.4 Medical diagnosis, leaves of absence and reduced working hours by age

Hygienists who were age 36 years and over had a higher incidence of a specific medical diagnosis for their pain, absence from work or reduced weekly working hours. The duration of these absences from work ranged from a few days to one year. The reduced number of hours ranged from 10 to 20 hours per week.

	Respon- dents	Torticollis	Bursitis/tendinitis: shoulder	Absences or reduced working hours
Age 35 -	101	9%	8%	7%
Age 36 +	23	26%	26%	35%
TOTAL	124			

1.7.5 Lower back problems

About half of the hygienists (53%) reported experiencing lower back problems. Those who had less than five years of experience reported more of these problems. However, about one-third of the respondents, regardless of their level of experience, reported that this pain interfered with their day-to-day activities (walking, outings, sports, sex life, etc.), woke them up at night or radiated into their legs. According to the standard criteria used to evaluate musculoskeletal impairment, these three characteristics are significant indicators used to assess the seriousness of the impairment.

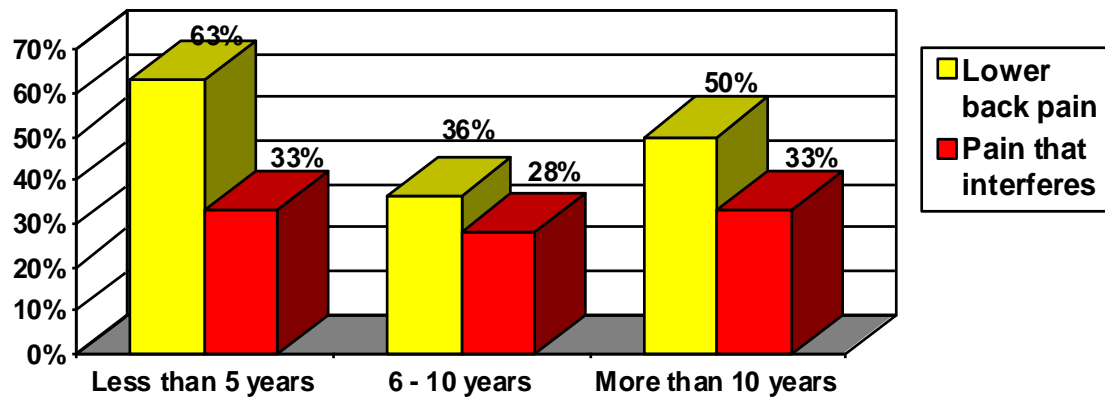


Figure 9. Percentage of dental hygienists with lower back problems and pain that radiates into one leg or interferes with day-to-day activities, with number of years of experience (n =124).

2. DEFINITIONS AND COURSE OF MSDs

2.1 Definitions

Over the years, a number of definitions have been developed to describe the pain and disabilities causing long-term injuries, as a result of strain in the workplace. In this document, we use the term *work-related musculoskeletal disorders* (MSDs). However, the terms *cumulative trauma disorder* (CTD) *repetitive strain injury* (RSI), and *overuse injury* generally refer to the same situations. These disorders affect the soft tissues, in other words, the muscles, tendons, nerves and blood vessels. They are caused or aggravated by overuse of these structures. MSDs are often associated with tendon problems. The tendon is where the muscle attaches to the bone. Depending on where it is, the tendon is surrounded by various structures.

2.1.2 Tendon injuries

Tendon injuries usually occur near the joints. They are caused by repetitive or extreme strain or by friction between the tendons, ligaments and adjacent bones.

a) Tendinosis

Tendinosis is a degenerative phenomenon which can be painless, but which causes sensitivity with inflammation related to unaccustomed activities (Dr. Vadeboncœur, personal paper).

b) Tendinitis

Unless an accident is involved, tendinosis always underlies any case of tendinitis (Vadeboncœur, *op.cit.*). At a more advanced stage, some of the tendon fibres may detach or tear. The tendon then thickens in certain places, which gives it a rather irregular appearance.

The most common symptoms of tendinitis are: localized pain and swelling, discomfort when performing specific movements, and sensitivity to touch. Without rest and sufficient time to heal, the tendons may become permanently damaged.

In the parts of the tendon that do not have a synovial sheath, such as the tendons in the rotator cuff in the shoulder, the damaged part may eventually calcify (see figures 70-71).

c) Tenosynovitis

Many tendons (particularly those in the wrists) are covered by a synovial sheath to facilitate gliding when they are stretched, i.e. when the muscle contracts and relaxes. When the tendon and its sheath are affected, this is referred to as tenosynovitis. De Quervain's disease, or stenosing tenosynovitis, which affects the tendons of the thumb, is most common in the dental field, generally on the dominant side (right side for right-handed people).

2.2 Onset and course of musculoskeletal injuries

In the shoulder, elbow and wrist joints, the structures (tendons, bursa, capsules, nerves) may be injured suddenly (after an accident), in the long term or a combination of both.

Pain is a protective mechanism and MSDs symptoms should be considered a warning signal. It is therefore important to pay attention to signs such as discomfort or pain. Depending on the area affected, the types of injuries can vary. The incidence, duration of the discomfort or pain and level

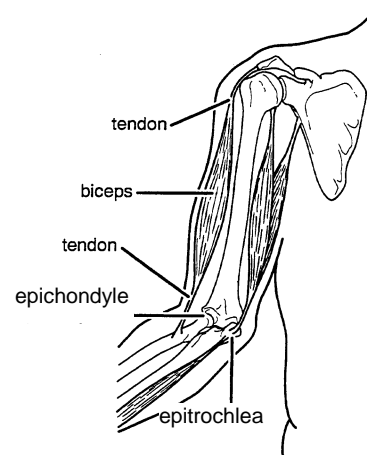


Figure 10. The biceps muscles and tendons in the shoulder and arm.

of interference with daily activities are indications of the seriousness of joint impairment. The progression of MSD symptoms often follows this sequence:

Table 7 Progression of MSD symptoms		
Initially	With continued exposure	MSD
Discomfort, fatigue	➔	Discomfort, pain
Associated with certain work activities	➔	Occur even at rest
Disappear quickly after work	➔	Persist outside working hours, may cause nocturnal waking
Complete recovery	➔	Possibility of sequelae

2.3 To keep the injury from becoming chronic

Once you begin to experience clinical symptoms, microscopic changes have already occurred and some degree of disease is already present. The prognosis for repetitive strain injuries and overuse syndromes is generally considered to be inversely proportional to the severity of the injury or its duration. Early intervention in the elements that caused the injury is required to avoid other inflammatory responses and to allow healing. Unless healing occurs in the acute or subacute phases (less than three months) and subsequent injuries are avoided, there is a risk of aggravating the injury. Chronic injuries are often vicious cycles that lead to other inflammations and relapses. Events that include micro-tears, inflammatory response, and the formation of adhesions leave the individual vulnerable to new injuries (figure 11).

2.3.1 Breaking the vicious cycle of chronicity

By eliminating or reducing workplace strains that represent risk factors for MSDs, and in order to avoid exceeding the capacity of anatomical structures, it is possible to prevent the aggravation of injuries likely to compromise a person’s ability to practice his/her profession. It is important to reduce any strains that can be controlled. Any strains or risk factors that can be reduced decrease the probability that an injury will occur or worsen. Everything possible should be done, even things that may seem trivial.

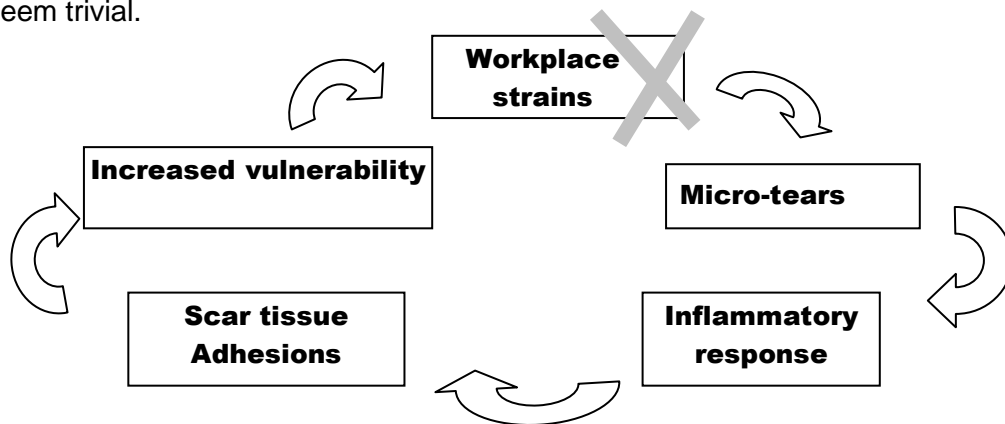


Figure 11. Elimination of workplace strains is the most effective way to break the vicious cycle of injuries that can become chronic. Source: adaptation from Kolber, “The Musculoskeletal Health of the Dental Care Worker” in Denise C. Murphy (ed.), *Ergonomics and the Dental Care Worker*, American Public Health Association, Washington, 1998, chap. 10, p. 238.

3. RISK FACTORS FOR MSDs

3.1 Strain combinations

MSDs are associated with a number of strains that are often combined in a single job, including strains related to holding various positions, force or repetitive movements. The problems vary according to the parts of the body affected. One or more factors may be involved. The presence of simultaneous strains increases the level of risk.

Injuries may be sustained either by repeating the same movements or by a lack of movement.

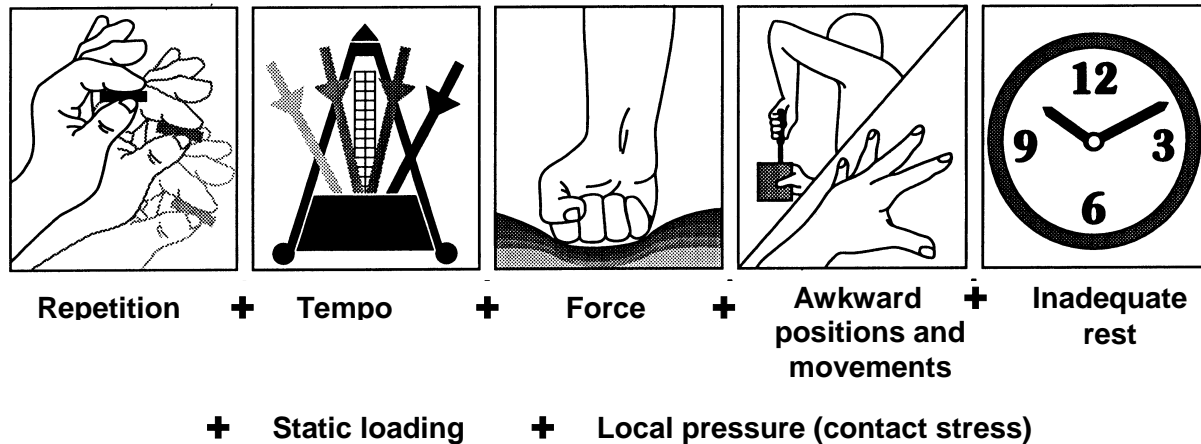


Figure 12. Combination of factors that may cause musculoskeletal injuries

3.2 Risks factors in dental work

Many ergonomic analyses of the work done by hygienists, dentists and dental assistants have made it possible to identify a certain number of risk factors, many of which have already been documented in the literature. Dental treatments involve very precise procedures using the upper limbs as well as numerous positioning constraints, as presented in the following list.

1. **Static sustained contractions** of muscles of the cervical area and upper trapezius while maintaining the neck in a forward flexed position for an extended period, for most treatments.
2. **Static sustained contractions** of muscles of the cervical area and upper trapezius while maintaining the neck in a lateral flexed position for certain treatments.
3. **Static sustained contractions** of lower back muscles while maintaining a seated position especially if the torso is bent forward with no lumbar support, or bent sideways for an extended period of time.
4. **Static sustained contractions** of the right shoulder muscles (upper trapezius) (for right-handed people) to stabilize the arms and control the accuracy of fine hand movements.
5. **Static sustained contractions** of the left shoulder muscles (upper trapezius) for right-handed people) to hold and pull on the mirror.

6. **Local internal pressure in the shoulder** (supraspinatus tendon) when the arms are held away from the body (abduction) for an extended period of time. (In a study of cleaning treatments performed by 3 hygienists, their right arm was in abduction of more than 40° for 48% of the time and their left arm, for 29% of the time) (Proteau, 1997).
7. **Awkward shoulder and wrist positions** (flexion, extension) and forearm positions (rotation) while holding instruments, depending on the direction of the force required to dislodge tartar, etc., especially if parts of the patient's mouth are hard to access.
8. **Forceful pinch grip** on the curette and other instruments to keep them from turning.
9. **Forceful movements of the wrist** and fingers needed to cut or to dislodge tartar.
10. **Repetitive wrist flexion and extension movements** (10-45 times/minutes when scaling). These repetitive rotations involve movements that start at the elbow joint.
11. **Inadequate rest**, particularly 12-hour days or six hours of work without a break.
12. **High-frequency vibrations**.
13. **A combination** of two or more of the above factors.

4. AWKWARD POSITIONS IN DENTAL WORK

4.1 Factors affecting working positions

The various steps involved in dental procedures and their duration are dependent on the dental condition of each patient. Certain factors increase treatment difficulties and risk factors, i.e. the patient's dental condition (poorly positioned teeth, small mouth, heavy salivation, bleeding, powerful tongue, hard, heavy tartar, etc.) and general condition (medical restrictions regarding the position of the patient's chair, his/her level of cooperation, etc.).

Although the above factors are specific to the patient and cannot be changed, the hygienist and dentist can make certain choices that foster safer working positions. The professional's working position is the result of a compromise between the work to be performed, the constraints to be overcome and the working methods used.

A number of elements affect the working positions of dentists and hygienists: their position in relation to the patient's head, the height and angle of the patient's chair back, the type of treatment to be given, and the location and visibility of the area to be treated, the environment and the equipment. Their position with respect to the patient's head (clock position) is the one that has the most impact on arm position, as we can see in figure 13.

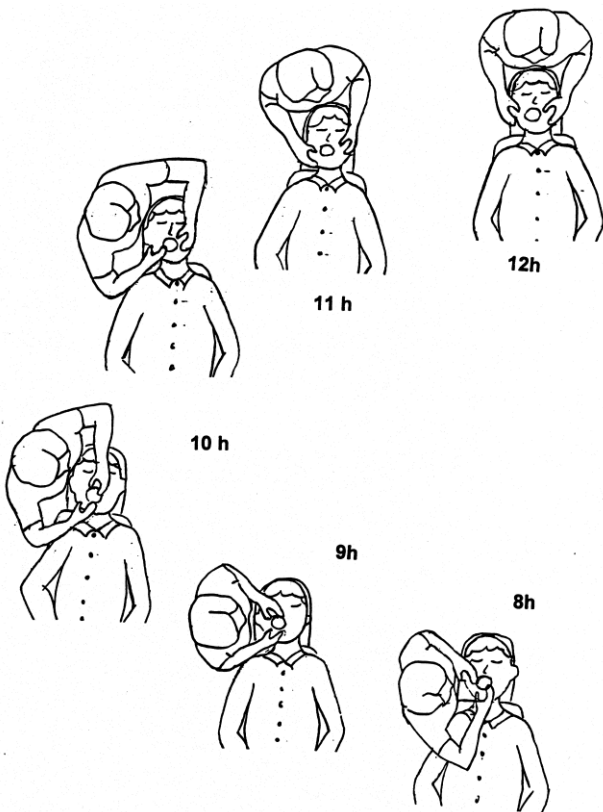


Figure 13. Arm positions in abduction most often observed in dental hygienists and dentists in relation to the patient's head (clock position) and their working methods.

The dental assistant's working positions are greatly dependent on the dentist's working position.

4.2 Awkward positions for dental hygienists

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 procedures associated with cleaning teeth (scaling, ultrasound, etc.). In dental clinics, hygienists frequently keep their arms in a position of extreme 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 (figures 14 to 16). These positions are more common when the hygienist is seated beside the patient's head (clock positions 8:00, 9:00 and 10:00) and are less common when she is seated behind the patient (11:00 and 12:00).



Figure 14. Right arm in abduction over the patient's chest at 9:00.



Figure 15. Left arm in abduction over the patient's head at 10:00



Figure 16. Both arms in abduction at the same time at 9:00.

The problems of awkward positions for dental hygienists can be increased by equipment and the environment. Many of the hygienists evaluated were working with a dental stool similar to the one used by dental assistants, i.e. with a narrow torso support used as a backrest (figure 17). This stool is designed so that the assistant can support her chest and arms on it while assisting the dentist. Some hygienists had access to the instruments only at the back and on the left side (Cox system, figure 18). This system was designed for a dentist working with an assistant (four hands), while hygienists generally work alone.



Figure 17. Hygienist working on an assistant's stool with a narrow torso support used as a backrest.



Figure 18. When access to instruments is only from the back and on the left side, the hygienist's back is often twisted to reach the instruments. She has to work with her right shoulder at the limit of its mobility.

4.3 Awkward positions for dentists

Dentists often adopt the same awkward positions as dental hygienists. They also have some awkward positions that are specific to them. Here are a few examples



Figure 19. Awkward positions used by a dentist during treatment.

Source: Hedge, Alan, "Introduction to Ergonomics" in Denise C. Murphy (ed.), *Ergonomics and the Dental Care Worker*, American Public Health Association, Washington, 1998, chap. 1, p. 20

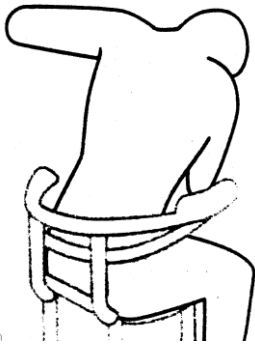


Figure 20. Typical position used by many dentists with flexed and twisted neck and torso.

Source: Dougerty, Michael, "Ergonomic Principles in the Dental Setting, Part 1," *Dental Products Report*, June 2001, p. 6.



Figure 21. Dentist working with neck bent and right arm in abduction at 12:00.



Figure 22-23. Dentists working with neck bent and twisted.



Figure 24. Dentist with torso and lower back twisted at 8:00.

4.4 Awkward positions for dental assistants

The working positions of the assistant depend largely on the adjustments of the patient's chair (height and angle of the patient's seat back) by the dentist. Space available for her legs is a major issue. The location of the various equipment is another important factor.

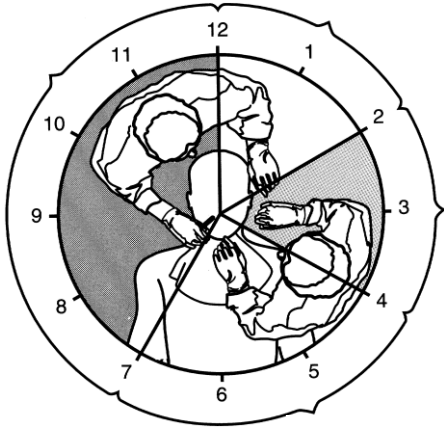


Figure 25. Ideal position for the assistant, who should be positioned facing the patient's mouth. Source: TORRES, 1995, p. 280. Image used with the permission of Elsevier Science.



Figure 26. Because she rarely has room to slide her legs under the patient's seat back, the dental assistant's back is often twisted.



Figure 27. Unsupported arms raised and flexed.



Figure 28. Back twisted while holding instruments (e.g. suction).



Figure 29. Flexion and abduction of right shoulder when holding a polymerizing lamp.

The dental assistant's stool is equipped with a rounded narrow torso support to support her arm or chest while working. However, dental assistants often can't rest their arms on it because they can't reach the patient's mouth, or don't have room for their legs under the back of the patient's chair and have to work from the side.

The rounded torso support is too narrow to rest their arm on while assisting the dentist. Some of the torso supports of old assistant's stools are not adjustable in height. The assistants can't rest their arm on them because they are either too high or too low.

Some dental assistants who suffer from back pain have tried to use the rounded support for back support. In discussions with the assistants that we met, we found that the use of the rounded support for back pain relief was unsuccessful because it doesn't have the right shape to provide adequate lumbar support.

5. STATIC POSITIONS IN DENTAL WORK

Static positions involve holding parts of the body in a fixed position, for a certain period of time, to resist the force of gravity, stabilize a part, hold a tool, etc. Holding a static position is made possible by muscle contraction (OSHA, 1998).

A static position involves the application of force without movement. However, even if there is some movement, if the joint does not return to a neutral position and muscle force continues to be required, the effect can be the same as not moving.

In dental work, the majority of awkward positions are held for a long time without moving. The postural rigidity imposed on the shoulder girdle muscles (neck, shoulders, upper back) is a major problem. The areas affected depend on their role:

- The shoulders and upper back are contracted to stabilize the arms and to allow greater precision of hand movements.
- The neck muscles (extensors) are contracted to keep the head tilted and to one side.
- The lower back muscles (spinal extensors) are contracted to hold the torso in a forward leaning position.

For dental health care workers, holding awkward positions without moving, or with little movement, generally has more serious consequences on the joints of the shoulder, and upper and lower back than repetitive movements, which have more of an impact on the elbow and wrist joints.

5.1 Forces to counter gravity in the joints

If you drop an object, gravity causes it to fall to the floor. The same is true when the torso is bent forward and the arms are held away from the body. Gravity pulls them toward the ground. They don't fall, because the muscles contract to pull in the opposite direction. When the muscles are contracted without moving, blood circulation is impeded. The muscles then receive less oxygen and nutrients, and eliminate less waste produced by muscle work. In the long term, this changes the biochemistry of the muscle, resulting in a state of "functional muscle pathology" (see 9.3).

5.1.1 Joints working against gravity

In each joint of the body, the muscles and tendons are activated to hold each segment and to keep its weight from falling down. The torque required in each joint to hold segments of the body is called a "moment" and is measured in Newton metres (Nm). The torque varies according to position and increases if the movement requires force and precision.

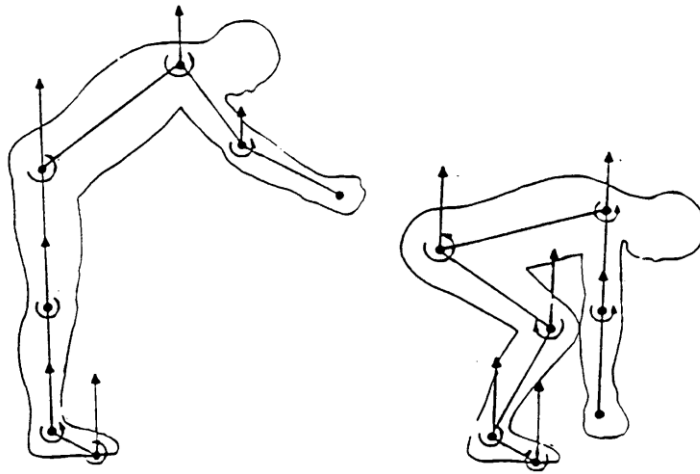


Figure 30. Joints that work against gravity.

Source: CHAFFIN and ANDERSSON, *Occupational Biomechanics*, 1991, p. 193.
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5.1.2 Force required for the shoulder to hold the arm up in the air

For the shoulder muscles, the force required to hold up the arm increases with the distance, even if the weight being carried is not heavy. The force increases when the distance between the shoulder and the weight of the segments (arm, forearm and hand) increases. It ranges from one to three times with or without load.

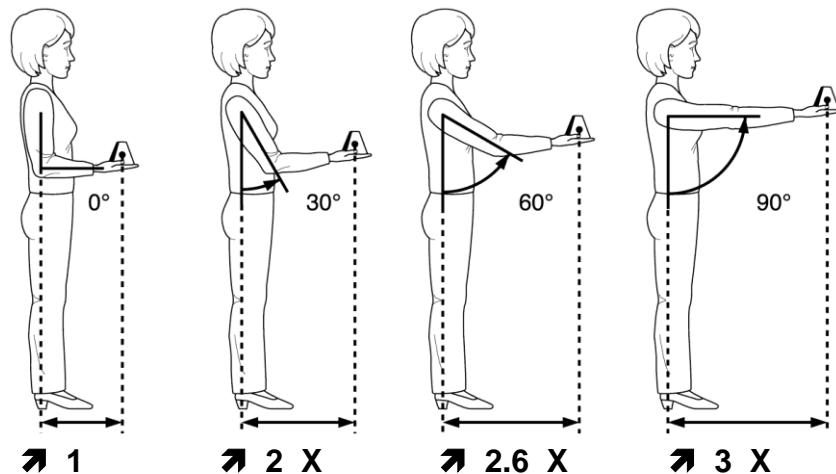


Figure 31. Increase in the force required by the shoulder when the arm is extended out from the body with or without load. These ratios also apply to positions in which the arm is open to the side.

5.2 Holding positions and effect on blood circulation in the muscles

The blood carries the energy the muscle needs to work. The energy is provided by nutrients (glucose, proteins, etc.) and oxygen. The wastes (mainly CO₂ and lactic acid) produced by the activities of the muscle are eliminated and are carried by the blood to the organs responsible for their elimination (lungs and kidneys).

However, when you hold a position, circulation is partly or completely blocked and there is little oxygen input into the blood. Lactic acid and wastes accumulate in the muscle, which then has difficulty moving. Fatigue and pain set in.

To understand the difference between effort during movement, in other words, dynamic effort and static effort, or maintaining a contraction, let's look at their respective effect on the blood circulation of the muscles involved.

5.2.1 Dynamic effort and blood circulation

The blood vessels pass through the muscles and feed them.

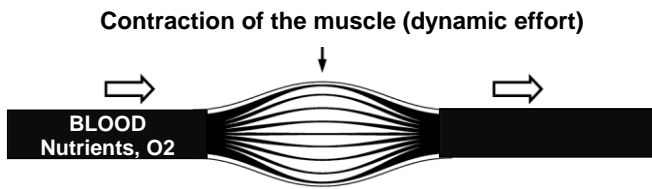


Figure 32. Arrival of blood containing nutrients and oxygen and elimination of waste.

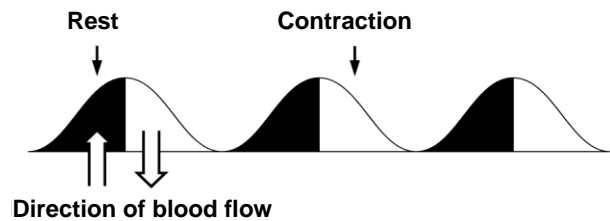


Figure 33. Dynamic effort, with alternating contraction and rest, acts as a pump that pushes blood circulation in and out of the muscle.

5.2.2 Static effort and blood circulation

The vascularization of muscle by the blood vessels depends on the intensity of the muscle contraction. Static muscle contractions can reduce blood circulation by up to 90%.

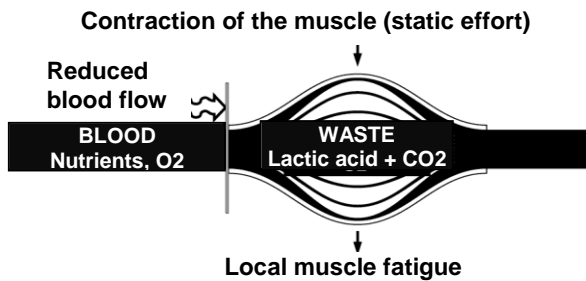


Figure 34. During static effort, blood flow to the muscle is reduced and can be blocked. Intake of nutrients and elimination of waste is impaired, which can cause pain.

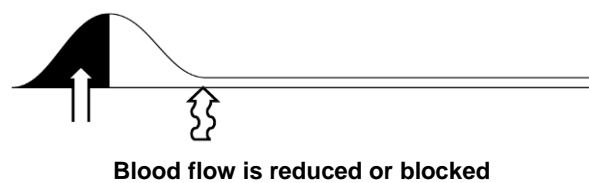


Figure 35. During static effort, blood flow to the muscle is reduced and can be blocked by up to 90%.

Source: Adapted from Grandjean, 1993, p. 23

Reduced intake of oxygen and nutrients and the elimination of waste produced by metabolism results in a more rapid onset of fatigue and predisposes the muscles and other tissues to injury.

5.3 Lower back strain and prolonged sitting

In a seated position, even if the upper body does not seem to be working because it is not moving, a large number of muscles are continuously contracted to maintain the position. The spine consists of various structures - vertebrae, ligaments, muscles and the nervous system - which work together to maintain upper body balance.

5.3.1 Lower back strain with forward flexion

The upper body is supported by the spine, which in turn is supported by the pelvis. When the torso is bent forward, the lower back supports the parts of the body that represent, on average, the following percentages of body weight:

- Head and neck 9%
- Arms 11%
- Torso 46%

If we don't count the part of the torso that is included in the pelvis, this means that approximately half of the body's weight is being held up by the lower back muscles when the torso is bending forward. These percentages are the same when the person is sitting.

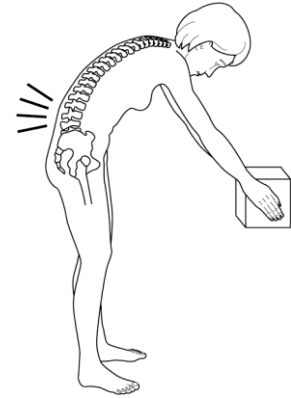


Figure 36. Pressure on the lower back when the torso is bending forward.

In a seated position, pressure on the spinal discs is greater when the torso, head and arms are leaning forward. The lower back muscles have to work much harder to hold up the torso and keep its weight from falling down.

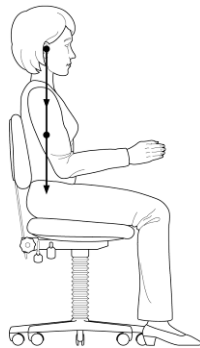


Figure 37. Seated position with a straight back:

- The centre of gravity of the head and torso are aligned.
- Little neck and lower back muscle strength is required to maintain this position.

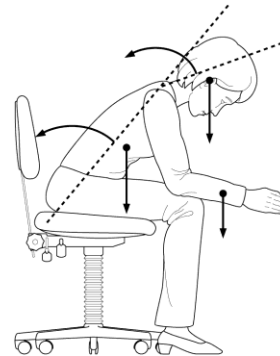


Figure 38. Torso, head and arms leaning forward:

- When the torso's centre of gravity is farther from the lower back, the lower back muscles must be contracted to keep its weight from falling down.
- The weight of the head and arms add to the force required by the lower back muscles to stabilize this position.

Source: Adapted from Chaffin and Anderson, *Occupational Biomechanics*, 1991, p. 400.
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The static effect is increased if the dental stool does not have any lumbar support, if you are unable to use the lumbar support while working, or, if your feet are not firmly supported on the floor or on a stable surface. Working for long periods of time without rest contributes to increasing the effects of static load.

5.3.2 Lower back strain with lateral flexion of the torso

Many dental care workers work in lateral flexion of the torso with a certain amount of rotation. These positions lead to asymmetry in the work of the muscles on the left versus those on the right side of the spine. Asymmetrical postures are recognized as being a risk factor for intervertebral disc and structures that stabilize the vertebrae. In dental work, these postures are often maintained in static contraction for prolonged periods of time.

This asymmetry leads to muscular imbalance, which may affect the functional quality of the muscle and lead to abnormal muscle fatigue. This may result in torsion and shear at the vertebral level and makes people more susceptible to long-term injury and painful recurrences. This situation worsens if it persists for many years. (Vadeboncoeur, 1995).

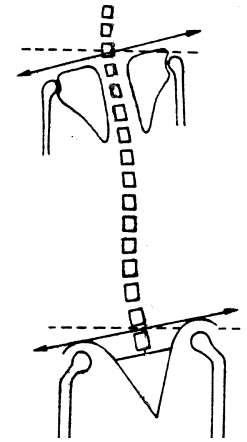

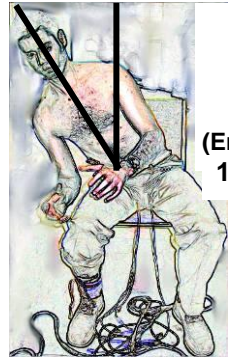


Figure 39. Illustration of the back and neck in lateral flexion (when the weight rests mainly on the one thigh).
Source: Adapted from Caillet, René, *Les lombalgies*, Éditions Masson, 1982, p. 33.

Flexed and twisted back positions activate a number of muscles including the erector spinae muscles in the back and the internal and external obliques in the abdomen. To check the load on the external obliques and erector spinae muscles in these positions, we conducted an exploratory study in the anthropokinetics laboratory at UQAM using surface electromyography (EMG) on an asymptomatic subject.

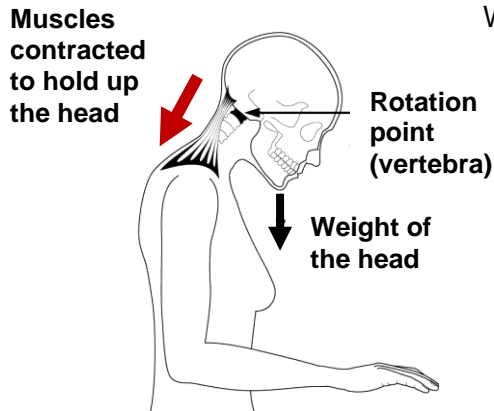
Table 8		
Percentage of maximum voluntary contraction (MVC) in positions of lateral flexion of the torso		
Muscles /Angles	15° (Erectors 1.2%)	30° (Erectors 1.3%)
		
Erectors on the same side	1.2%	1.3%
Erectors on the opposite side	9.3%	13.9%
External obliques on the same side	8.7%	15.1%
External obliques on the opposite side	1.6%	2.2%

Without lateral flexion: MVC of erectors at 0° = 2.5%; MVC of obliques at 0° = 1.6%

Table 8 shows that even with slight lateral flexion of only 15°, the erectors (lower back muscles) on the opposite side had to work four times harder than the ones on the same side. These uneven forces can lead to shear at the vertebral level in the lumbar region of the back (Marras, 2000). The limit of secure compression on the vertebral column is decreased from 2/3 in presence of shear.

5.4 Neck and upper back strain when the head is bent

In order to see into the far reaches of a patient's oral cavity, dental hygienists and dentists have to bend their heads forward. The angles of flexion of the head required in dental work far exceed safe angles of flexion for the neck when they are held for long periods.



When the head is bent forward:

- The weight of the head (approximately 9% of the body's weight) is pulled downward.
- The rotation point of the head is the first cervical vertebra (indicated in black).
- The muscles of the neck and upper back are contracted to prevent the weight of the head from falling down.
- After a certain amount of time, constant pressure on the neck muscles to hold up the weight of the head can lead to pain.

Figure 40. The muscles of the neck and upper back are under pressure to support the weight of the head and keep it from falling down.

Source: Adapted from Rodgers, Susanne H and al. *Ergonomic Design for People at Work*, vol. 2, Eastman Kodak Co, New York, 1986, p. 125

5.5 The muscles most challenged by static load

5.5.1 Neck and upper back: trapezius and rhomboid

The neck and shoulder muscles that are most challenged by static work are the upper trapezius and rhomboid muscles on each side of the spine. The upper trapezius contributes to supporting both the head and arms at the same time. It is particularly challenged by movements that involve neck flexion and holding the arms up. It stabilizes the shoulder girdle by working in conjunction with the rhomboids that connect the shoulder blades to the dorsal spine and the levator that connects them to the upper cervical spine.

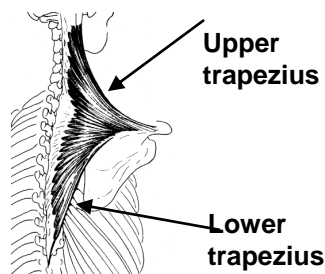


Figure 41. The trapezius is a triangular muscle situated on each side of the spinal column. The upper trapezius supports both the head and arms.

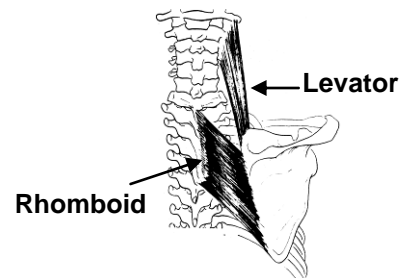


Figure 42. The rhomboid connects the shoulder blade to the last cervical vertebra (C7) and to the first four dorsal vertebrae (D1 - D4). It is stretched when the arms are held forward and in abduction.

The trapezius is a triangular muscle. The upper trapezius muscle raises the shoulder, and the lower trapezius lowers it. The upper trapezius ends at the lower edge of the clavicle (external 1/3) and the acromion.

5.5.2 Front thoracic muscles: the pectorals

The following figures indicate that simple movements of the hand in flexion and extension involve numerous muscles in the shoulder, back and thoracic regions.

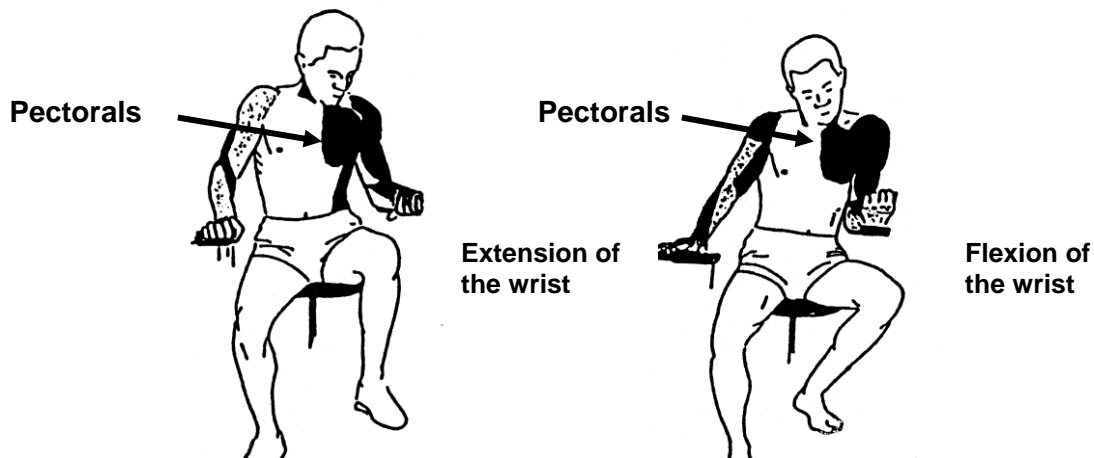


Figure 43. Muscles in the shoulder, back and thoracic regions involved in wrist movements. The muscles illustrated in black are more active than the ones in grey.

Source: Hellebrant et al, "Tonic Neck Reflexes in Exercises of Stress in Man,"
American Journal Phys. Med. 35, 1956, p. 145

In dental work, holding the mirror with the left hand (for right-handed people), when the arm is unsupported, involves frequent prolonged and static contraction of the pectoral muscles that attach the arm to the collarbone and sternum.

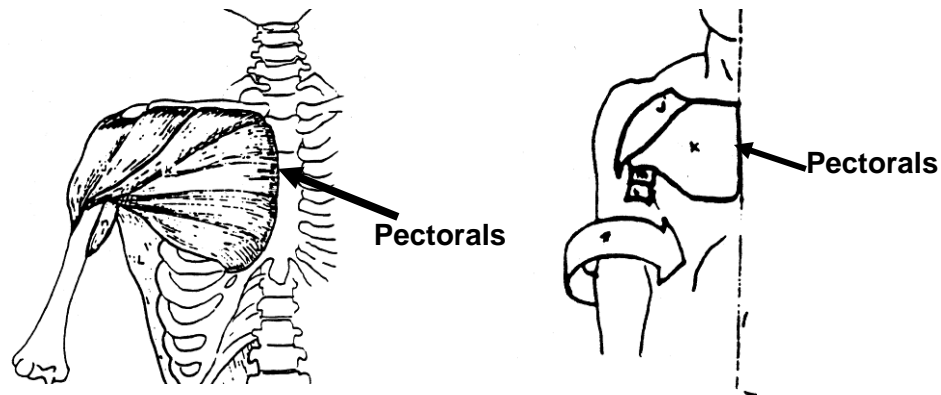


Figure 44. The pectoral muscles in the front of the body are in constant static contraction when the dentist or hygienist is pulling on the mirror.

Source: Kapit and Elson, *L'anatomie à colorier*, Edisem-Maloine, Canada, Plate 33, 1st edition.

5.6 Self-evaluation exercise

Take off your watch. Close your eyes and hold your watch as if you were going to change the time. Pull out the pin, then open your eyes.

- How far away from your eyes is your watch?
- How are your arms positioned?

You are probably holding your watch 8 to 10 inches from your eyes with your elbows bent and your hands up. Similar types of exercises were performed by a large number of dentists holding instruments in order to find a position that would feel more natural and that would create less musculoskeletal discomfort. This approach is called "*design by feel*." It was originally developed by Japanese dentists, and led to positioning the patient's head higher and in a more horizontal position. They even turned the patient's chair into a dental bed (see figure 154). This approach will be discussed further in the safe working methods section (Chapter 14).

This position is not the same as the theoretical "*ideal position*," where the clinician is supposed to be able to see what he is doing with his arms held parallel to the floor, keeping his neck and back straight (see 5.9).

Even without changing the patient's chair, we can draw some inspiration from this approach by changing the positioning of the patient's chair and by reviewing chairside working positions.

5.7 Neck comfort angles

Neck comfort angles of vision are designed for distance, not for close range. Comfort angles of vision for dental care workers extend far beyond their work area, which is the patient's head. Similarly, when writing on a patient's chart in a standing position, the hygienist is very far from her line of comfort.

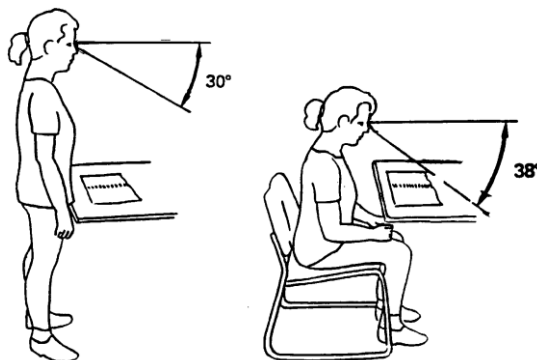


Figure 45. Neck comfort angles according to horizontal line of vision.

In a standing position, the limit for a comfortable angle of vision for distance is around 30° downward from horizontal.

In a seated position, the limit for a comfortable angle of vision is increased to about 40° downward from horizontal.

Source: Adapted from GRANJEAN, *Précis d'ergonomie*, Les éditions d'organisation, Paris, 1983, p. 63.

5.8 Impact of work surface height on back and neck position

The height of the work surface is responsible for flexion of the neck and back. If you have to look at your work surface, it should be high. If not, your back will curve or sag, and so will your neck. It is very difficult for dental care workers to keep their back and neck straight when they have their elbows parallel to the floor or at 0° from horizontal (or 90° to the shoulder), because then the work surface (the patient's mouth), is too low.

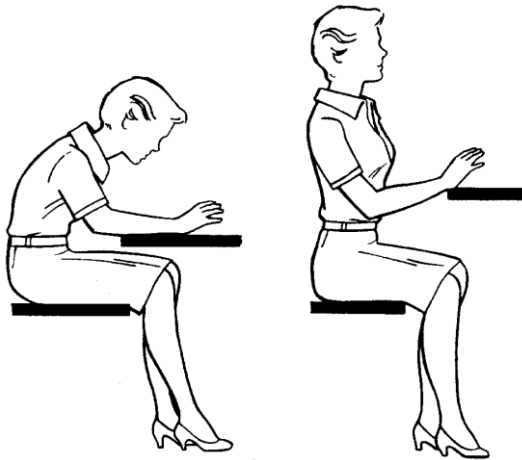


Figure 46. Effect of work surface height on back position .

Source: Dupuis, Michel and Richard Leclaire, *Pathologie de l'appareil locomoteur*, Edisem, Québec, 1991, p. 457.

The dentist below is working with his neck and back bent, when the patient's mouth is positioned low, at elbow level.



Photo 47. Dentist with forward back and neck flexion, with patient at elbow level.

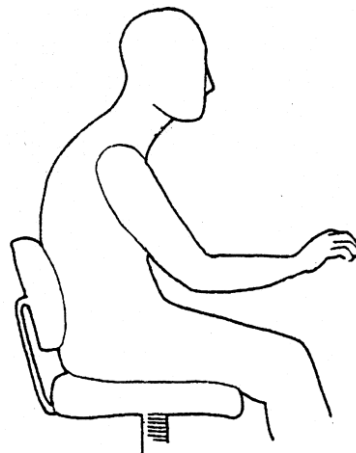


Figure 48. Back and neck structures stretched in a seated position.

Source: Kolber, Ellen, A., "The Musculoskeletal Health of the Dental Care Worker," in *Ergonomics and the Dental Care Worker*, American Public Health Association, 1998, p. 265.

5.9 Theoretical “ideal position” and its effect on neck flexion

5.9.1 Neutral seated position

In a neutral seated position, the torso is leaning back slightly between 100° and 110° (90° is vertical), the buttocks, thighs and legs are supported, and the back of the knee is free. Wilkins (1991) recommends that the operative field (the patient's mouth) be placed at the same height as the practitioner's elbows, held close to the body. This means that the arms are at 0° from the horizontal axis (or 90° to the shoulder).

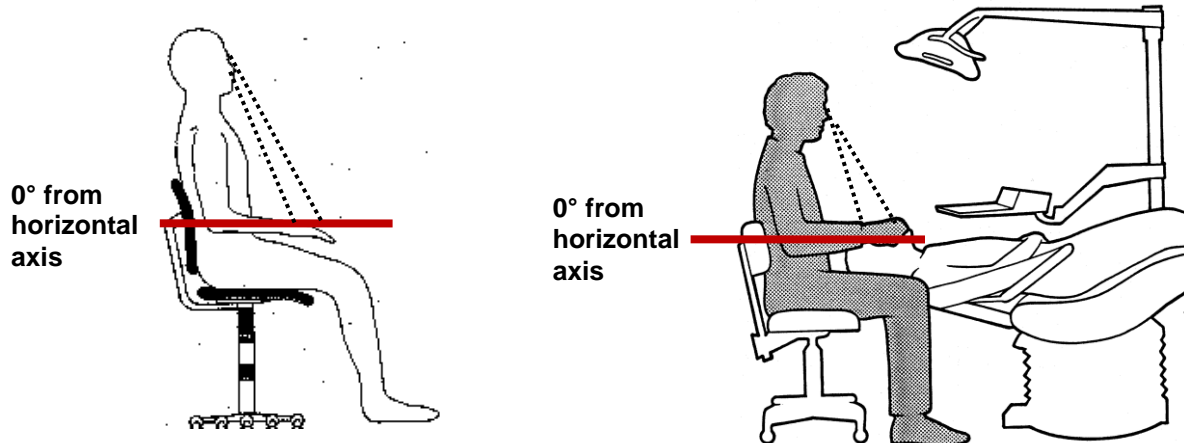


Figure 49. Neutral seated position. Source: Hedge, Allen, “Introduction to Ergonomics,” *Ergonomics and the Dental Care Worker*, American Public Health Association, 1998, p. 19

Figure 50. Theoretical “ideal position”: shoulders in line with the ears and arms at nearly 90° . The patient's mouth is positioned at elbow level, forearm angle at 0° from the horizontal axis. Source: Nield-Ghering and Houseman, *Fundamentals of Periodontal Instrumentation*, Williams Wilkins, 3rd edition, 1996, p. 22

5.9.2 Proper forearm position at 0° from the horizontal axis for computer work

For many jobs, including computer work, the appropriate elbow position is 0° from horizontal, especially for people who can type without looking at their hands (figure 51).

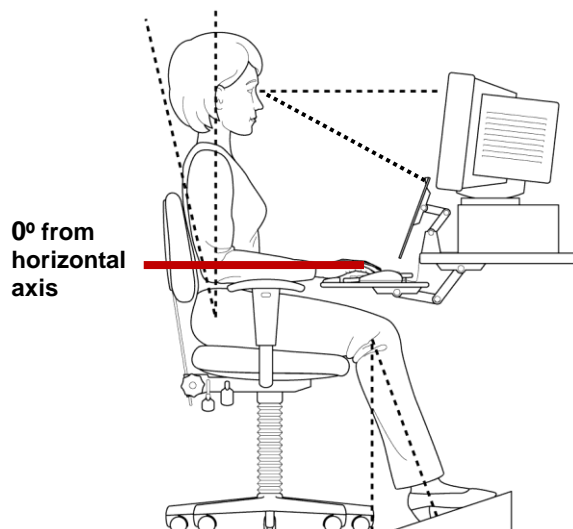


Figure 51. Forearm position at 0° from horizontal axis for computer work.

5.9.3 Conflict between forearm position at 0° from horizontal and neutral neck position

The theoretical “*ideal position*” is rarely observed in dental clinics, because for many dental care workers, the eye-task distance is too great. If you ask many dental care workers about their ideal working position, the majority of them would describe the theoretical “*ideal position*” illustrated above. As seen in figures 49 and 50, many manuals and articles describing safe working positions recommend a similar position.

What is the most important factor that determines posture?

It is the eye-task distance.

Have you ever tried to thread a needle while keeping your head straight, your elbows at 90° and your arms parallel to the floor? Is it possible? Just try it - it's hard, because you can't see what you're doing. Dental work requires bending the neck and back in order to be able to see and to perform extremely precise work in the patient's oral cavity.

Therefore, an inability to see is what makes a dental health worker bend her neck and back to be able to see and perform quality work in her patient's mouth. Extremely bent-over positions are frequently observed, as illustrated in figure 53. Hygienists and dentists therefore have a great deal of difficulty maintaining a straight back and neck position, when their arms are held at 0° from the horizontal axis.

Two examples of sequences (53-54 and 55-56) are given comparing neck and back positions resulting from the angles of the forearms in relation to the horizontal axis. By raising the level of the client's mouth and holding your arms up, you can straighten both your neck and back as illustrated in figure 54 and 56. In general, there is less conflict between arm and neck position when the patient's head is raised.

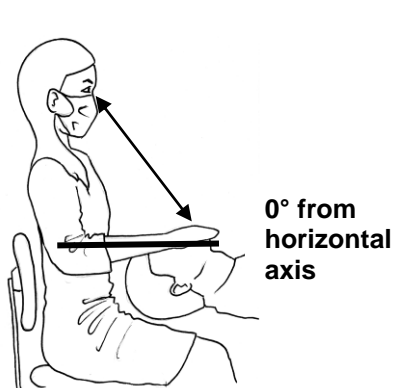


Figure 52. Theoretical “*ideal position*”: shoulders in line with the ears, patient's mouth positioned at elbow level, arms at 0° from horizontal. The eye-task distance is too great.

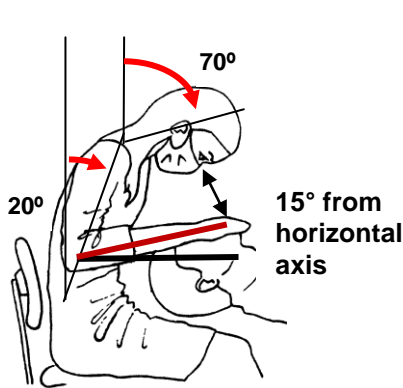


Figure 53. Neck flexion (70°) and back flexion (20°) when forearms are at 15° from horizontal axis. These are common positions when the patient is positioned low.

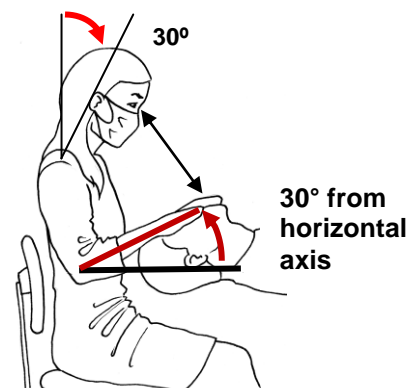


Figure 54. Neck position is reduced (30°) when rising the height of the patient's head. There is less need to bend over to see into the oral cavity. Forearms are at 30° from horizontal axis.

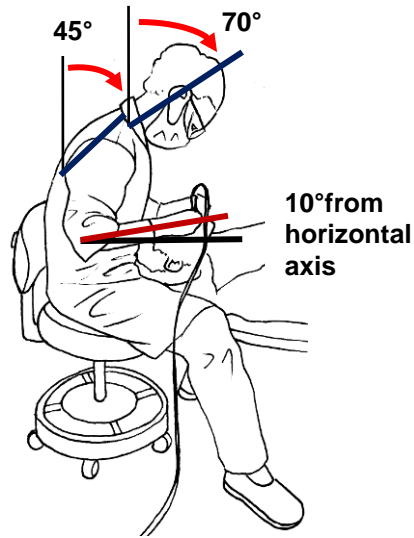


Figure 55. Neck flexion (70°) and upper back flexion (45°) when the patient is positioned low. The forearms are at 10° from horizontal. Leg movements are limited by the patient's chair back.

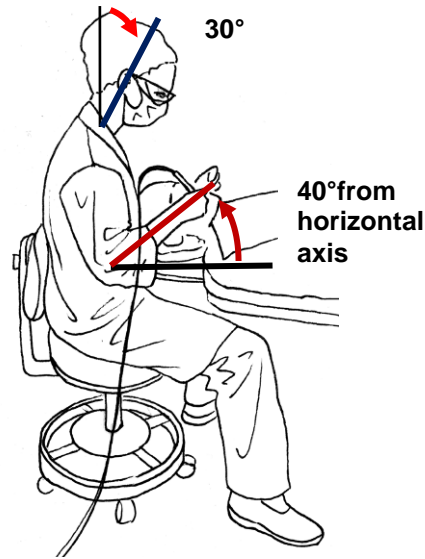


Figure 56. Neck flexion (30°) and back flexion are reduced when the height of the patient's head is raised. The forearms are at 40° from horizontal. The legs can move freely under the the patient's chair back.

When raising the patient's head, hygienists and dentists often have the impression that the patient's mouth is much too close to their eyes. However, when we measured the distance between the eye and the mouth in figures 55 and 56, we found that the distance was almost the same. In many cases, we observed that the hygienist and the dentist had less difficulty getting used to working at this new height when their arms were supported by *free-motion elbow supports*.

5.9.4 More elbow force is required when the forearm is horizontal

Contrary to the belief of many dental care workers, working with the forearms in a horizontal position is more demanding on the biceps, elbow muscles and ligaments. Since the weight of the arm is pulled downward by gravity, force is required in the opposite direction, i.e. upward. The axis of rotation is situated at the elbow level. The force of rotation around the elbow is called "moment", and is represented by rotation in a counterclockwise direction (figure 57).

Chaffin (1999) measured elbow moments at different forearm angles. When the arm is horizontal, he considers the angle to be 0°, which is when greater elbow force is required (figure 58). When the forearm is raised to 30°, elbow forces are reduced by about 10% and when it is raised to 45°, they are reduced by about 30% (figure 58). This produces less tension in the muscles responsible for flexion and extension of the hand. When the forearms are raised to 30° to 45°, less neck flexion is required to see into the oral cavity (see figures 53 to 56).

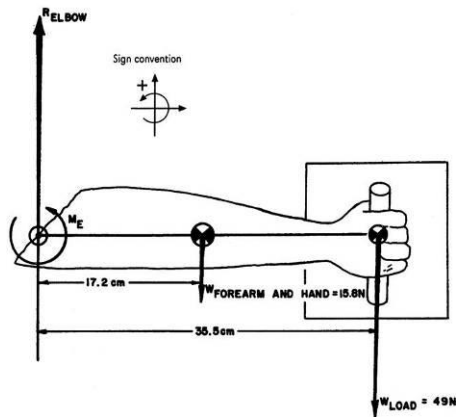


Figure 57. Elbow force to counter downward arm rotation (moments) when the arm is holding a load horizontally. The elbow muscles and ligaments must exert force in the opposite direction.

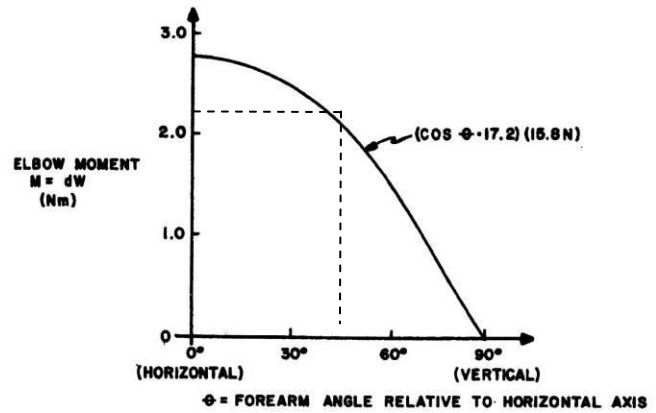


Figure 58. Elbow moments with the arm at 0° and 90° relative to the horizontal axis. When the forearm is flexed at 45°, elbow force is reduced by about 30%.

5.10 Sitting with arms and back unsupported

Most of the dental work done by dentists and dental hygienists is performed with the arms unsupported because the majority of stools do not have armrests. When a person's torso is bent forward as seen in figures 60 and 61, her back is usually not in contact with the narrow torso support on the dental hygienist's stool, used as a lumbar support. Some of the older stools have a lumbar support that cannot be adjusted forward, which is usually necessary to be able to lean on it while working in the patient's mouth. Lack of support increases static load on the lower and upper back muscles required to maintain working positions.

In a research study evaluating the work situation of dental hygienists (Proteau, 2001), we found that most of them were working with a dental stool equipped with a rounded narrow torso support, similar to the one used by dental assistants (figure 59). This stool is designed so that the assistant can support her chest and arms on it while assisting the dentist. The hygienists we observed do not use it to support their arms because it hinders their movements and keeps them too far away from the patient. They cannot use it to rest their back either, because the support is too far away and is not the right shape to provide adequate lumbar support.



Figure 59 to 61. Examples of assistant's stools used by many dental hygienists (7 out of 10 dental hygienists in the research study (Proteau, 2001)).

6. EFFORT IN DENTAL WORK

The term “effort” refers to the amount of physical effort required to perform a task or movement or to prevent a movement. Force is generally exerted on a tool or to counter gravity. The force required to perform the work is a critical factor in the development of MSDs. When muscular effort increases, blood circulation, nutrients and oxygen diminish, and waste accumulates in the muscle, causing rapid muscle fatigue.

When force is exerted on a tool being held in an awkward position or when it is used repetitively, the effect on the joints is increased. When there is a significant amount of effort involved, recovery time can easily exceed the duration of the work activity. If there is insufficient recovery time, injuries can occur at the tissue level. Effort exerted against gravity to stabilize parts of the body does not necessarily involve movement. In dentistry, the amount of time a position is maintained is more important than repetition.

6.1 Simulation of static contractions when performing precision tasks

Here are some simple exercises to try using a pen to simulate the muscle contractions that occur in the shoulders, upper back and neck when you perform a task that requires both strength and accuracy.

a) Using your right (or dominant) hand

Hold a pen in your dominant hand. Using the wrong end, pretend that you are removing nail polish from the thumb of your other hand. Try it as follows:

First method: Hold your arms out, away from your body. Bend your neck. Pretend that the nail polish is really hard to remove and rub hard, trying to only remove ½ mm at a time. Continue this for at least one minute or until you feel tightness in your upper back.

Press hard on the thumb nail to remove only 1/2 mm of nail polish at a time
(to create a situation requiring force and accuracy)

Bend your head forward so that you can see what you are doing



Figure 62. Method 1: Holding arms up in the air, neck bent, ***press hard on the thumb nail for one minute*** .



Method 2: Cross your right leg over your left (same side as your hand). Support the elbow of your dominant hand on your right thigh, and repeat the same activity ***for 30 seconds***.

b) Using your left (or non dominant) hand

Using all your fingers, hold the pen upright (like a dental mirror pulling on the patient's cheek).

Hook the pen using two fingers of your right hand.

Bend your head forward to see what you are doing.



Figure 63. Method 1:
Holding arms up in the air,
neck bent,
***pull hard on the pen
for one minute.***



Method 2:
Cross your left leg over your right
(same side as your hand).
Support your left elbow on your
left thigh and repeat the same
activity ***for 30 seconds.***

Can you feel a difference in your shoulder and upper back muscles when you use method one, as opposed to method two?

When performing this activity without support, many people can feel their shoulder and upper back muscles tightening up. With the second method, it is mainly the forearm that does the work when the elbow is supported. The upper back and shoulder muscles are hardly involved in stabilizing the actions of the hand. This shows how *free-motion elbow rests* can significantly reduce shoulder girdle and upper back strain.

6.2 Effort while performing very precise tasks

When a dental health worker performs very specific movements with her hands, her shoulders and upper body must be very stable because even a small shoulder motion could produce a false hand movement.

Manual scaling using a curette is the activity that requires the most force. It also accounts for the most risks. A hygienist must apply enough force to dislodge tartar that can be as hard as limestone but must be able to immediately stop her movement to avoid slipping and cutting the mouth tissues (gums, lips, inner cheeks). This requires co-contraction movements which increase the strains related to application of force. This activity is performed as follows:

- Sustained pinch grip (thumb, index finger and middle finger together).
- Mechanical stress of the nerves in the hand due to sustained pinch grip.
- Pulling motions.

7. LOCAL PRESSURE OR CONTACT STRESS ON THE TISSUES

Local pressure results from occasional, repeated or continuous contact between sensitive parts of the body and a hard or pointed object. The contact may create very strong pressure on a small part of the body and thus inhibit blood circulation, muscle or tendon movement and nerve function. This pressure can have an external or internal source. In dentistry, the major local pressures are at the level of the wrists and shoulders. At the wrist level, inflammation of the tendon sheaths can occur, in response to friction and irritation when the wrist is in flexion, extension or deviation toward the little finger or thumb. These positions increase pressure in the carpal tunnel, compressing the median nerve. This can cause carpal tunnel syndrome. In the shoulder, compression and inadequate blood flow may destroy cells in the tendon of the supraspinatus muscle. These dead cells form debris which may collect calcium deposits. This results in calcification and degeneration, which in the shoulders, may develop into frozen shoulder syndrome (see 8.1 and 8.2).

7.1 Internal pressure on the tendons and shoulder bursa

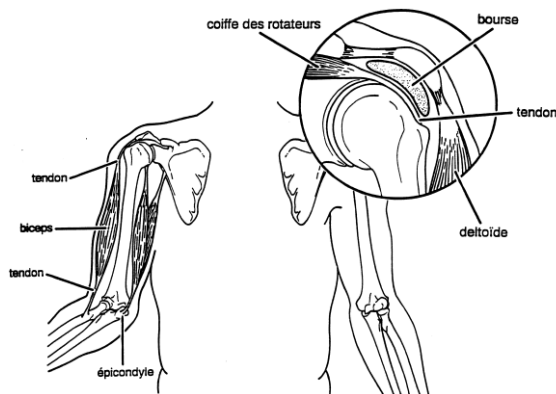
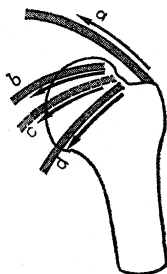


Figure 64. Elements of arm and shoulder anatomy.

The bursa acts as a cushion between the acromion and the humeral head. The four muscles of the rotator cuff along with the deltoid are responsible for abduction movements (holding the arms out from the body) and internal and external rotation of the shoulder. One of the four tendons in the rotator cuff, the supraspinatus tendon, passes through a narrow channel under the acromion (bone forming the highest point of the shoulder).



- a) supraspinatus
- b) infraspinatus
- c) subscapular
- d) teres minor

Figure 65. The four rotator cuff muscles and tendons. Of the four, the supraspinatus is the most subject to tendinitis, because it is wedged under the acromion.
Source: CAILLIET, *L'épaule*, 1985, p. 19

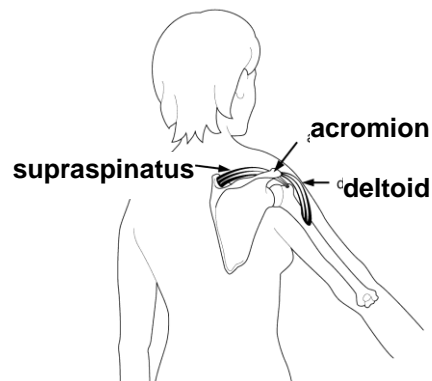


Figure 66. Abduction is performed by the deltoid and supraspinatus muscles. The latter is wedged under the acromion.
Source: Adapted from Karpandji, *Physiologie articulaire, Membre supérieur*, 5th edition, 1980, p. 73

7.2 Pressure on the supraspinatus muscle depending on arm and shoulder position

Studies have shown that at 30° forward flexion or abduction in the shoulder joint, the intramuscular pressure in the supraspinatus muscle exceeds 30 mm mercury (mm Hg), which is the threshold at which blood circulation starts to be disrupted. The greater the compression (as of 30° abduction), the less blood can pass. Inadequate irrigation and blood flow as well as mechanical constraints can lead to cell death in the tendon (Kuorinka, 1995). Static abduction positions are recognized as causing tendinitis in the shoulder. Dental work involves many of these positions that are held for long periods of time.

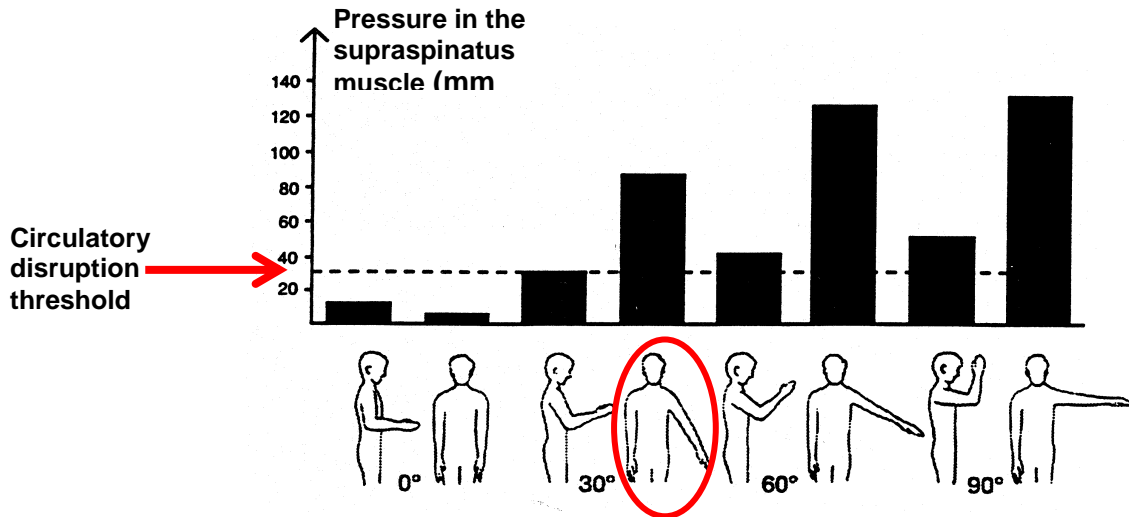


Figure 67. Pressure in the supraspinatus muscle according to arm and shoulder position.
Source: Kuorinka, Ilkka and Lina Forcier, *Les lésions attribuables au travail répétitif, ouvrage de référence sur les lésions musculo-squelettiques reliés au travail*, Ed. Multimondes, Ste-Foy, 1995, p. 65.

7.3 Desirable arm positions

25° forward arm flexion

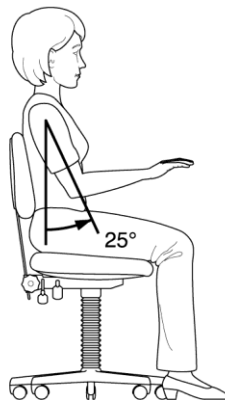


Figure 68. In this position, many structures are supporting the arm, including the biceps which are large, strong muscles.

Source: Adapted from Chaffin and Andersson, *Occupational Biomechanics*, 1991, p. 360.
This material is used by permission of John Wiley & Sons, Inc.

Open to the side: 15°- 20° (abduction).

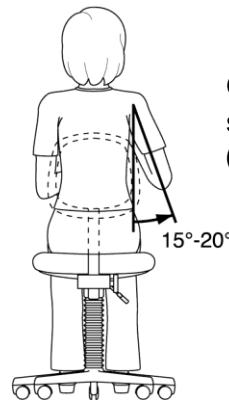


Figure 69. Abduction should be limited to 20°, especially if these positions are held for long periods of time.

8. SHOULDER PATHOLOGIES

8.1 Tendinitis of the supraspinatus (rotator cuff tendinitis)

Because the shoulders are often kept in a position of abduction in dental work, rotator cuff tendinitis is a common problem. As we have just seen, there are four muscles and tendons in the rotator cuff. The supraspinatus tendon is the one most frequently affected. This type of tendinitis is most often associated with tasks requiring an elevated elbow position, which causes compression of the tendons and bursa in the shoulder. Constant use of the arms in a pronounced position of abduction, flexion, reaching and lifting may cause these injuries.

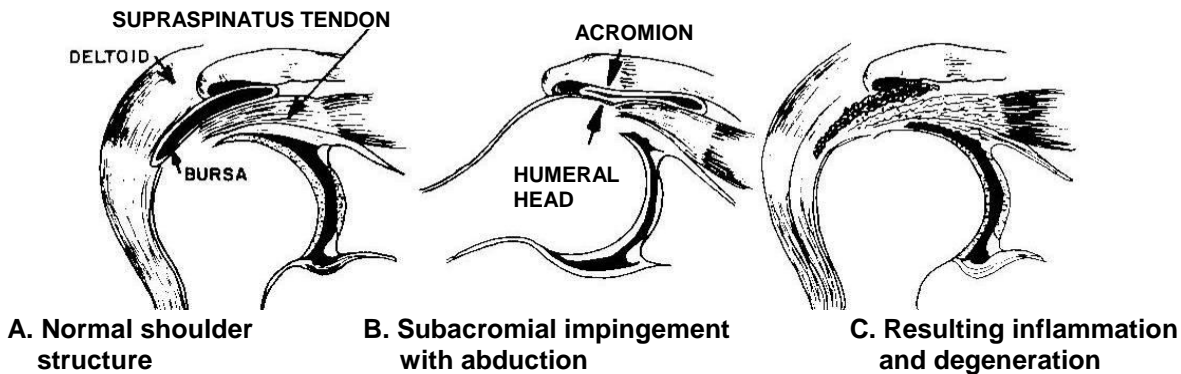


Figure 70. When the arm is abducted (held away from the body) or flexed, the rotator cuff and bursa are impinged between the acromion and the humeral head, causing inflammation and swelling of the tendon and the bursa.

Source: Chaffin and Andersson, *Occupational Biomechanics*, 1991, p. 360. This material is used by permission of John Wiley & Sons, Inc.

In the acute phase, there is severe pain, movement limitation and stiffness of the shoulder. The situation can be reversed to a certain extent. However, degenerative changes may persist if situation "C" is reached and risk factors remain in place.

8.2 Bursitis and frozen shoulder syndrome

If the risk factors are not corrected, sustained compression of the tendons and inadequate blood flow may lead to cell death in the supraspinatus tendon. These dead cells form debris in which calcium can be deposited. This leads to calcification and degeneration, which may evolve into a painful syndrome known as frozen shoulder (Kuorinka, 1995).

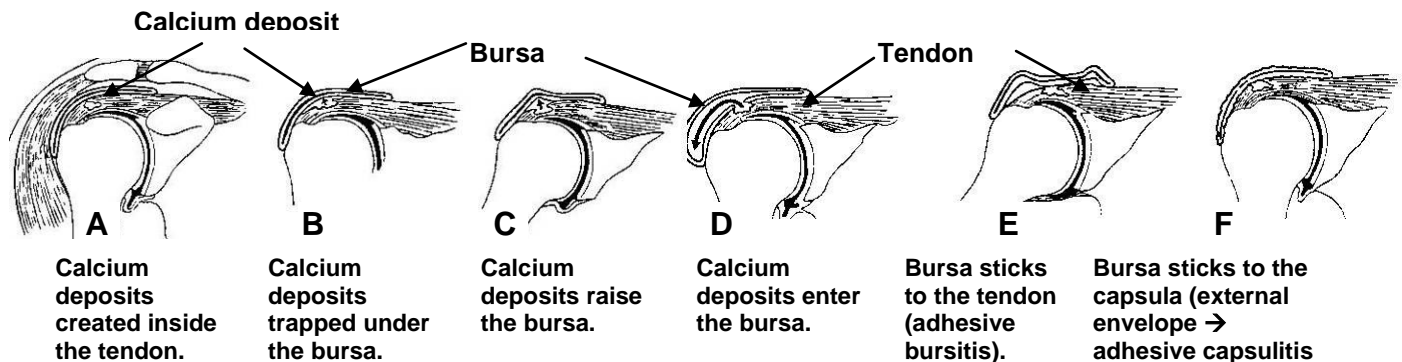


Figure 71. Development of the problem, from calcium deposit to bursitis to adhesive capsulitis.

Source: Dupuis, Michel and Richard Leclaire., *Pathologie de l'appareil locomoteur*, Edisem, Québec, 1991, p. 489.

9. NECK, UPPER BACK AND LOWER BACK PATHOLOGIES

9.1 Disc degeneration and herniated disc

Disc pathologies range from degeneration to herniation. When the neck is flexed forward for a long period of time, as is the case in dental work, the anterior area of the cervical vertebrae is compressed, which may lead to the degeneration of cervical vertebrae C4, C5 and C6. Lateral flexion and twisted neck positions may also lead to disc degeneration. According to Herbert *et al.* (1998), the most common sites are C5-C6 and C6-C7.

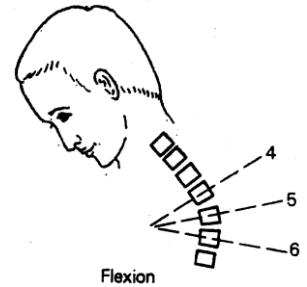


Figure 72. When the head is in flexion, the anterior area of cervical vertebrae 4, 5 and 6 is compressed. Source: Caillet, *Les névralgies cervico-brachiales*, Ed. Masson, 1978, p. 21.

9.2 Minor Intervertebral Dysfunction (MID)

The vertebral structure, with the vertebrae grouped two by two, makes up one functional unit (figure 74). The functional units are interdependent. The proper functioning of each unit depends on the one immediately above and below it.

Although movement of the functional units is limited by the ligaments, there is a movable part known as the intervertebral mobile segment (figure 75), that permits certain movements. This is the structure involved when a “minor intervertebral disorder” (MID) is diagnosed.

When particularly challenged areas (neck and lower back) are asymmetrically overstressed, distortion may set in, which increases the asymmetry, leading to a vicious cycle. Minor intervertebral disorders (MIDs) occur at these locations.

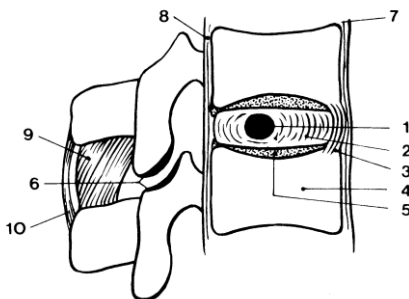


Figure 73. All of the structures (vertebrae (4), disc (1, 2), facets (6), ligaments (7 to 10) make up one functional unit.

Source: Dupuis and Leclaire, *Pathologie de l'appareil locomoteur*, Edisem, 1991, p. 123

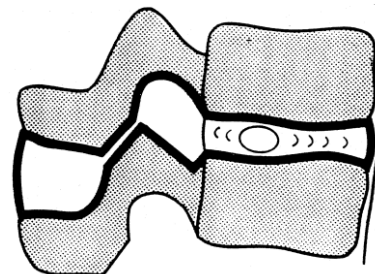


Figure 74. Intervertebral mobile segment (in bold) consisting of a disc and the joint between the two vertebrae.

Source: Vadeboncoeur, *Le syndrome facettaire du dos et le concept de la pathologie fonctionnelle*, 1985, p. 9

Often, vertebral pain is felt even if clinical tests and X-rays remain normal. A medical examination can indicate the involvement of one or more vertebral segments. MID is a segmental dysfunction of a mechanical or reflex nature. It tends to be self-maintaining as a result of holding asymmetrical positions when working. The segment involved is painful when used. Initially MID is only a postural stress factor, but it may lead to a remote chain reaction. It may affect one or more parts of the intervertebral mobile segment. MID is usually reversible.

9.3 Functional Muscle Pathologies

Many authors agree that muscle pain is related to functional overload of a particular muscle, due either to overuse, bad habits, static problems or joint injury.

The concept of functional muscle pathology covers a number of concepts: myalgic cords (*hardened muscle fibers very sensitive to pressure, of variable diameters*), trigger points (*circumscribed area of hypersensitivity*) and myofascial pain syndrome (*involving the fascia, the sheet of connective tissues enclosing groups of muscles*). Functional pathologies mainly affect the muscles of the neck, shoulder girdle and pelvic girdle (lower back) that may lead to hypertonicity, represented by the knotted ropes in figure 75.

Dr. Vadeboncoeur (physiatrist at the Rehabilitation Institute and director of education at *Université de Montréal*) is convinced that common and painful joint dysfunctions (involving cervical (C2 to C4), dorsal (D3 to D5), dorsolumbar (D12 to L2), and lumbosacral (L4 to S1) vertebrae), are primarily the result of muscle shortening, not the primary cause. Overactivation of retracted muscles leads to muscle fatigue.

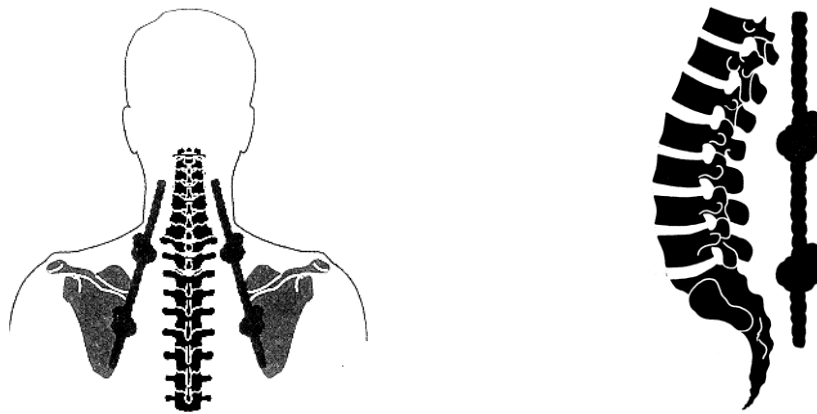


Figure 75. The knotted rope illustrates hypertonicity and muscle retraction in the cervicoscapular and lumbopelvic regions. Source: VADEBONCOEUR, “La pathologie fonctionnelle du rachis et des ceintures, 2^e partie,” *Le clinicien*, May 1995, p. 157.

This muscle dysfunction is characterized by hypertonicity and shortening of the muscle at rest. There is a reduction in the muscle’s irritability threshold, which leads to easy or exaggerated activation when performing simple movements. This muscular hypertonicity is found primarily in the cervical region, the shoulder, and the lumbopelvic region.

In some people, imbalances between the different groups of muscles are reflected by hypertonicity and muscular retraction, while in others, the result is hypotonicity (reflex inhibition) leading to atrophy and weakness. Retracted hypertonic muscles change movement patterns in the neck, static balance and posture.

Table 9	
Muscle group imbalances by predominant postural functions	
Muscles that tend to become retracted and hypertonic	Muscles that tend to become hypotonic, atrophied and weakened
Upper trapezius Certain spinal erectors Large pectorals Small pectorals	Rhomboids Lower trapezius Abdominals

Source: VADEBONCOEUR, op. cit., May 1995, p. 161

9.3.1 Trigger points in the neck and upper back

The most common sites for myalgic cords and myofascial pain are in the neck and in the upper and lower back, as illustrated below.

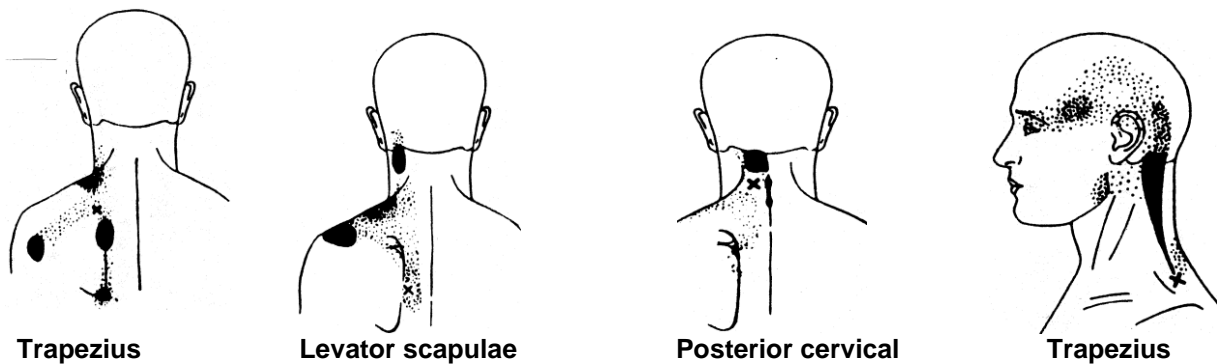


Figure 76. The most common sites for trigger points in the neck and upper back (The “x” corresponds to the location of the trigger points; the black and shaded areas indicate myofascial pain).

Source: Travell and Simons, *Myofascial Pain and Dysfunction*, 1983, p. 638.

9.3.2 Trigger points in the upper and lower back

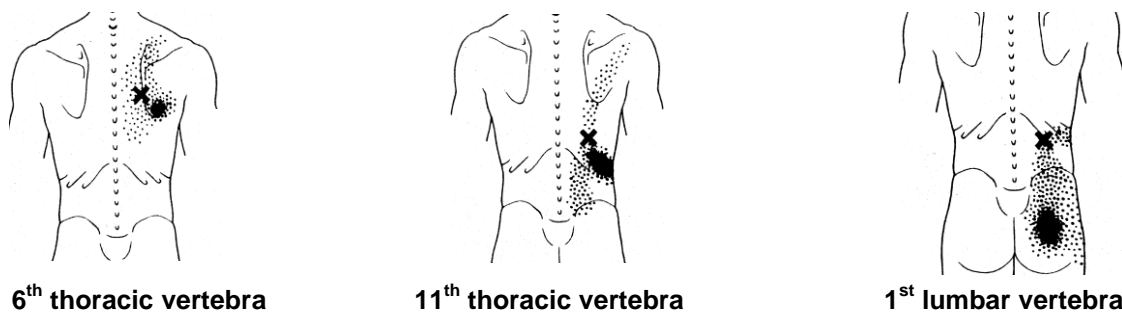


Figure 77. Common trigger points in the back (The “x” corresponds to the location of the trigger points; the black and shaded areas indicate myofascial pain).

Source: Travel, *op.cit.*, p. 638.

An understanding of these different muscle situations can lead to varying approaches and therapies, either for you or for a therapist. For instance, the common practice of applying ice to a painful area increases, rather than reduces, myofascial pain. The type of exercise and stretching used should also be adapted, as indicated in the table below.

Table 10 Elements affecting myofascial pain	
What can increase it	What can reduce it
<ul style="list-style-type: none"> ● Sustained and extreme muscle contractions ● Rapid passive stretching of the muscle ● Local cold on the trigger point ● Cold damp weather 	<ul style="list-style-type: none"> ● Short periods of rest ● Short periods of active exercise <i>(see EXERCISES BREAKS, chapter 17)</i> ● Heated cushion or pad ● Local wet heat on the trigger point

Source: Vadeboncoeur, "La pathologie fonctionnelle du rachis et des ceintures," *Le clinicien*, May 1995.

PART TWO - SOLUTIONS TO PREVENT OR REDUCE SHOULDER, NECK, UPPER AND LOWER BACK PAIN

10. APPROPRIATE DENTAL STOOL FOR HYGIENISTS AND DENTISTS

10.1 Distribution of weight

When it comes to distribution of body weight, a chair with armrests makes it possible to share the load and relieve pressure on the lower back.

Armrests can relieve the mobilizer muscles in the shoulders (trapezius, deltoids, rhomboids, etc.). However, the armrests on standard chairs are not adapted to dental care workers, whose arms have to move to reach different quadrants of the patient's mouth.

In terms of height, having the thighs at 90° and the feet firmly planted on the floor helps to share the load.

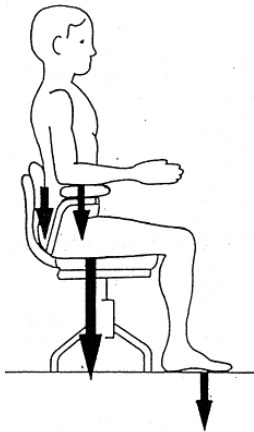


Figure 78. Depending on the chair and the posture, the body's weight is transferred mainly to the seat, but a certain percentage of the total weight is also transferred to the floor, the backrest, and the armrests.

Source: Chaffin and Andersson, *Occupational Biomechanics*, 1991, p.336.

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Even when the arms appear to be relaxed near the body, there is still static contraction at the level of the pectoral girdle to stabilize the arms and to control the precision of the movement. It is important to support the arms while still permitting adequate mobility that does not obstruct the work. Many trials were needed to develop a stool with armrests that follow the hygienist's movements.

10.2 Dental stool with lumbar support that moves forward

When the neck is bent forward, so is the lower back. When the lumbar support cannot be moved forward, the dental care worker cannot keep her back in contact with the lumbar support. The support is then useless for relieving back discomfort while she is working in the patient's mouth.



Figure 79. When the neck is bent forward, so is the lower back.

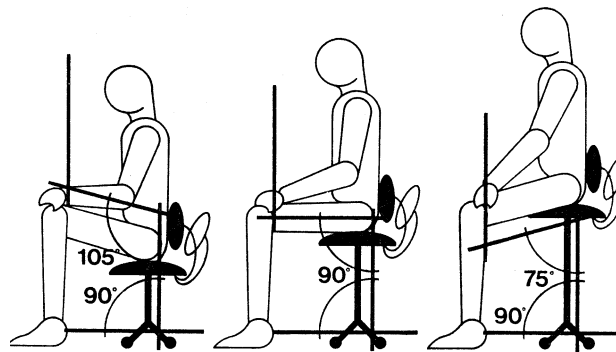


Figure 80. This lumbar support cannot be moved forward, so it is not in contact with the lower back during dental procedures in the oral cavity.



Figure 81. This lumbar support can be moved forward and remains in contact with the lower back during procedures.

According to Hardage, who conducted a study using electromyography (EMG), the most important factor for lower and upper back relief is contact with the stool's lumbar support. In fact, the maximum voluntary contraction (MVC) decreased significantly, from an unsafe level of more than 10%, to approximately 5% for the lower back and from 16% to 10% for the upper back. Depending on seating height (low - 105°, 90° and high - 75°), the variation in MVC ranged only from 2 to 3%.



	LOWER BACK	UPPER BACK
Without lumbar support	9 - 11%	15 - 17%
With lumbar support	4- 5.5%	9 -12%

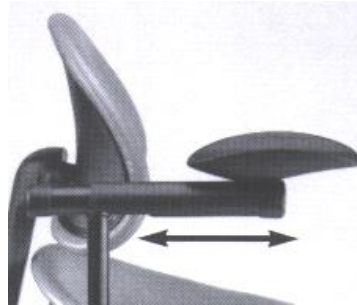
Figure 79. Evaluation of percentage of maximum voluntary contraction (% of MVC) in the muscles of the upper and lower back based on the use of lumbar support and chair height.

Source : HARDAGE et al., 1984, p. 18

10.3 Dental stool with telescopic pivoting armrests

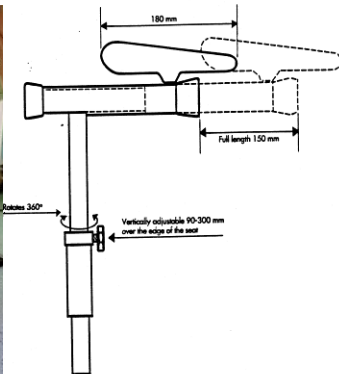
10.3.1 Testing the RGP chair

The hygienists who tried it felt as if they were being projected forward. They also found this chair too large to be able to move around easily. They did not accept this chair.



Figures 83 to 85. The RGP stool with forward-adjusting backrest and telescopic pivoting armrests was tested. The armrest supports are shell-shaped and unpadded. They are made to support the forearm, not the elbow.

10.3.2 Putting together a stool with telescopic pivoting armrests



Figures 86 to 89. Three companies were involved in making this stool: a stool manufacturer, a company that makes telescopic pivoting armrests (Relax Armrest) and a third company to weld the parts together in the middle of the stool (when they were welded at the back of the stool, they did not move forward enough).

This stool was used for three years and it did help many dental hygienists keep working or return to work. However, the armrests were not really adapted to the work of the hygienists and dentists who tested them. The shell-shaped armrest was adapted to the forearm, but the hygienists were using it mainly as an elbow rest. It also had to be padded for comfort. When the hygienists raised their arms, the armrest often turned around or sideways and had to be repositioned. When their elbows were placed on the ends of the pivoting armrests, the armrests would often tip slightly, making them unpredictable. The telescopic slide for forward movement was also relatively unpredictable.

10.4 Dental stools with *free-motion elbow supports*

Thanks to a technology development agreement between ASSTSAS and a Quebec manufacturer, some new elbow rests were created by an industrial designer. The purpose of this project was to increase the comfort and functionality of the elbow rest. We wanted the professional's arms to be supported while still offering mobility that would not obstruct their work. The equipment had to support the hygienist's elbows while maintaining horizontal freedom of movement.

Soft pad elbow rests were introduced, maximizing comfort. The soft pad elbow rests are round, flat and made of soft urethane. When the elbow is resting on it, it is stable, even on the sides. Since the elbow is somewhat moulded into the soft pad, this helps follow the dental care worker's movements.

Each pad is attached to a rod with a ball joint that allows it to move on a horizontal axis. The pivoting mechanism was completely changed and now uses a ball joint featuring adjustable resistance. This produces greater freedom of movement. The elbow supports can follow the movement of the hygienist's or dentist's arms, but they stay in place when they raise their arms. The rods are attached to the underside of the stool seat and their height is adjustable. Initially, they were named as "mobile soft pad elbow rests". They are now called "free-motion elbow supports". All of the components are closed and easy to clean with standard disinfectants.



Figure 90. Stool with *free-motion elbow supports* and lumbar support.



Figure 91. Use of the stool with *free-motion elbow supports* by a hygienist, with the patient in a high, flat position.



Figure 92-93. Use of the stool with *free-motion elbow supports* and lumbar support.



Although they were originally designed for hygienists, the *free-motion elbow supports* also proved to be helpful in relieving MSDs in dentists and dental assistants (figures 94 to 96). The following photographs illustrate their use by two dentists and a dental assistant. Note that in figure 96, the dentist's and the assistant's legs are placed alternately their legs, which allows the assistant to get closer to the patient's mouth and still remain supported.



Figures 94-95. Use of the stool with *free-motion elbow supports* by dentists.

Figure 96. Use of the stool with *free-motion elbow supports* by dental assistant.

10.5 Research on the impacts of using free-motion elbow supports

The purpose of this study was to evaluate the physical impact of using these new *free-motion elbow supports* and their potential for promoting the adoption of safer working positions and methods, in order to prevent musculoskeletal disorders. It aimed to see if these elbow rests, coupled with basic training on ergonomic concepts, helped to reduce static muscle load under usual working conditions. This research was funded by the *Institut de recherche Robert Sauvé en santé et en sécurité du travail du Québec* (IRSST) and by ASSTSAS. The research was conducted under the direction of Denis Marchand, PhD, a professor at the master's level in the anthropokinetics department at the *Université du Québec à Montréal (UQÀM)*. Masters students from the department took the measurements and processed data. Ten volunteer dental hygienists in the Montreal area took part in the study.

10.5.1 Methodology

The muscular activity of specific muscles can be measured using surface electromyography (EMG). The values obtained are then compared to those achieved by the person during the maximum voluntary contraction (MVC) specific to each of the muscles studied. By dividing the two values (measurement during activity/maximum measurement), we obtained the mean percentage of maximum voluntary contraction (MVC) for each muscle. The safe MVC value for the static muscle load required to maintain a position is 5% or less as suggested by Bjöksten and Jonsson (1977). MVCs exceeding 10% are considered high-risk because they impede blood circulation in the muscle.

The muscular activity of eight muscles was measured by EMG before and after one month's use of the new elbow supports. Electrodes were attached to the eight muscles being evaluated: bilateral upper trapezius and bilateral anterior deltoids (figure 97), first right radial, right anterior cubital and bilateral spinal erectors. On each evaluation day, for each muscle being studied, the hygienists exerted maximum isometric effort against resistance. The EMG (uV) results for each muscle were then converted into a percentage of maximum voluntary contractions (MVC), using the highest maximum value achieved on both days.

For each of the muscles, mean MVC was calculated as follows:

$$\text{MVC} = \frac{\text{mean EMG values measured} \times 100}{\text{EMG maximum contraction value}}$$



Figure 97. Position of the electrodes for the upper trapezius and anterior deltoid muscles.

10.5.2 Results

a) Impact on the stabilizer muscles of the shoulders and neck (upper trapezius muscles)

The left and right upper trapezius muscles lift the shoulders and are responsible for extension of the head. The results of our research 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 support did not lead to an increase in muscle load on the wrists.

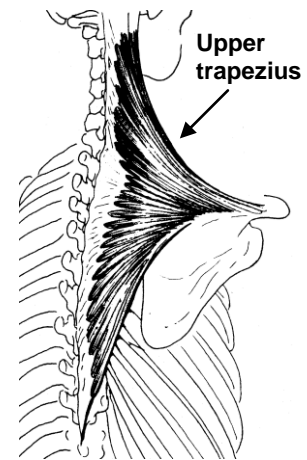


Figure 98. Upper trapezius

For the hygienists' principal work activities, i.e. scaling, ultrasound and polishing, the results of the variance analyses (ANOVA) show that using *free-motion elbow supports* causes a significant reduction ($p < 0.05$)* in the use of the upper trapezius muscles, responsible for stabilizing the arms and neck * ($p < 0.05$) = 95% probability of rejecting the null hypothesis, which in this study would be that the free-motion elbow supports have no effect).

For the left trapezius, use of the elbow support led to an average 38% to 50% reduction and made it possible to approach a safer static load level of 5% or less (figure 99).

For the right trapezius, there was less reduction, i.e. an average of 8% to 23%, but the elbow support also made it possible to approach safe levels when using a curette and ultrasound (figure 99).

When using dental floss, it seems that the majority of the hygienists made little use of the elbow supports, but a statistically significant effect was observed nevertheless on both sides (figures 99).

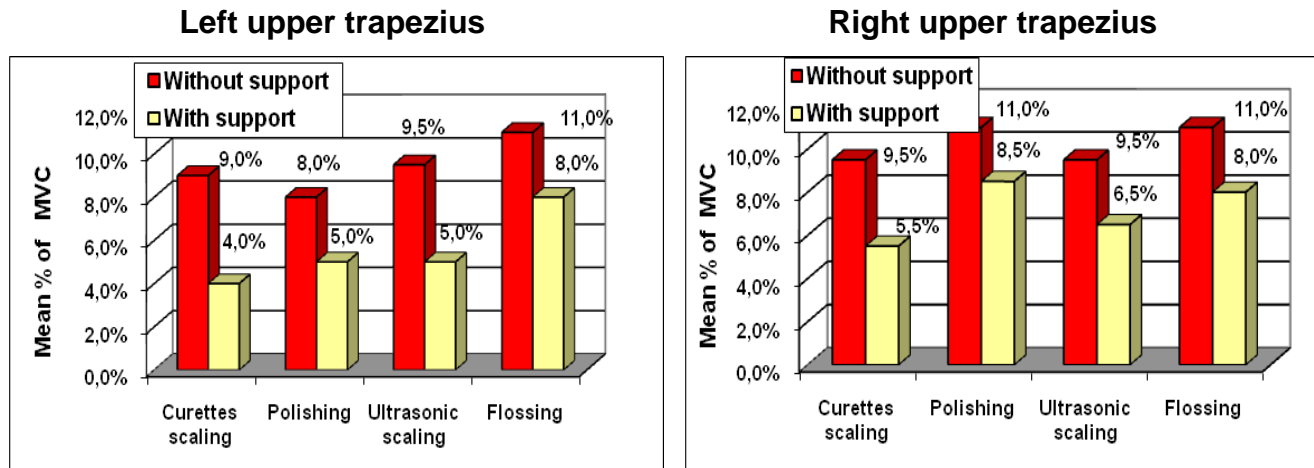


Figure 99. Mean percentages of maximum voluntary contraction (% of MVC), with and without *free-motion elbow supports*, for the upper trapezius muscles when performing four cleaning procedures (total of 72 procedures by 10 hygienists: 37 with and 35 without elbow supports).

b) Impact on working positions in relation to the patient's head

The elbow supports and training were designed to reduce the use of positions with the arms maintained in a position of abduction above the patient's chest and head. These positions, frequently observed when the hygienist is working beside the patient's head (8:00, 9:00 and 10:00 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 support and education on working methods.

It is difficult to change people's habits and movements, because when a person's attention focuses on the task at hand rather than on posture, the efforts made to control movement patterns are generally of short duration (Kolber, 1998). Several of the hygienists mentioned that when using the elbow supports, it took less time for them to realize that they had their arms up in the air, which prompted them to correct their position.

The posture analyses revealed that the percentage of time spent working behind the patient's head (at 11:00 and 12:00) increased from 34% to 67% by the time of the second evaluation ($p < 0.05$) (figure 100). In addition to providing arm support, the use of the *free-motion elbow supports* seems to facilitate the adoption of safer working methods by dental hygienists.

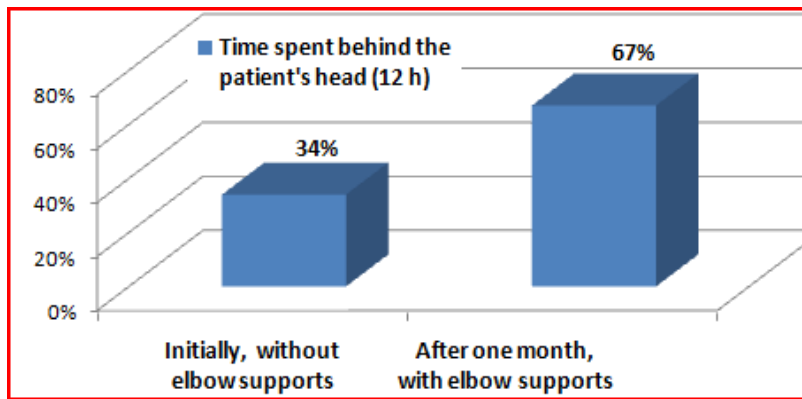


Figure 100. Change in percentage of time spent beside and behind the patient's head with and without *free-motion elbow supports* in a one-month period. These data are statistically significant ($p < 0.05$) (total of 72 procedures by 10 hygienists: 37 with and 35 without elbow supports).

c) Importance of adjusting the height of the elbow supports to a low position

At the beginning of the study, the majority of the hygienists were working with their arms held out at some distance from their body (abduction). When the height of the elbow supports was being adjusted, they asked that the elbow supports be set quite high so they could use them. This resulted in their arms being held in a position of abduction with angles ranging from 30° to 40° (figure 101).

After one of the hygienists in the first group experienced an increase in her symptoms, we insisted that the elbow supports be set lower for the six other subjects, so that they could work with their arms held closer to their body (figures 102-103). Five of the six hygienists who were successful at using the elbow supports set at a lower position showed considerably less static muscle contraction in the upper trapezius muscles. None of the hygienists in this group experienced an increase in their symptoms.



Figure 101. Subject 3 uses the elbow supports set at a high position: arms are in abduction at about 35° . Her neck shows major forward flexion and the patient's head is low, at her elbow level.



Figure 102. Subject 10 uses the elbow supports set at a lower position: her arms are held near her body (no abduction).



Figure 103. Subject 10 shows less neck flexion when the patient's head is higher and more horizontal.

For two of the hygienists (subjects 3 and 10), working with the elbow supports set high and low, the EMG results for the left and right upper trapezius muscles showed a reduction in MVC in both situations, but the reduction was greater when the elbow supports were set low (figure 104). During polishing procedures, for subject 10, the reduction was approximately 80%.

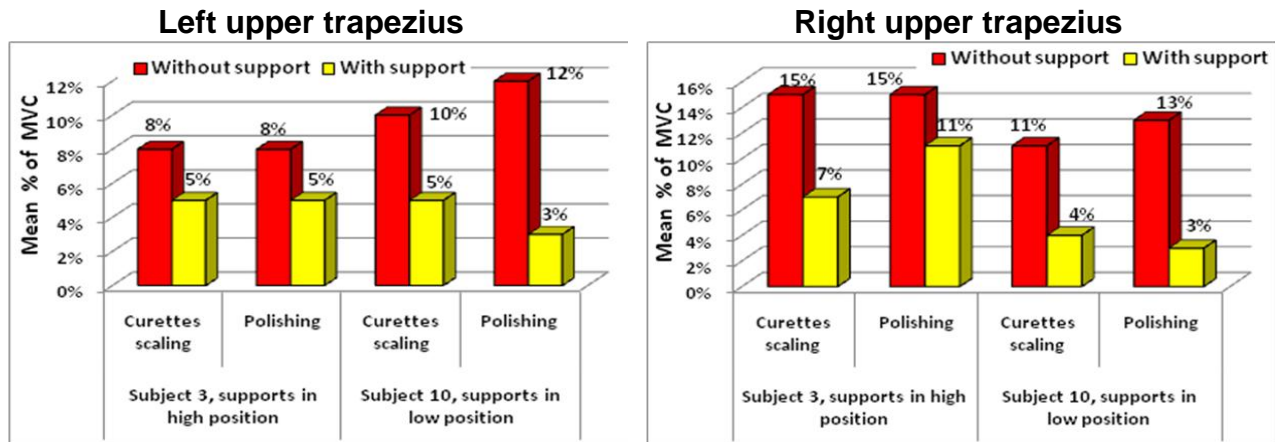


Figure 104. Mean percentages of maximum voluntary contraction (% of MVC) with and without *free-motion elbow supports*, for the upper trapezius muscles for two hygienists (each performing 4 procedures with and 4 procedures without elbow supports). Use of the elbow supports reduced the % of MVC in both subjects 3 and 10. It was further reduced in subject 10, whose elbow supports were set lower (*total of 16 procedures by 2 hygienists: 8 with and 8 without elbow supports*).

In these photographs, it is clear that subject 3's neck is bent more when the patient's head is lower (figure 101). Subject 10's neck is straighter when the patient's head is higher and in a more horizontal position (figures 102-103). When the hygienist's neck is straight, this also contributes to reducing the static load on the upper trapezius muscles.

d) Evaluation of satisfaction level

In a satisfaction questionnaire, eight of the ten hygienists in the study indicated that they were satisfied or very satisfied with the back support and with the comfort of the *free-motion elbow supports* on the stool tested during the experiment. These hygienists also stated that they would buy the stools if they could.

e) Is the reduction in muscle contraction related to the use of free-motion elbow supports or to changing working methods and positions?

Given that there were changes in the clock positions (figure 100) and possibly other changes in working methods after instruction, the data were compiled for a single position, i.e. working behind the patient's head (12:00), in order to determine the actual effect of the elbow supports. It is in this position that hygienists most often have their arms closest to their body.

Impact of the elbow supports on the upper trapezius in the 12:00 position

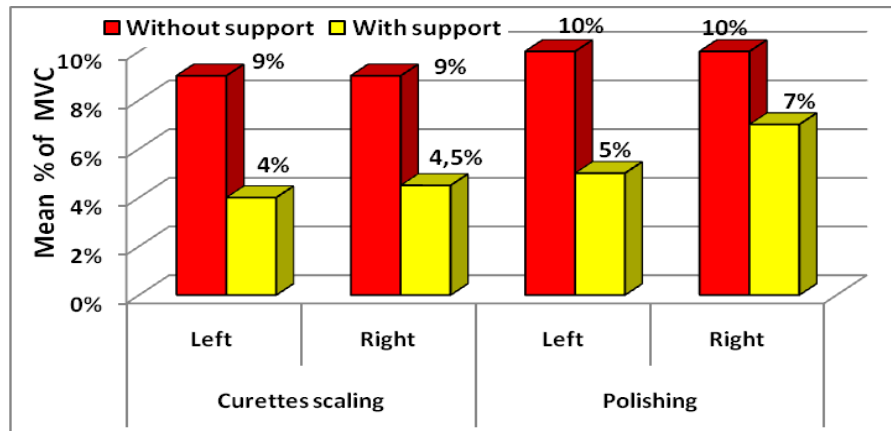


Figure 105. Mean percentage of maximum voluntary contraction (% of MVC) with and without *free-motion elbow supports* of the left and right upper trapezius muscle, working behind the patient's head (12:00), when using currettes and polishing (total of 72 procedures by 10 hygienists: 37 with and 35 without elbow supports).

As we can see, in the 12:00 position, even when the arms appear to be relaxed near the body, there is still static contraction at the level of the upper trapezius to stabilize the arms and control the accuracy of the movement.

10.6 Recommendations on the use of free-motion elbow supports

The dentists, hygienists and dental assistants were instructed to use them as often as possible, but to avoid leaning on either one if this caused flexion or extension of the wrist on that side. Despite every effort, there are still times when the dental care worker's arms have to be maintained in an abduction position to work on certain quadrants of the mouth. The less time spent in these positions, the less likely they are to damage shoulder or back structures.

The main recommendations put forward to facilitate the use of *free-motion elbow supports* were:

- Increase the amount of time spent working behind patient's head instead of beside the patient.
- Place the patient in a more horizontal position (raise the patient's chair and lower the seat back).
- Place the patient's chair in a higher position to be able to move legs freely under the seat back.
- Move the patient's head more often.

The recommendations given in section 12 on safe environment and section 14 on safe working methods will help any dental care worker, but will particularly facilitate the use of *free-motion elbow supports*.

10.6.1 Adapting to *free-motion elbow supports*

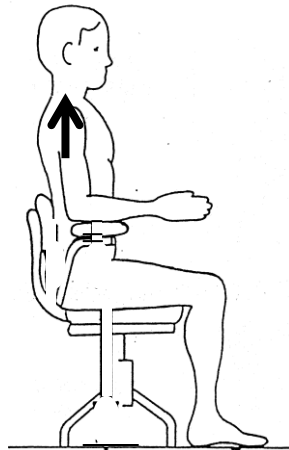
Depending on current working methods, equipment and environments, getting used to *free-motion elbow supports* can be somewhat difficult. The following chart outlines some problems and possible solutions.

Table 11 Adapting to <i>free-motion elbow supports</i>	
Problem	Solution
Overcrowding	Make sure there is enough room. If necessary, move the patient's chair away from the back counter to clear some space.
Feeling trapped	Start with the left or the non-dominant arm.
Not easy to get used to at first	At first, alternate their use. It takes about two weeks to get used to the elbow supports.
With the right arm, the support is hard to use in the 8:00 or 9:00 position	Easier to use in the 10:00, 11:00 and 12:00 positions.
May result in a sharper wrist angle	Don't try to use the supports at all times.
Optimal height adjustment of the supports is hard to do alone	Ask for help and adjust them as low as possible (relax the shoulder).

10.6.2 Adjusting the height and tension of the *free-motion elbow supports*

The adjustment of the height of the free-motion elbow supports is very important for comfort and ergonomic benefits from them. At first, it may be easier to get somebody else to adjust it for you.

1. Arms along the body, raised the shoulders.
2. Adjust the height of the elbow supports to the tip of the elbows.



3. Move the elbows forwards.
4. Shoulders are relaxed and arms are supported.



The tension of the pivoting mechanism is adjusted to produce freedom of movement. The desired level of tension is the one which allows the elbow supports to follow easily the movement of the hygienist's or dentist's arm, but stay in place when they raise their arms.

11. APPROPRIATE DENTAL STOOL FOR DENTAL ASSISTANTS

11.1 Objective: reduce twisting of the lower and upper back

The dental assistant has to adjust her working position to suit the dentist's. She sits higher than the dentist so that she can see over his or her hands. In one ergonomic study, a dentist worked with two assistants in two different positions. One assistant experienced upper back pain, while the other did not. The first one worked with her back twisted (figure 106-107) while the other assistant worked facing the patient (figure 107). Working opposite one another, the dentist's and second assistant's legs were placed alternately under the chair, which allowed the assistant to work closer to the patient without having to twist her body. The dentist did not notice the difference in the two assistants' positions. She had adjusted the patient's seat back to a flat position that was high enough for the assistant to be able to work facing forward (figures 137 to 140, 147 to 149).

Unfortunately, most assistants are unable to choose their own working position. Since most dentists have been trained to work with their elbows at a 90° angle, they adjust the patient's seat back too low for the assistant to be able to slide her legs under the seat. In order to be close enough to see into the patient's mouth, the assistant has to twist her lower back while she does most of her work (figure 106).



Figure 106. When there is no room for her legs under the patient's seat back, the assistant has to twist her back, while keeping her legs parallel to the patient's chair.



Figure 107. There is less back twisting if the assistant can work at an angle; no back twisting if she can work facing the patient.

11.2 Problem: assistant's stool with narrow torso support and no lumbar support

The assistant has to position herself carefully to avoid touching the dentist's instruments or disturbing the patient. The torso support is often too narrow for her to rest her arms on it when holding instruments in the patient's mouth (figure 108-109), so her arms are often unsupported. Static positions in abduction are a recognized cause of shoulder tendinitis and in dental work, many of these positions are held for extended periods of time. Furthermore, the majority of stools made for assistants have no lumbar support.

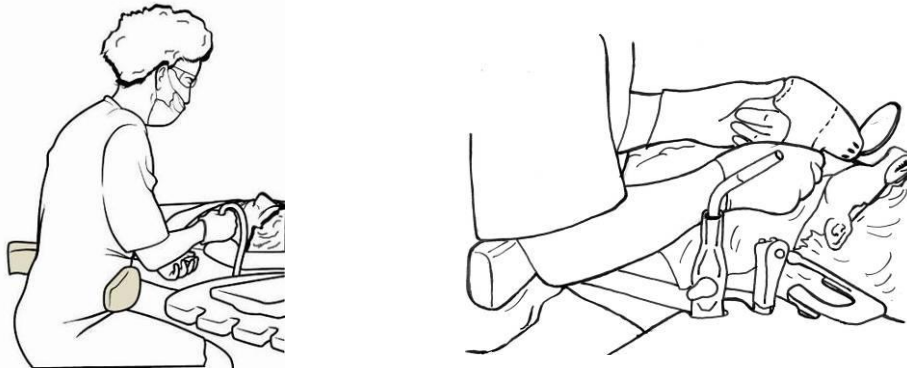
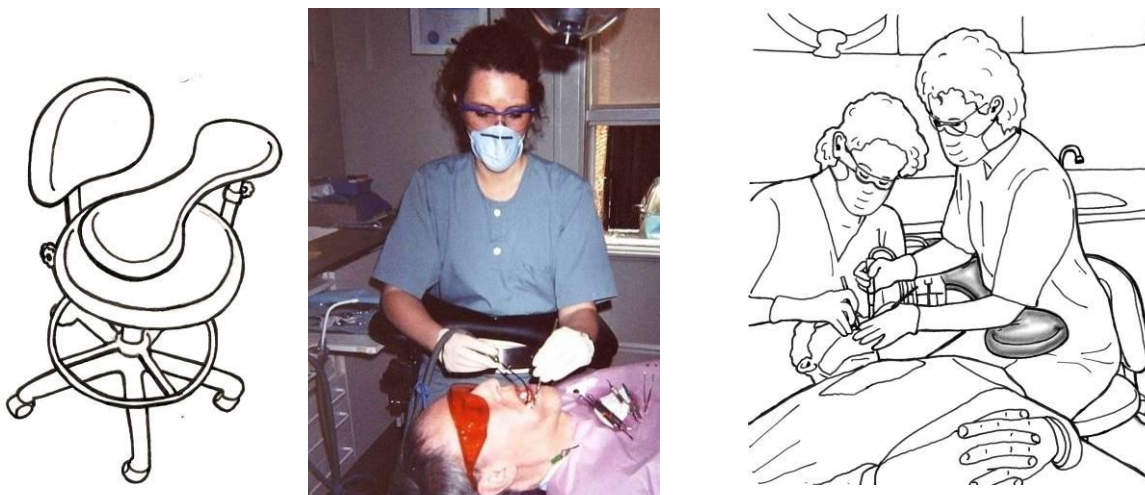


Figure 108, 109. The dental assistant has to hold the instruments (suction, air-water syringe, light, etc.) accurately, without moving, to avoid getting in the dentist's way. The thoracic support of the assistant's stool is often too narrow to support the elbow and stabilize the work of the arm and hand. This means that she has to contract her shoulders and upper back for long periods of time. This stool has no lumbar support.

11.3 Solution: assistant's stool with *wide figure 8 elbow and torso support* plus lumbar support

It is recognized that lumbar support is important for reducing static contractions of the lower and upper back muscles (Hardage, 1984).



Figures 110 to 112. A *wide figure 8 elbow and torso support* provides support for the assistant's elbows, gives her support when holding instruments and allows her to get closer to the patient for better visibility into the oral cavity.

11.4 Study on the use of the Posiflex 8 assistant's stool *with wide figure 8 elbow and torso support plus lumbar support*

11.4.1 Methodology

In August 2008, a study (Proteau, 2008) was prepared to assess the impact of using the Posiflex 8 stool. Following an initial telephone call, 32 screening questionnaires were faxed to the clinics that had purchased the stool within the previous two years. Twenty-four questionnaires were returned by 23 women and one man.

The purpose of the study was to identify changes made with the use of the stool with a *wide figure 8 elbow and torso support* by assistants who were accustomed to using a stool with a narrow torso support. The respondents were asked to indicate how long it took before they observed an improvement or deterioration in their symptoms. The average time required for changes to occur was five weeks; the time ranged from one to 24 weeks.

The average age of the respondents was 40 (range: age 23-65) and their average experience was 16 years (range: 1-37 years); 22 were right-handed, one was left-handed and one did not say. The assistants work an average of 33 hours per week (range: 21-40 weeks) in a four-day week (range 3-5 days); seven assistants have been using the stool since 2006, seven since 2007 and 10 since 2008. The results covered frequency of pain and changes in the workstation.

11.4.2 Results on frequency of pain

a) *Parts of the body with pain, all frequencies*

The questionnaire covered 11 parts of the body. There was a choice of four responses: *never, sometimes, quite often, all the time*. If we include the response *sometimes*, 100% of the assistants experienced pain over the past twelve months in the back (neck, upper back or lower back), 83% in the arms (shoulder, elbow, wrist) and 50% in the legs (hip, thigh, knee, calf, ankle/foot). Some 87% had taken medication or received treatment for pain relief.

The majority of the respondents felt pain in more than one place: with the narrow torso support, two-thirds (62%) had pain in four or more areas; in direct comparison with the wide figure 8 support, just one-third responded in the affirmative (33%).

b) *Frequent serious back and arm pain*

The following analyses present the results for the respondents who indicated a high frequency of pain, i.e. *quite often* or *all the time*. The "narrow torso support" group corresponds to the old stool, while "wide figure 8 support" corresponds to the *Posiflex 8* stool with a wide elbow and torso support plus an adjustable lumbar support that can be moved forward.

Two-thirds of the assistants had frequent low back pain with the narrow torso support. This percentage dropped to 29% with the wide figure 8 support and for the 40% of assistants with frequent neck, upper back and shoulder pain, the pain almost disappeared. Elbow pain, which affected about one-third of the respondents (29%) was also eliminated (figure 113).

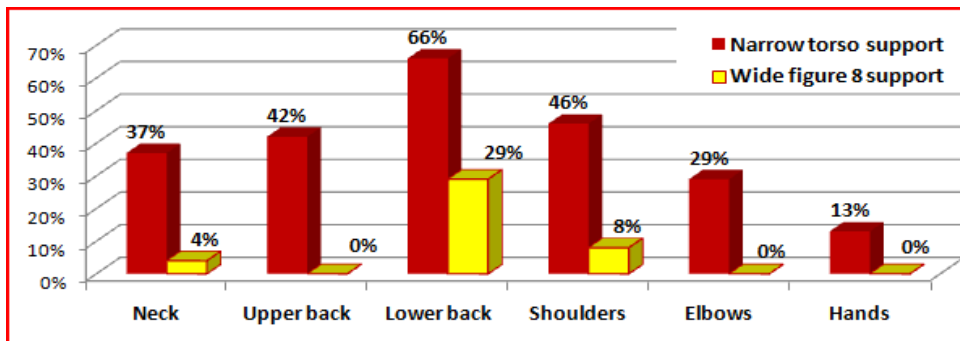


Figure 113. Percentage of assistants with back and arm pain *quite often* or *all the time* with the old stool with a “narrow torso support” compared to the new stool with “wide figure 8 support” (24 respondents).

c) Frequent serious leg pain

With the narrow bar, 25% of the assistants had hip pain. With the new wider support bar, this percentage dropped to 8% for hip pain and disappeared for thigh pain.

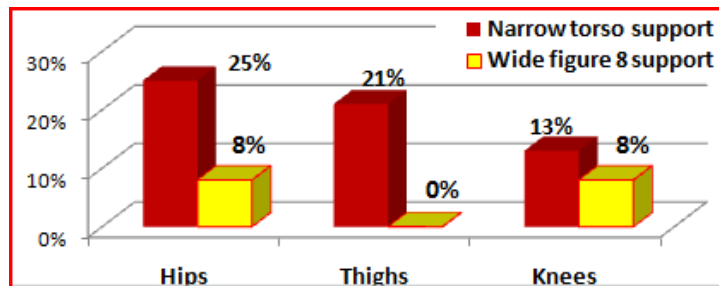


Figure 114. Percentage of assistants with leg pain *quite often* or *all the time* with the old stool with “narrow torso support” compared to the new stool with “wide figure 8 support” (24 respondents).

11.4.3 Changes in the assistant’s workstation

The questionnaire was also designed to check changes made in the assistant’s workstation, to determine which factors had led to a reduction in the frequency of pain measured.

a) Most common positions

The most common working position used by assistants was beside the patient’s head, with the lower back twisted. The percentage of assistants using this position dropped from 83% to 42% with the new stool. While previously, just one assistant had been working facing the patient, now one-third were able to adopt this position, and one-quarter were able to work on an angle (figure 115).

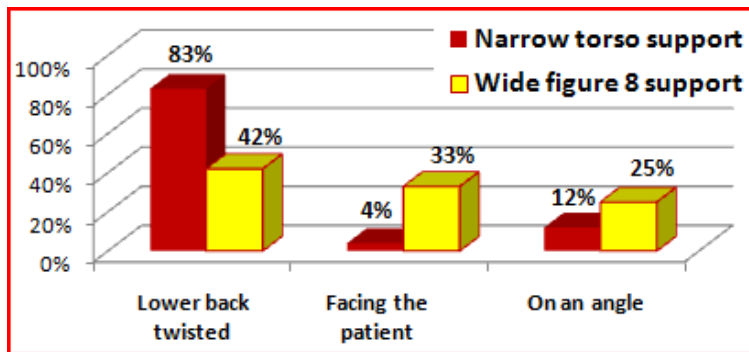


Figure 115. Percentage of assistants according to most common working positions with the old stool with “narrow torso support” compared to the new stool with “wide figure 8 support” (24 respondents).

With the narrow torso support, none of the assistants were able to place their legs far enough under the patient’s chair. Only 17% of the assistants indicated that they were able to do so with the new stool. These data seem to indicate that many, but not all dentists have changed the height of the patient’s seat back to allow the assistant to work facing the patient. In fact, 42% of the assistants were still working in a twisted back position.

b) Percentage of time spent working with arms supported

With the narrow torso support, 58% of the assistants were able to support their left elbow, but only one-third had support for their right elbow. With the wider figure 8 support, three-quarters of the assistants were able to support both elbows.

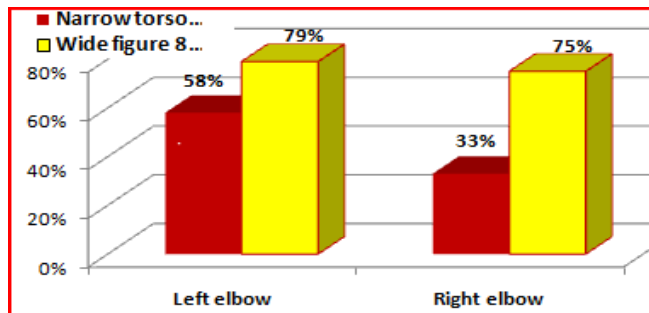


Figure 116. Percentage of assistants able to support their elbows *quite often* or *all the time* with the old stool with “narrow torso support” compared to the new stool with “wide figure 8 support” (24 respondents).

c) Percentage of time spent working in contact with the lumbar support

One-quarter of the stools with the narrow torso support are equipped with lumbar support, but only two of the assistants (8%) were able to rest their back on them. The lumbar support on the new stool is adjustable and moves forward, so 67% of the assistants were able to rest their back on it while performing dental procedures.

12. SAFE ENVIRONMENT FOR DENTISTS AND HYGIENISTS

According to ergonomists, a person's work area should be close to and in front of him/her (figure 117). However, because of precautions taken to prevent infections and to avoid making patients feel nervous, many instruments are kept out of these areas.

A work area that respects the length of the arms is safe for the shoulders, neck and back. As can be seen in the following figure, the usual work area should be within the length of the forearm, or 25 cm (10 inches).

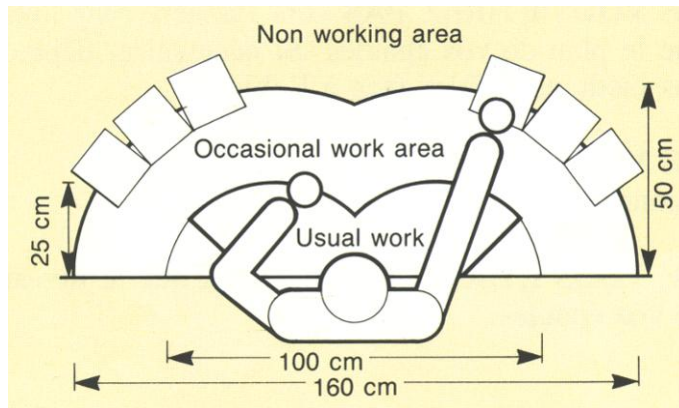


Figure 117. Safe work zones according to the layout recommendations of the Canadian Center for Occupational Health and Safety (CCOSH)
Source: Ergonomic-infogram E-A01,1998

12.1 Enough space behind the chair to work behind the patient's head

To be able to work behind the patient's head (12:00 position), the dentist and hygienist have to be able to move easily between the back of the patient's chair and the rear counter or wall of the room. A minimum of 46 cm (18 inches) is necessary. In many clinics, this space was increased from 9 to 12 inches by moving the patient's chair away from the counter or back wall. Many dental care workers are surprised to learn that it is possible to move the heavy patient chair. However, it may take several people or one very strong person to slide the chair.

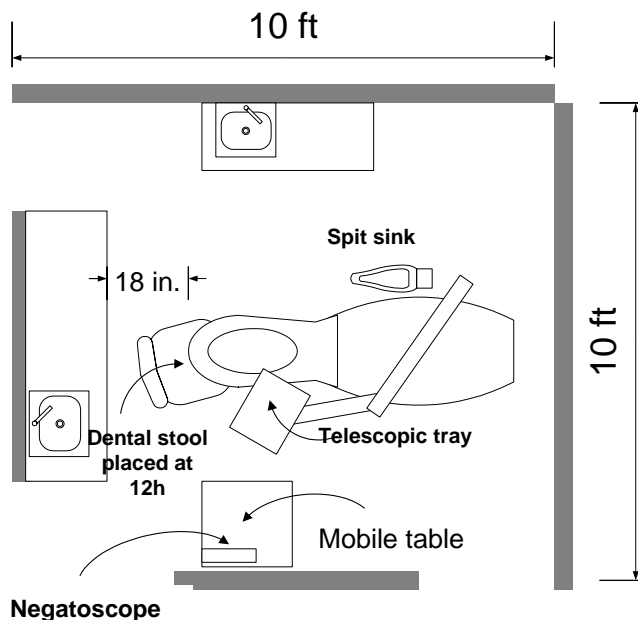


Figure 118. There should be a minimum of 46 cm (18 inches) behind the patient's chair to allow access for the dental stool. The instruments and products should be arranged in front and on the right side (for right-handed people).

In a well organized set-up, the instruments and their connections are within easy reach of the dentist and assistant on their dominant side, but unfortunately, this is not always the case. Different examples and suggestions for improvement are presented below.

12.1.2 Move the patient's chair to increase available space

If there is not enough space behind the dentist's chair, it is possible to move the patient's chair. In the example shown below, the suction instruments are on a fixed stand behind the dentist, at some distance from the assistant.



Figure 119-120. In this example, there is not enough space behind the patient's chair for the hygienist or the dentist, and they felt too cramped in this small room. The tubing and connections are attached to the rear counter, where they are too far away for the assistant.

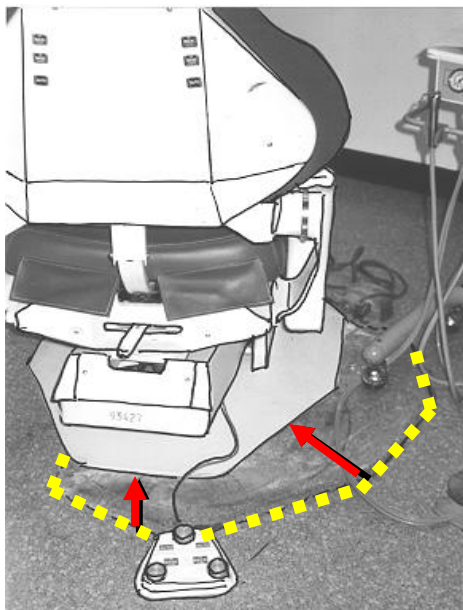


Figure 121. The patient's chair has been pushed sideways, away from the counter. By turning the chair to the right, the dentist was able to increase his workspace. He is now working more with his back on an angle to the corner rather than with his back to the counter. The instruments with tubing are within easier reach of the assistant.

12.2 Choose patient's chair with a narrow chairback or reduce their width

Assistants, in an attempt to get closer to their patient's mouth, tend to damage the upholstery on the edge of the wide seat back with the bar of their stool.

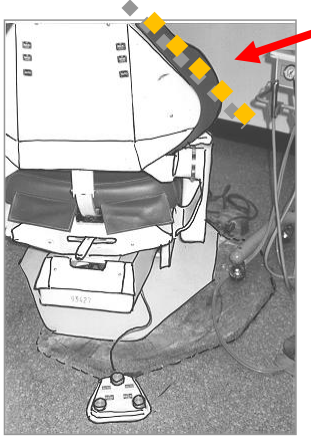


Figure 122. It is possible to have an upholsterer remove some of the excess padding on the chair back (see dotted line) so that the assistant and dentist get closer to the patient when they are working from the side.

12.3 Access to instruments in front of you and on your right side (for right-handed people)

For many hygienists, access to the instruments was provided at the back only (Cox system). This system was designed for a dentist working with an assistant (four hands), while hygienists generally work alone. With access to instruments only at the back, the hygienist has to turn around, which causes her to twist her neck, and upper and lower back. This layout doesn't comply with the layout recommendations of the Canadian Center for Occupational Health and Safety (CCOSH) (figure 117).

When access to instruments is not close at hand, the risk of MSDs in the shoulders is increased, because the movements are being performed at the limit of the joint's capabilities, i.e. stretched to the maximum. Application of force at the joint limit is very stressful on the muscles, which are shortened and less effective at this point. This also causes stress to elbow muscles and tendons.



Figure 123. Rear delivery lay-out generate twisting of the neck and upper and lower back, and pulling in the shoulders. It is also more demanding on the right elbow.



Figure 124. Rear delivery lay-out causes twisting of the neck and lower back, even when switching to the left hand to pick up and replace instruments.

In dentistry, instruments are frequently picked up and put down. The patient's mouth is in the usual work area, but unfortunately, the instruments are not always there. When doing frequent or even occasional work, each arm should not cross over the line in the middle of the body (see figure 117).

The effort and right shoulder strain involved in picking up and putting down instruments is related more to holding up the weight of the arm (5% of the body's weight), which is stretched forward and inward, rather than to the weight of the instruments being handled. The arm itself is a lever that multiplies the weight of its segments (hand, forearm and arm) and the instruments.

Tubing that is too short or stiff increases the effort required to pick up and put down instruments during procedures.

For a hygienist who works alone and uses the stool with *free-motion elbow supports*, it is necessary that at least some of the instruments be accessible from the front or from the side. Adding movable cabinets, carts or a telescopic-arm tray are options for bringing the instruments to the front.

The proposed changes generally involve lengthening the main supply hose (electricity, air and water) so that a movable cabinet can be placed in front and on the right (dominant) side of the hygienist.



Figure 125. Rear view of a movable cabinet added in order to bring instruments in front and on the right (dominant) side of the hygienist. The supply hose is extended to reach the movable cabinet.

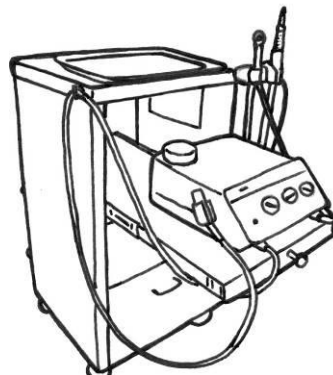


Figure 126. Front view of a movable cabinet equipped with holders for dynamic instruments, a sliding shelf for the ultrasonic machine and a drawer to facilitate storage of equipment in front.

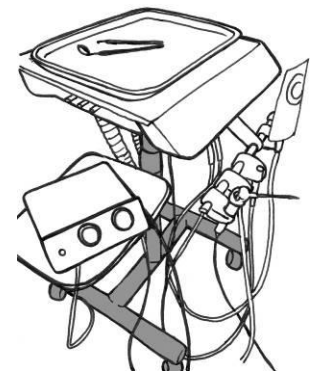


Figure 127. Movable cart with dynamic instrument holders and a shelf on the side for the ultrasonic machine.

The addition of a telescopic-arm tray attached to the counter (figures 128-129) or wall (figure 130) is another way to bring the instruments closer to the hygienist or dentist.



Figure 128-129. Telescopic-arm tray which attached to the counter to have instruments in front on the dominant side.



Figure 130. Telescopic-arm tray attached to the wall.

12.3.1 Instruments above the patient

When the instruments are placed above the patient, the distance for the dentist is minimized. It is important to make sure that the tension to pull back the instruments is not too tight. This type of arrangement seems to be very popular in some European countries. One dentist who changed his rear delivery unit to a front delivery system with instruments above the patient (figure 131) saw a significant reduction in his neck and left shoulder pain.

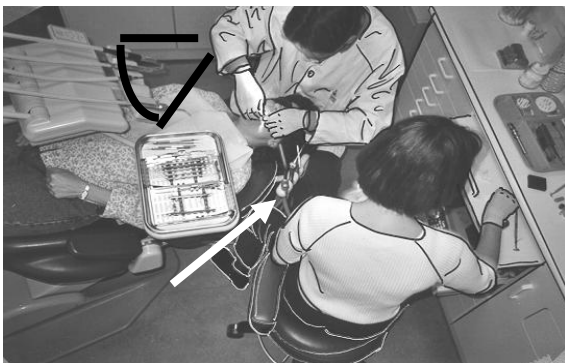


Figure 131. In this example, the dentist has easy access to connected instruments. The assistant's instruments are also in front of her (white arrow). Unfortunately, the counter does not have a mobile unit to provide access to products.

12.3.2 Negatoscope and writing zone in front



Figure 132. Installation of negatoscope in front and on the dominant side makes it possible to maintain the neck, the upper and lower back in a straighter position.



Figure 133. A counter or table on the dominant side to allow taking notes without twisting the body.

13. SAFE ENVIRONMENT FOR DENTAL ASSISTANTS

The safe work zones for dental assistants are the same as for dentists and hygienists as seen in figure 117. Her position depends on environment and working positions of the dentist.

13.1 Problem: access to instruments and products in a fixed counter

When products, instruments and equipment such as the amalgamator are placed on a fixed counter, this can result in twisting of the lower and mid back and neck, when the dental assistant has to pick-up instruments and mix products.



Figure 134. Tools and products placed in the drawers of a fixed counter are at some distance from the assistant, who has to twist or strain her back to reach from the patient to the counter.



Figure 135. The assistant has to twist her upper and lower back to mix products in the amalgamator which is located in a drawer in a fixed counter.

13.2 Solution: movable unit with shelf



Figure 136. Straight back position when preparing products in the top shelf or drawer of a movable unit. The shelf or drawer offers space for the legs requiring less twisting of the neck and back.

13.3 Higher patient's chair and lower chairback

The assistant's working position depends on the dentist's. Most dentists have learned to work with their arms at right angles (90°) or 0° from horizontal. However, this height makes them work with their neck bent forward (see 5.6 to 5.10 and 14.1 to 14.4). When the patient's chair is raised and the seat back is completely flat, this creates enough space for the dental assistant's legs. She can then work facing patient's mouth instead of twisting her back and neck.



Figure 137. This dentist has positioned the patient chair higher and more horizontally, creating more room underneath for her legs and those of her assistant.



Figure 138. This dental assistant can work facing forward using elbow supports because she has enough room under the patient's chair for her legs.

13.4 The dentist's and assistant's legs are placed alternately



Figures 139-140. The dentist's and assistant's legs are placed alternately, allowing the assistant to work facing patient's mouth and allowing her to get closer without having to twist her body. .

14. SAFE WORKING METHODS

As mentioned in section 4, a number of elements affect the working positions of dentists and hygienists: their position in relation to the patient's head, the height and angle of the patient's chair back, the type of treatment to be given, and the location and visibility of the area to be treated, the environment and the equipment.

14.1 Increase the amount of time spent in the 11:00 and 12:00 position

The position with respect to the patient's head (clock position) is the one that has the most impact on arm position, as we have seen in figure 13. In dental clinics, hygienists and dentists frequently keep their arms in a position of abduction (arms held away from the body). The right arm is placed in a position of abduction above the patient's chest (figure 141), while the left arm is in abduction above the patient's head (figures 142-143). These positions are more common when the hygienist or dentist are seated beside the patient's head (clock positions 8:00, 9:00 and 10:00) and are less common when they are seated behind the patient (11:00 and 12:00).



Figure 141. Right arm in abduction over the patient's chest at 9:00.



Figure 142. Left arm in abduction over the patient's head at 10:00.



Figure 143. Both arms in abduction at the same time at 9:00.



Figure 144 -145. Both arms are closed to the body behind patient's head (at 11:00 and 12:00).



12:00



11:00

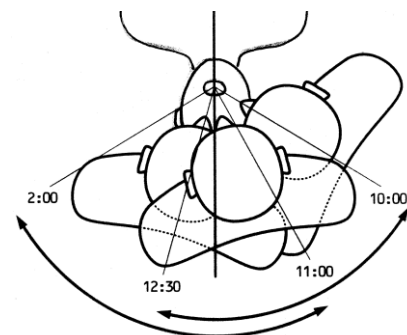
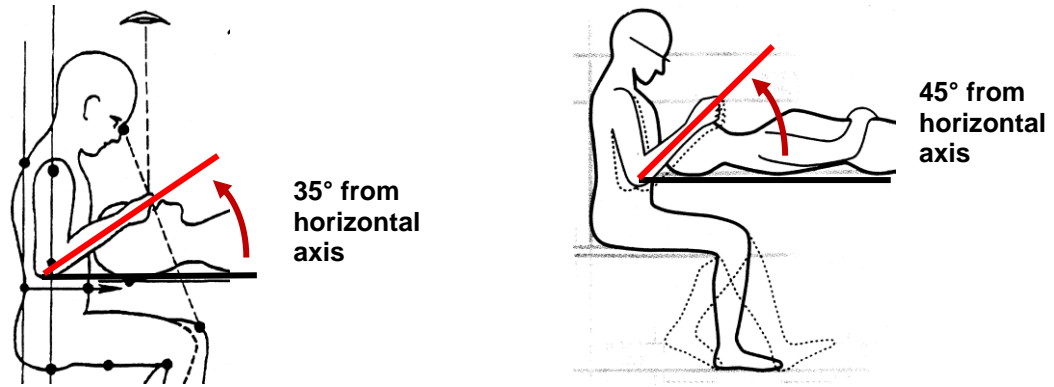


Figure 146. The right-handed clinician is working mainly at 12:00. He moves from 10:00 to 12:30 while the left-handed clinician moves from 11:00 to 2:00. Source: Dougherty, M. "Ergonomic Principles in the Dental Setting, Part 1," *Dental Products Report*, June 2001, p 6.

14.2 Raise the height of the patient's chair to approximately mid-chest level on the dental care worker

As we have seen before, most people adjust the time on their watch at mid-chest height. This method of spontaneously finding the correct posture is called “*design by feel*” and was developed by Japanese dentists. This made it possible to develop a new approach for achieving safer working positions in dentistry. Using this method, the elbows are close to the body and the hands are raised.



Figures 147-148. The dental care worker's lower back is straight, his neck is slightly bent and his arms are flexed between 35° and 45°. There is room for his legs under the patient's chair.

Source: BELENSKY, M. “Human-Centered Ergonomics: Proprioceptive Pathway to Occupational Health and Peak Performance in Dental Practice,” in Denise C. Murphy (under the dir. of), *Ergonomics and the Dental Care Worker*, American Public Health Association, Washington, 1998, p. 288.

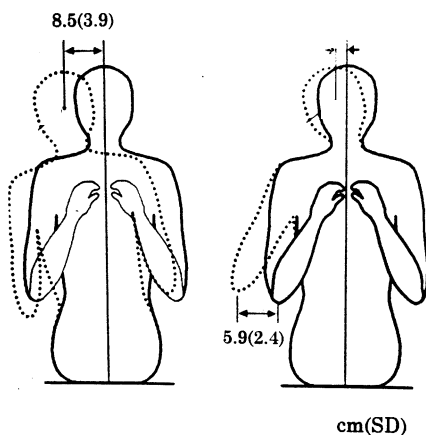


Figure 149. Using this method, there should be less lateral flexion or torsion of the neck. The torso, back and arm movements required to see or reach different parts of the mouth should not exceed those illustrated. Source: Wittenstrom and Kawaguchi, 2000

14.3 Have the patient's head in a flat position

Adjusting the angle of the patient's seat back can have a major impact on the working positions of the dental care worker. Lower the patient's seat back so that his head is flat.

According to Wittenstrom and Kawaguchi (1998), the dental bed (or similar position) (see figure 154) is safer because there is less of a swallowing reflex when the patient is lying flat than when he or she is seated at an angle. According to them, this position allows for greater precision and control over movements to be performed. They recognize that it takes some relearning and adjustments for clinicians to be able to adopt this approach.

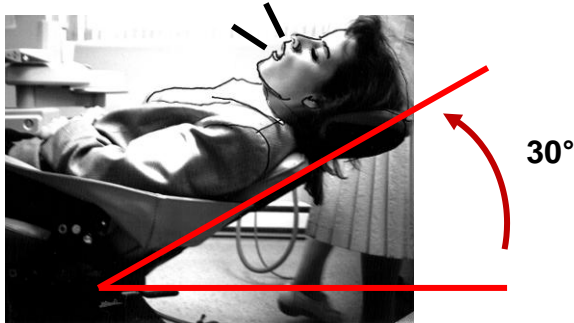


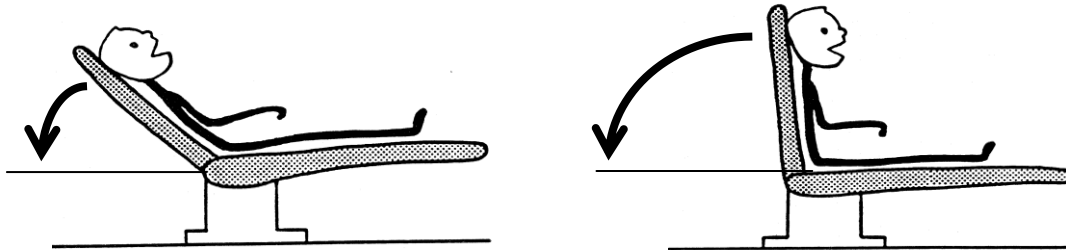
Figure 150. When the patient's seat back is tilted at a 30° angle, the patient's opened mouth is pointed forward.



Figure 151. In that position, to see into the patient's mouth, the hygienist positions herself at 9:00, resulting in the following awkward positions:

- Abduction of the right arm at 60° over the patient's chest.
- Lateral flexion of the head at 20°.

The recommended position for the patient's head is flat, to allow you to work with your arms relaxed and have a better view into the patient's oral cavity. One of the problems is the patient's reluctance to be positioned so low. This problem can be alleviated by having the patient sit down when the chair back is already tilted to about 30°.



Figures 152. If a patient sits down on a dental chair with the back already tilted to 30°, he will be less reluctant to be lowered flat than if he were sitting on the chair with a straight back (90° drop). Source: Wilkins, Esther M. *Prévention et traitement en hygiène dentaire*, produced for Cégep Maisonneuve, p. 81

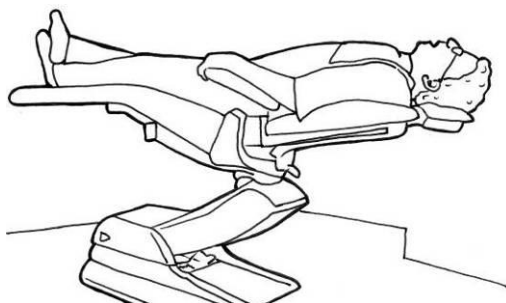


Figure 153. Patient in the correct flat position. The height of the whole chair has been raised and the chairback is as flat as possible.

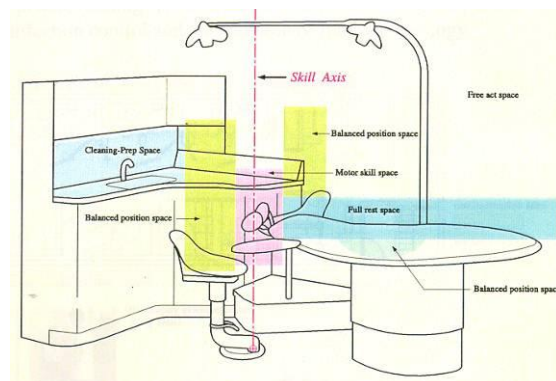


Figure 154. In the "design by feel" approach, a dental bed is used instead of an articulated patient chair. The patient lies himself down on it.

14.4 Bring the patient's head to the edge of the headrest

The patient's head must be at the end of the headrest so that the dental care worker can keep her back supported on the lumbar support and also limit forward flexion of her back and neck. This also depends on the type of patient's seat back and headrest.

When the patient is lying flat, it is easy to position his head at the end of the headrest. When the seat back is on an angle, the patient tends to drop down, as illustrated below. The dental care worker then has to lean forward and overstretch her back muscles to reach the patient's mouth with her instruments and to see into the oral cavity.



Figure 155. When the patient is lying flat, his head is easy to position at the end of the headrest and it stays there.

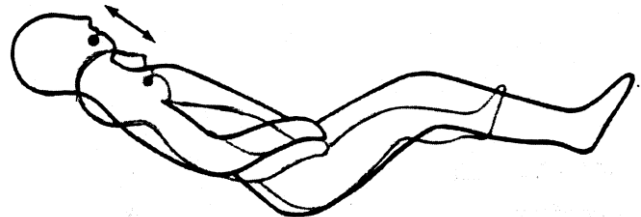


Figure 156. When the patient's seat back is on an angle, the patient tends to slide down into the seat.

Source: Wittenstrom and Kawaguchi. "Ergonomically Correct Design Concepts of a Functioning Dental Office," in Denise C. Murphy (under the dir. of), *Ergonomics and the Dental Care Worker*, American Public Health Association, Washington, 1998, Chap. 13, p. 332.

14.4.1 Adjustable-length headrest

When the length of the headrest can be adjusted, it is important to:

- Adjust the length according to the patient's height.
- For children and people who are very short: remove the headrest.

14.4.2 Add a booster cushion

When the headrest is part of the chairback (i.e. it is not adjustable), it can be uncomfortable for a patient lying flat to move up to the edge of the headrest because of the built-in rounded lumbar support. If the patient's chairback has to be positioned at an angle, a short patient will slide down as seen in figure 156. If the patient's head does not reach the edge of the headrest in a seated position, it will be lower in an inclined position. To avoid these two situations, have the patient sit on a booster cushion, triangular (figure 157) or articulated (figure 158).



Figure 157. Booster cushion (triangular helper) to bring the patient's head closer to the end of the dental chair. Place under the knees of an adult patient or under the buttocks of a child.



Figure 158. Booster seat (articulated cushion) with a back rest that fits into the dental chair, making it possible to bring the patient's head to the edge of the chairback.

14.5 Rest the non-dominant hand on the patient's cheekbone

In dental clinics, dentist and dental hygienists frequently keep their non dominant hand (left for left-handed) above the patient's head and make a constant effort not to touch it. These positions are less common when she is seated behind the patient (11:00 and 12:00). In addition to supporting your hand on the patient's teeth, support your left hand on the patient's cheekbone.



Figure 159. Positioned beside the patient's head, the non-dominant arm reaches over the patients's head while trying not to touch it.

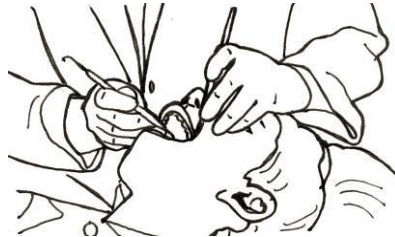


Figure 160. Rest on bony structure (zygomatic bone) on the left cheek.

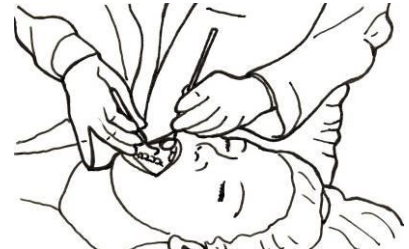
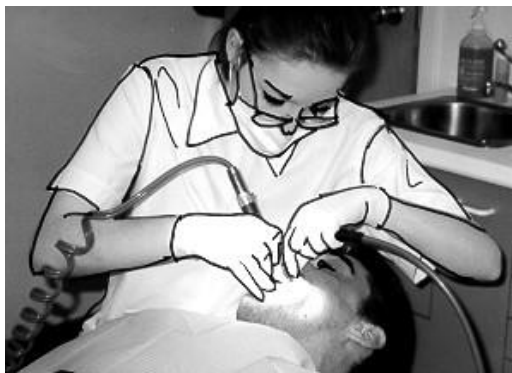


Figure 161. Rest on bony structure (zygomatic bone) on the right cheek.

14.6 Have the patient hold the suction when working without an assistant

When working without a dental assistant, one of the easiest and most effective ways to reduce static load on the left arm is to ask the patient to hold the suction. Run the tube under his left armpit and show him how to activate the "On-Off" button. Experience has shown that many patients like to control the suction. Leaving the suction on the corner of the patient's mouth is another possibility. The hygienist can still manipulate it for short periods when needed. Overall, those simple methods relieve strain on the dental care worker's left shoulder, elbow and wrist.

If slow suction is not strong enough, for instance when you are using ultrasound, you can add a rapid suction adapter so that you can use a saliva pump end on rapid suction. After a month of using this method, one hygienist's golfer's elbow (*epicondylitis*) symptoms disappeared.



Figures 162-163. Giving the suction to the patient frees up your left hand, reduces the angle of abduction in the left shoulder and the angles of deviation of the wrist (ulnar, flexion and extension).



Figure 164. Letting the patient use the suction reduces left wrist strain.



Figure 165. Show the patient how to activate the “On-Off” button. If you need to use it yourself, it is still close by.

14.7 Have the patient hold the tubing of other equipment

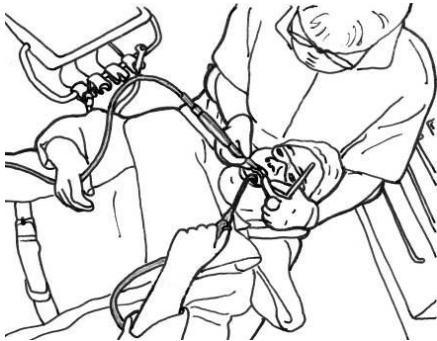


Figure 166. Ask the patient to hold the tubing of other equipment (handpiece, suction, camera, etc.)

14.8 Use indirect vision to view hard-to-see areas

When treating teeth at the back of the mouth, particularly in the upper jaw, try to use indirect vision to maintain a correct neck position and to avoid neck strain as showed in the following figures (167-168).



Figures 167-168. Significant twisting and flexing of the neck and back when using direct vision.

15. SAFE INSTRUMENTS

15.1 Use magnifiers (surgical telescopes)

Magnifiers or surgical telescopes are an effective way to provide better visibility of the work area, improve the quality of procedures and reduce eye fatigue. What are their effects on MSDs involving the neck and back? Or as Rucker (1998) entitled his chapter, “Surgical Magnification: Posture Maker or Posture Breaker?” The author states that wearing surgical telescopes may reduce symptoms, but only if the person’s working postures are already satisfactory. The appropriate choice and adjustment of surgical telescopes should make it possible to view the entire oral cavity without having to further turn or tilt the head. There are two different models: spectacle-mounted or flip-up. Each model has its pros and cons. For one thing, sterility is harder to maintain with the flip-ups, but they are easier to adjust. Magnification increases the need for good lighting. Some systems can be equipped with a lamp to meet this need.



Figure 169. Surgical telescopes mounted on eyeglasses with a head harness to keep it in place.

Ideally, the loupes should allow you to **see into the oral cavity without having to turn or tilt your head.**

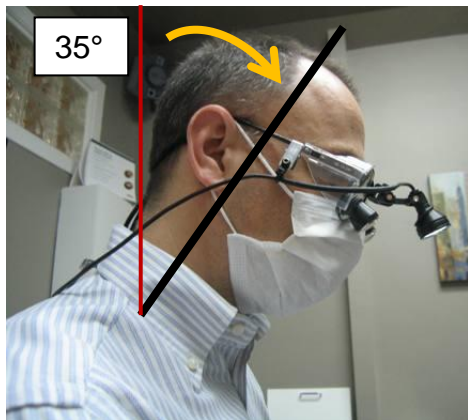


Figure 170. Dentist with surgical telescopes mounted on eyeglasses plus lamp.



Figure 171. Spectacle-mounted flip-up telescopes in the raised position.

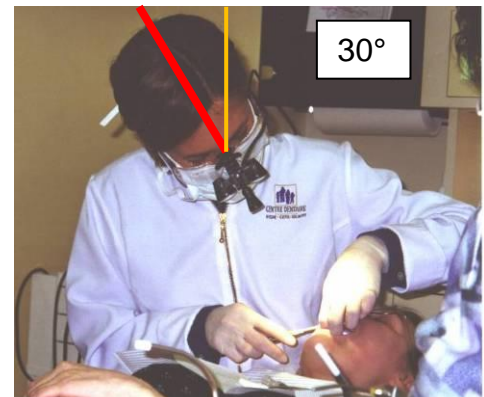


Figure 172. 30° lateral flexion of the neck plus forward flexion in a dentist wearing spectacle-mounted surgical telescopes plus a lamp. Her neck pain has increased with the use of those magnifiers.

Ideally, the magnifiers should make it possible to work with your arms close to your body and your neck straight. Positioning the patient's chair as illustrated in sections 14.2 and 14.3 could improve positions involving abduction of the right arm over the chest and of the left arm over the patient's head.

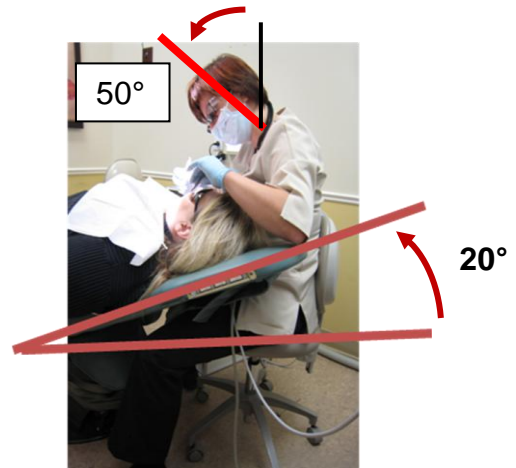
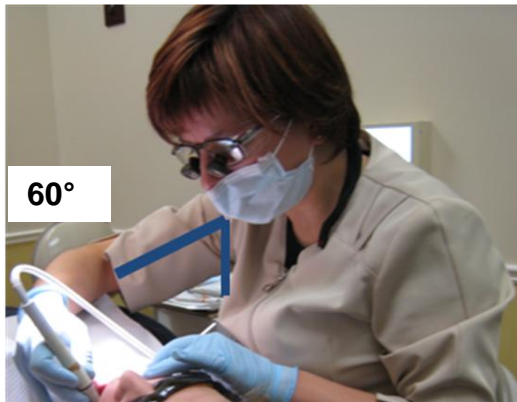


Figure 173-174. Positions of a dental hygienist wearing magnifiers. Notice the abduction of 60° of the right arm, and flexion of the neck of 50° when the patient's chairback is tilted upward 20°.

15.2 Use large diameter curettes with sharp tips

When grasping a very small object, the flexor muscles in the fingers shorten to the point of losing their contractile ability. This situation is worse if the wrist is flexed, which further shortens the flexors of the fingers (Chaffin, 1991).

To increase the strength of your grip, use larger diameter curettes (e.g. black-handle *American Eagle* curettes or the *Hu-Friedy* curette. Cost: approx. \$38 each). Also, some handles are designed to reduce the turning of the curette (e.g. *Knurled Grip of PDT* curettes).

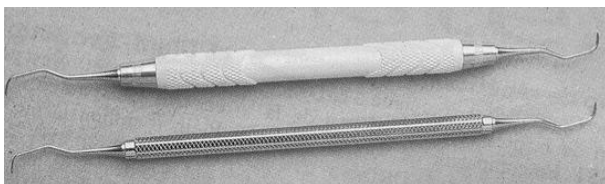


Figure 175. Small and large diameter curettes.

15.2.1 Use very sharp curettes

- Sharpen the curettes more often to decrease effort.
- Change the curette as soon as it becomes less effective.
- Replace worn curettes.
- Set aside time for sharpening at least twice a week.
- Use mechanical sharpening devices.

15.2.2 Use curettes with different curves

Curettes with a variety of curves can reach the different parts of the mouth more easily (e.g. *Montana Jack of PDT*).

15.3 Make greater use of ultrasonic equipment and subgingival end-pieces

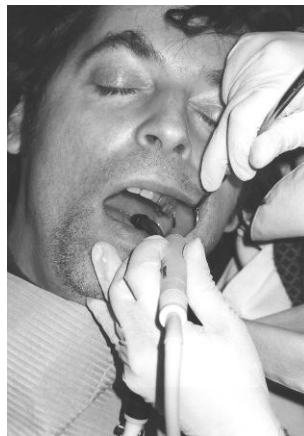
Increasing the amount of time spent using ultrasound is the main way to reduce scaling-related strain. Ultrasound is most effective when very little force is applied. In fact, if you use lateral force, the instrument is less effective because it reduces the vibrating action (Gotteher, 1997). If you are not already doing so, use ultrasound for subgingival treatments as well.

One reason why hygienists are reluctant to make greater use of ultrasonic equipment is the amount of water and spray generated. It is recommended that the patient's mouth first be rinsed with an antimicrobial solution to reduce germs in the spray. Use only the minimum amount of water required. It seems that the models that generate more heat in the handpiece require more water to cool them. On the other hand, the piezoelectric and newer magnetorestrictive models generate less heat, and therefore require less water.

Use ultrasonic equipment that requires less cooling water (and generally produce less spray and less patient resistance) such as piezoelectric equipment (e.g.: *Mini-Piezon*) and that uses less water than magnetorestrictive scaling equipment (e.g.: *Cavitron*).

- Magnetorestrictive: scaler or handpiece (25,000-30,000 cycles/sec.) (e.g.: *Cavitron of Dentsply*).
- Piezoelectric: quartz crystal (29,000- 40,000 cycles/sec) (e.g.: *Piezo EMS -400* or *Mini-Piezon of EMS*).

According to some studies (Woodall, Drisko, 1993), ultrasound is as effective as curettes in removing supra and subgingival tartar. Subgingival treatments require special smaller hand-pieces, about the size of a probe. It is recommended that hygienists receive special training on how to use them. One hygienist told us that after serious chest pain forced her to stop working for six months; she now does more than 90 percent of her scaling with Piezo equipment and is now working full-time.



Figures 176 to 178. The use of ultrasound (in this case, a mini-Piezon) makes it possible to work with arms that are more relaxed, with wrists in a more neutral position (straight) to reach the various quadrants (left-handed hygienist).

The use of any hand-held vibrating instrument leads to involuntary contraction of the muscles of the forearm. It is therefore recommended that the pressure be released frequently (one-second microbreaks) to decrease the contraction of the muscles and restore blood circulation.

15.3.1 Comparing curettes and ultrasound: effort, postures and movements

Table 12	
Effort, postures and movements with curette and ultrasound	
Curette	Ultrasound
Tight grip to keep curette from turning	Gentle grip (similar to probe)
Force required to dislodge tartar	Little force required
Large repetitive movements of wrists and fingers	Light continuous “brushing” or “erasing” movements
Placement of curette tip under deposits	Positioning of ultrasound tip similar to probe
Position of wrist and arm depends on the direction of force to be applied	More relaxed arm and wrist positions
No vibration	Vibration

16. DURATION OF TIME WORKED

If you spend long periods of time performing the same task, particularly if there is any strain involved, you may be causing damage to the joints in your wrists, elbows, shoulders, neck and back.

Discomfort, fatigue and joint pain are signs that you have exceeded the capacity of your joints and muscles, and that you are at risk of injury.

16.1 Planning your work schedule

Divide up long procedures and schedule several appointments.

Alternate demanding and easier cases in the schedule.

Avoid 12-hour days. Fatigue and pain persisting the day after a 12-hour workday are indicators that you worked for too long a period. This is common practice in dental clinics, and is a serious risk factor for the development of MSDs involving the shoulders, neck, upper back and lower back. This practice should be reconsidered.

During a long procedure, take a short break at least every fifteen minutes. This also gives the patient an opportunity to relax his/her jaws.

16.2 Introduce warm-up exercises, micro and mini breaks

See *EXERCICE BREAKS*, page 89.

Introduce short group sessions to help everyone think about doing them.

While you work, make an effort to relax your neck and move your shoulders frequently.

16.3 Introduce breaks in the patient schedule

You should take a break for at least fifteen minutes during every half-day (five hours) of work. Breaks are important to help you relax and recharge your batteries physically and mentally.

17. MUSCLE RECOVERY TECHNIQUES

This document recommends a number of measures which, if implemented, will reduce excessive muscle strain associated with static or awkward positions as well as job-related stresses and injuries. These include working with your arms closed to the body, supported with *free-motion elbow supports*, forearms up about 45°, working with your neck straighter and your lower back in contact with the lumbar support.



Figure 179. Ergonomic working position with arms supported by *free-motion elbow supports* and lower back in contact with the lumbar support.

Nevertheless, even if you make a consistent effort to position yourself correctly, which is very difficult to achieve 100% of the time, dental work is still extremely demanding on the muscles of the neck, upper back and lower back, because of the level of accuracy and stability required. Here are some exercises that you can do at work as frequently as possible, to help relieve muscle tension.

17.1 Exercises to restore muscle balance

These exercises are designed to help you restore muscle balance. When the muscles in your neck and upper back are contracted for long periods of time, there is less blood circulation. At the same time, the muscles between the shoulder blades are stretched for long periods of time, and they tend to lose their tone, becoming weak.

The following exercises, reflecting a broad consensus in the field of exercise training, were developed in consultation with Dr. Denis Marchand, who has an M.Sc. in biomechanics, and a Ph.D in motor development. He is professor of ergonomics at the Université du Québec à Montréal (UQAM). Muscle recovery exercises involve voluntary contraction and relaxation to warm up the muscles and to counter the effect of static work (table 13). Postural correction exercises often use movements that are opposite the ones use in awkward positions.

Table 13	
Exercises to restore muscle balance in dental work	
MUSCLE GROUP	TYPE OF EXERCISE
Contracted muscles in the neck, upper back and shoulder muscles.	Relax and circle your shoulders, frontwards and backwards, to restore blood circulation in these muscles.
Stretched muscles between the shoulder blades (rhomboids)	Circle your shoulders backwards to activate the muscles between your shoulder blades
Lower back muscles	Straighten your head and push your torso backward.

Source: Adapted from Vadeboncoeur, May 1995, p. 161 and Marchand, Denis (personal paper)

17.2 Active movements to restore blood circulation

The static muscle contractions in the neck and upper back needed to hold the head upright and prevent it from falling forward onto the chest also inhibit blood circulation in them. Contraction of these muscles is also required to ensure accurate hand movements, especially if the arms are not supported.

MOVE your head and shoulders to restore and increase blood circulation which will:

- supply oxygen and nutrients.
- clear away accumulated metabolic waste.

a) *How often ?*

As often as possible, ideally every minute! We propose integrating these movements into your daily work routine, either as frequent micro-breaks during procedures, or as mini exercise breaks between patients or between steps in lengthy procedures. We have prepared an EXERCISE BREAKS sheet that you can post in the workplace as a reminder (see next page).

b) *Breathe as you exercise*

To make the most of these exercises, we recommend that you do them at the same rate as your breathing. This means that you should breathe in as you lift your shoulders, and breathe out as you lower your shoulders, to make sure that you have enough oxygen in your bloodstream.

17.3 Active warm-up

The purpose of a warm-up is to increase the internal temperature of the muscle before putting it to work. The best way is to contract and relax the muscle. Shoulder circles are also a good way to warm up the muscles in the mid and upper back. The following recommended exercises will only take about a minute.

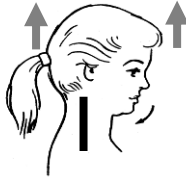
EXERCISE BREAKS

**Contract and relax your muscles
to restore blood circulation and relieve stress**

Warm up at the beginning, middle and end of the day
(standing, 1 minute)

1. Keep your arms held close to your body, and circle your shoulders 10 times (breathe in as you lift your shoulders up to your ears, and breathe out as you lower them).	5 times frontwards 5 times backwards
2. Circle your arms 10 times , alternating left and right. (<i>Check with a physician first if you have tendinitis in your shoulder.</i>)	5 times forwards 5 times backwards

Mini-breaks between patients (1½ minutes)

Seated or standing	
1. Keeping your arms close to your body, circle your shoulders 6 times (breathe in as you lift your shoulders up to your ears, and breathe out as you lower them).	3 times frontwards 3 times backwards
2. Turn your head slowly from side to side (breathe in as you turn your head to the side and breathe out as you turn it back to the centre)	3 times to the left 3 times to the right
3. Pull in your chin and push your head up (try to make yourself taller). Hold 1 second and release	
Standing	
4. Walk in place (to relieve the pressure on your thighs, buttocks and lower back), hang your arms down by your sides and shake your hands.	10 seconds

Micro-breaks as often as possible

(seated, 5 seconds) Ideally, every few minutes
(e.g.: whenever you take your hands out of the patient's mouth)

1. Keeping your arms close to your body, circle your shoulders 2 times (breathe in as you lift your shoulders, and breathe out as you lower them).	2 times backwards
---	--------------------------

To successfully incorporate micro-breaks as often as possible during the workday, you have to make them an integral part of your activities. For instance, practice these moves:

- Whenever you change instruments
- Whenever the patient uses the suction (after being taught how to use the controls)
- Whenever you change tooth surface, if the procedure lasts longer than 5 minutes
- Whenever you change teeth, if the procedure lasts longer than 5 minutes
- Whenever you change quadrant, if the procedure lasts longer than 5 minutes
- Any other handy reference which would remind you to practice these moves.

17.4 Warm-up with heat

17.4.1 For neck and upper back tension

Using a warm cushion or pad every evening can to help relieve the tension accumulated during the day and help your muscles relax during the night. The “Magig bags”, that can be heated in the microwave, are practical and easy to wear while watching TV or relaxing. They stay warm for about 20 minutes which is sufficient to have an effect. We suggest using the following 2 types: the long version 45 cm (18”) is placed to circle the neck (figure 179) while the U-shaped bag is placed to cover the upper back and shoulders (figure 180). To make sure to cover all of the upper trapezius, you can wear the two types of “Magic Bags” at the same time (figure 181). They sell for about 20 \$ each.



Figure 179. “Magic bag”, 45 cm (18”) long that goes around the neck.

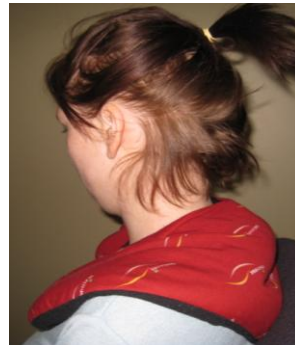


Figure 180. “Magic bag” in a “U” shape that goes over the shoulder and upper back.



Figure 181. Use of the 2 types of “Magic bags” at the same time.

17.4.2 Middle or lower back tension

If you have aches lower down, in the middle or lower back, you could try a larger, round moist heat pad when you are sitting or lying. If you are sitting, for the mid-back, place a small cushion on your lower back to keep the round cushion in place. For acute pain, first check with a therapist if heat or cold is the better approach.



Figure 182. Moist heat pad heated in the microwave according to the manufacturer’s directions. It is large enough to cover the upper back and can be used when you are sitting or lying down. (e.g.: Kaz SmartTemp Moist Heat Pad: about \$24).

17.5 Factors that can increase or decrease pain associated with static muscle contraction

Generally speaking, pain in the neck and upper back muscles is caused by sustained, unreleased contraction, even at rest. Once you understand the origin of the problem, you can adopt a specific approach and find treatments that you or a therapist can try. It is also important to understand that the popular practice of applying ice to a painful area increases rather than relieves myofascial pain. The following table presents the type of modified exercises and stretching recommended for myofascial pain.

Table 14 Factors affecting myofascial pain	
FACTORS THAT CAN INCREASE IT:	FACTORS THAT CAN RELIEVE IT
<ul style="list-style-type: none"> ▪ Sustained, extreme muscle contraction ▪ Passive, fast muscle stretching ▪ Cold wrap on the trigger point ▪ Cold, damp weather (avoid swimming in cold water) 	<ul style="list-style-type: none"> ▪ Short period of rest ▪ Brief periods of gentle exercise ▪ Local heat (“Magic Bag”) for about 20 minutes every evening ▪ Moist local heat on the trigger point ▪ Swimming in a therapeutic (warm) pool; swimming on your back while wearing a life belt (to avoid neck extension)

Source: Vadeboncœur, 1989, p. 9 and Marchand, Denis (personal paper)

17.6 Lower back exercises

Curvature of the spine tends to be exacerbated with fatigue, leading to increased strain on the intervertebral joints and lower discs, and resulting in pain after holding positions for extended periods of time.

Standing exercises

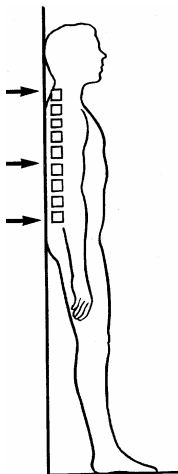


Figure 183. Wall exercises to correct spinal posture can be practiced a few times a day, particularly after procedures that are physically demanding.

Pull in your chin and hold the position for 3 deep breaths.

Source: Dupuis et al., 1991, p. 459

Floor exercises

Spinal adjustments release the muscles in the lower back. Lie on the floor, with your knees bent. Lift your pelvis up toward the ceiling (pelvic tilt). This is an exercise that you can do at home.

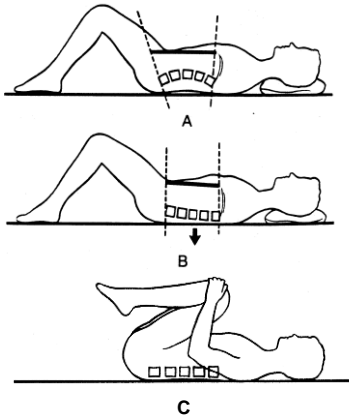


Figure 184. Floor exercises

A = Starting position

B = Pelvic tilt

C = Stretching the back muscles bending both knees at the same time.

Source: Dupuis et al., 1991, p. 459

17.7 Warning about certain type of exercises

17.7.1 Warning about stretching

Dr. Denis Marchand warns that the muscle is under passive pressure while it is being stretched, and that there is less blood circulation. He recommends that muscles only be stretched when warm and that the **stretch not be held for more than six seconds**. Stretches should be done gently, without bouncing and they should not be painful. Pain indicates that the tendon has reached its limit. Stretching too hard could cause injury and tearing (Kolber, 1998).

17.7.2 Warning about exercises that involve pressing your hand against your head

If you have neck pain associated with static work, you may have problems in your spinal joints ranging from minor intervertebral problems (MID) to disc degeneration or even herniation. This type of injury can be aggravated by pressing one or both hands against your head. These moves generate a significant amount of force, because your arm muscles are much stronger than the muscles in your neck.

17.8 Recovery positions while you sleep

The position you sleep in can facilitate muscle recovery. It is generally recommended that people sleep on their side. Various types of equipment are available to help people adopt the best possible sleep recovery positions which can reduce pain in the neck, shoulders, and upper and lower back.

17.8.1 Memory foam pillow and mattress topper

Closed cell memory foam pillows and mattress toppers adjust to the body's curves and provide pressure-free support to keep the spine in proper alignment while you sleep. When used in combination, they can relieve pressure on the shoulders and neck. In many cases, they can significantly reduce shoulder pain.

a) Memory foam pillow



Figures 185-186. A memory foam pillow can support the head, and reduce pressure on the neck and shoulders (e.g. Tempur, cost: \$150-\$200 depending on thickness: 4, 4.5 or 5 inches).

<http://www.tempurpedic.ca/en/index.php>

b) Memory foam mattress topper

Mattress quality varies considerably and memory foam mattresses are generally quite expensive. Firm mattresses are generally not recommended anymore. Adding a memory foam mattress topper is a cost-effective way to enjoy the benefits of memory foam on a budget. These topper is 1.5 inches (4 cm) thick.

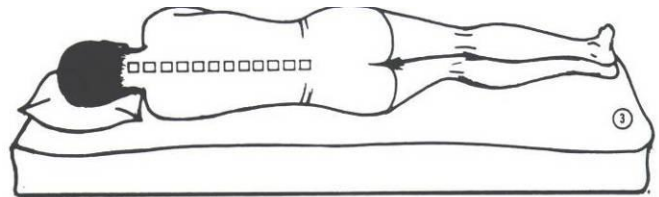
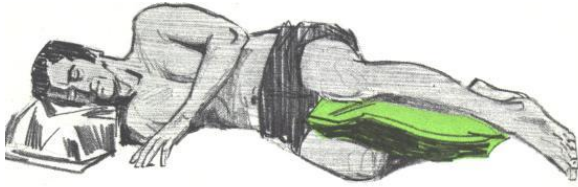


Figure 187 to 189. A 4 cm (1.5 inch) thick memory foam mattress topper used over any kind of mattress provides good spinal and neck alignment. The ObusForme 4 cm (1.5 inch) Memory Foam Mattress Pad is available in Canadian Tires Stores in three sizes: twin, double and queen. Cost: \$150 - \$200 Also available on the web site <http://sitincomfort.com/obfomefomato.html> Cost from \$180 to \$280\$ including king size.

17.8.2 Sleep with a pillow between your knees

Many therapists recommend that you keep a pillow between your legs at night. For people who have trouble keeping the pillow in place during the night, there are cushions that come with a strap.



Figures 190-191. To keep your spine in alignment, sleep with a pillow between your knees with your knees bent. Some models come with a strap to keep the pillow or cushion in place. (e.g.: *Prime de Luxe*, \$30). *Primes de luxe Inc.* Postal and phone orders at 6766, rue Jarry Est, Saint-Léonard, QC H1P 1W3, Telephone: 514-323-5100

17.8.3 Sleep with a pillow under your top arm

It is important that your upper back muscles (rhomboids) that are stretched during the day be relaxed during the night.



Figure 192. A pillow under your top arm can keep the muscles between your shoulder blades from stretching at night, and help them recover if they are being stretched at work all day. Putting the arm on the spouse on one side is also an option.

17.8.4 Use a body pillow

Instead of using 2 pillows, a long body pillow can support both your arms and your knees and be easier to keep in place during the sleep.

17.8.5 Place a pillow under your knees when you sleep on your back



Figure 193. Sleep with a pillow under your knees to reduce lordosis if you tend to sleep on your back.

17.9 Ball massage

If you feel tension in your upper neck muscles that persists even at rest, you can ask a friend to use a small ball to massage and relax these muscles.



Figures 194-195. Ask a friend to gently roll a firm but not hard ball around your shoulder blades, keeping their hand flat. This can be done while you are sitting or lying down.

17.10 Wear a narrow cervical collar for biofeedback

It is understandably difficult to be aware of your posture while you work, because your attention is focused on what you are doing. In addition to implementing the techniques recommended in this document, dental care workers who have annoying neck and upper back pain can try wearing a narrow cervical collar to help them become aware of their neck position before it becomes painful. This is a simple, inexpensive technique (about \$14), but you have to be prepared to constantly explain why you are wearing the collar to your colleagues and patients. The effect of this collar on its own may be limited, but when it is combined with other techniques, as illustrated below, it can be very beneficial. Wear it for a few days or a few weeks depending on results to improve your head position.

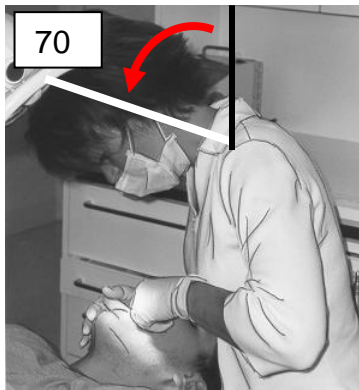


Figure 196. Initial neck flexion angle of 70° down.

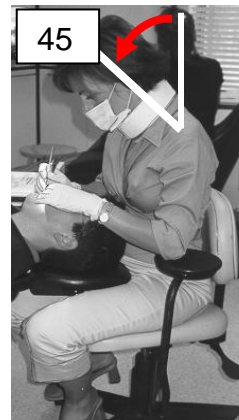


Figure 197. Reduced neck flexion angle to 45° when wearing a narrow, rigid cervical collar (6.5 cm or 2.5 inches).

Looking at these two photographs, you can see that the patient in the second photo is positioned higher and that the hygienist is using a stool with free-motion gel elbow supports. The neck flexion angle has been reduced by about 20° and her supported back is straighter and her lower back is in contact with the lumbar support.

18. SYNTHESIS OF SOLUTIONS TO PREVENT OR REDUCE SHOULDER, NECK, UPPER AND LOWER BACK PAIN (hygienists (H), dentists (D) and dental assistants (A))

Dental care worker

<p>Working methods</p> <ul style="list-style-type: none"> • Increase the amount of time spent in the 11:00 and 12:00 positions. • Leave the suction in the corner of patient's mouth or give the suction to the patient, run the tube under his left armpit and show him how to activate the "On-Off" button. If needed, add an adapter to the rapid suction to install a slow suction piece. • In addition to supporting your hand on the patient's teeth, support your left hand on the patient's cheekbone. • Work with your elbows close to your body and your arms flexed at about 45°. 	<p style="text-align: center;">H and D</p> <p style="text-align: center;">H</p> <p style="text-align: center;">H and D</p> <p style="text-align: center;">H and D</p>
<p>Equipment</p> <ul style="list-style-type: none"> • Use a dental stool with a lumbar support that moves forwards. • Use an operator stool with <i>free-motion elbow supports</i> that support the weight of your arms and share the weight of your upper body. • Use an assistant's stool with <i>wide elbow and torso support</i>. • Increased ultrasound use and use sub-gingival pieces. 	<p style="text-align: center;">H, D and A</p> <p style="text-align: center;">H, D</p> <p style="text-align: center;">A</p> <p style="text-align: center;">H</p>
<p>Environment</p> <ul style="list-style-type: none"> • Make sure that you have at least 46 cm (18 inches) behind the lowered patient seat back so that you can easily work at 11:00 or 12:00 o'clock position. If necessary, push the patient's chair away from the rear counter. • Keep instruments in front of you (not behind), on your right (if you are right-handed). • To correct rear delivery layout, add movable cabinet, carts or telescopic-arms tray attached to the counter or the wall. • Have a counter equipped with a movable unit for the assistant. 	<p style="text-align: center;">H and D</p> <p style="text-align: center;">H, D and A</p> <p style="text-align: center;">H and D</p> <p style="text-align: center;">A</p>
<p>Adjustment of the patient's chair</p> <ul style="list-style-type: none"> • Have the patient sit down with the chairback already lowered to about 30° so that he will feel less fearful and uncomfortable when the seat back is lowered further. • Adjust the chair so that the height of the patient's mouth is at your mid-chest level <ul style="list-style-type: none"> ➤ Raise the patient's chair so that you can move your legs under the seat back. ➤ Lower chairback so that the patient's head is flat. • Adjust the headrest so that the top of the patient's head is right at the end of the headrest. • If necessary (if the chairback has no adjustable headrest or the patient is too short), add a triangular or articulated cushion to bring the patient's head to the edge of the chairback. • Press yourself against the end of the headrest or against the top of the patient's head to limit forward flexion of the back and neck. • To allow the assistant to face the patient's mouth, the dentist's and the assistant's legs are placed alternately. 	<p style="text-align: center;">H, D and A</p> <p style="text-align: center;">H, D and A</p> <p style="text-align: center;">H and D</p> <p style="text-align: center;">H, D and A</p> <p style="text-align: center;">H and D</p> <p style="text-align: center;">D and A</p>

SYNTHESIS OF SOLUTIONS TO PREVENT OR REDUCE SHOULDER, NECK, UPPER AND LOWER BACK PAIN (cont'd)

Dental care worker



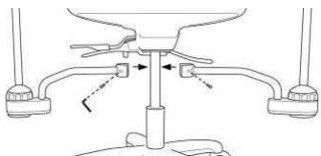

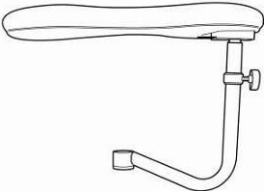

<p>Work organization</p> <ul style="list-style-type: none"> • Schedule breaks. • Introduce frequent micro-breaks (a few seconds) while working to relax the muscles and encourage blood circulation. • Eliminate 12-hour work schedules. • Schedule time to sharpen cures at least twice a week. • Alternate between heavy and light cases. 	<p>H, D and A H, D and A H, D and A H H and D</p>
<p>Muscle recovery techniques</p> <ul style="list-style-type: none"> • Do active shoulder movements frequently (see <i>Exercise breaks</i>). • Use heated pad (“Magic Bag” or others) for about 20 minutes every evening. • Implement the appropriate sleeping conditions to help the neck joints and upper and lower back muscles recuperate at night. 	<p>H, D and A H, D and A H, D and A</p>

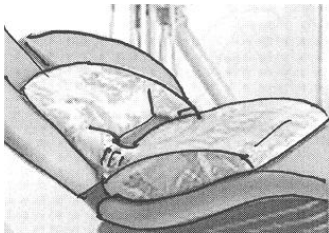
19. SYNTHESIS OF SOLUTIONS TO PREVENT OR REDUCE IN ELBOW, WRIST AND HAND PAIN (hygienists (H), dentists (D) and dental assistants (A))

Dental care worker

<p>Working methods</p> <ul style="list-style-type: none"> • Leave the suction in the corner of the patient’s mouth or give the suction to the patient, run the tube under his left armpit and show him how to activate the “On-Off” button. If needed, add an adapter to the rapid suction to install a slow suction piece. • Ask the patient to hold tubes that pull downward (e.g. hand piece, camera, suction, etc.) or wrap them around your forearm. • Change any tubing that is stiff or too short. • In addition to supporting your hand on the patient’s teeth, support your left hand on the patient’s cheekbone. • Increased ultrasound use so that you can work with your wrists in a straighter (neutral) position and reduce hand flexion, extension and rotation efforts. 	<p>H H, D and A H, D and A H and D H</p>
<p>Equipment</p> <ul style="list-style-type: none"> • Increased ultrasound use of and use sub-gingival pieces. • Use ultrasound equipment that requires less cooled water (generally less spray and less patient resistance) such as piezoelectric equipment (e.g.: <i>Mini-Piezon</i>) and that use less water than magnetorestrictive equipment (e.g.: <i>Cavitron</i>). • Replace worn currettes, tubing that are too short or too stiff. • Use large-diameter currettes. • Use currettes with different curves to be able to reach different areas of the mouth more easily. • Make sure that your gloves are not too small. 	<p>H H H H H H, D and A</p>
<p>Environment</p> <ul style="list-style-type: none"> • Have a movable unit and bring it close to the work area. • Keep instruments at arm’s reach on the right side (for right-handed people). If necessary, add a movable cabinet, cart or telescopic-arm tray attached to the counter or the wall on the dominant side (right for right-handed) for instruments. 	<p>A H, D</p>
<p>Work organization</p> <ul style="list-style-type: none"> • Schedule breaks. • Introduce frequent micro-breaks (a few seconds) while working to relax the muscles and encourage blood circulation. • Eliminate 12-hour work schedules. • Schedule time to sharpen currettes at least twice a week. • Alternate between heavy and light cases. 	<p>H, D and A H, D and A H, D and A H H and D</p>
<p>Muscle recovery techniques</p> <ul style="list-style-type: none"> • Do active shoulder movements frequently (see <i>Exercise breaks</i>). • To reduce the effects of working in a static position, stretch in the opposite direction of the positions used while working, ideally four times a day. 	<p>H, D and A H, D and A</p>

20. PRODUCTS AND SUPPLIERS 2007

PRODUCTS		SUPPLIERS 
<p>FREE-MOTION ELBOW SUPPORTS POSIFLEX</p> <ul style="list-style-type: none"> ▪ Stool with standard cylinder (5.5"): \$1,380 ▪ Upholstery upgrade available \$300 ▪ Stool with long cylinder (8.5") and footrest \$1,480 		<p>Manufacturer:</p> <ul style="list-style-type: none"> ▪ Posiflex Design www.posiflexdesign.com 1 888-767-4353 <p>Distributors (3):</p> <ul style="list-style-type: none"> ▪ Henry Schein Canada www.hsa.ca 1-800-263-3621 ▪ Patterson Dental www.pattersondental.ca 514 745-4040 1 800 363-1812 ▪ Sinclair www.sinclairdental.com 450 766 1277 1 800 663-7393
<ul style="list-style-type: none"> ▪ 2 free-motion elbow supports and adaptors to add to an existing stool: \$660 		
<p>ASSISTANT'S STOOL WITH <i>WIDE FIGURE 8</i> ELBOW AND TORSO SUPPORT PLUS ADJUSTABLE LUMBAR SUPPORT THAT CAN BE POSITIONED FORWARD</p> <p>POSIFLEX 8</p> <ul style="list-style-type: none"> ▪ \$1,350 		
<p><i>WIDE FIGURE 8</i> ELBOW AND TORSO SUPPORT WHICH CAN REPLACE MOST EXISTING NARROW TORSO SUPPORT</p> <ul style="list-style-type: none"> ▪ \$535 		
<p>BOOSTER CUSHION (TRIANGULAR HELPER)</p> <p>To bring the patient's head closer to the edge of the chairback of the dental chair. Place under:</p> <ul style="list-style-type: none"> ▪ the knees of an adult patient; ▪ the buttocks of a child. <p>Comes with 2 straps for hanging on the wall when not in use. Cost : \$195</p>		<p>Manufacturer and distributor:</p> <ul style="list-style-type: none"> ▪ Posiflex Design www.posiflexdesign.com 1 888-767-4353

PRODUCTS		SUPPLIERS ☎
<p data-bbox="289 243 597 306">BOOSTER SEAT SIRONA (ARTICULATED CUSHION)</p> <ul style="list-style-type: none"> <li data-bbox="188 348 406 380">▪ Approx.\$280 		<ul style="list-style-type: none"> <li data-bbox="1068 306 1437 436">▪ Patterson Dental www.pattersondental.ca 514 745-4040 1 800 363-1812

Available at dental supply firms:

- Small left-side cart for ultrasound equipment.
- Small right-side cart or articulated arm on the right for instruments with tubing and air, water or electric connections or to hold a tray of instruments.
- Curettes with large and ultra-large handles (e.g. *American Eagle, Hu-Friedy and PDT*).
Price: approximately \$38.
- Special mouthpieces for ultrasound used to remove sub-gingival tartar; universal mouthpiece (generally right) and special angles (right and left).

21. ASSTSAS

ASSTSAS is a non-profit organization whose mission is to promote occupational health and safety prevention by providing consulting services and information, training, research and development activities and the organization of prevention actions. It is funded mainly by dues collected by the CSST from all employers in the health and social services sector (dental clinics are in the same sector as hospitals, nursing homes, CLSCs, etc.).

To obtain a copy of the complete book, *Guide de prévention des troubles musculo-squelettiques (MSD) en clinique dentaire*, (276 pages, available in French only), please send a clinic purchase order or cheque in the amount of \$12 (or \$24 for people outside the province of Quebec) to ASSTSAS.

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