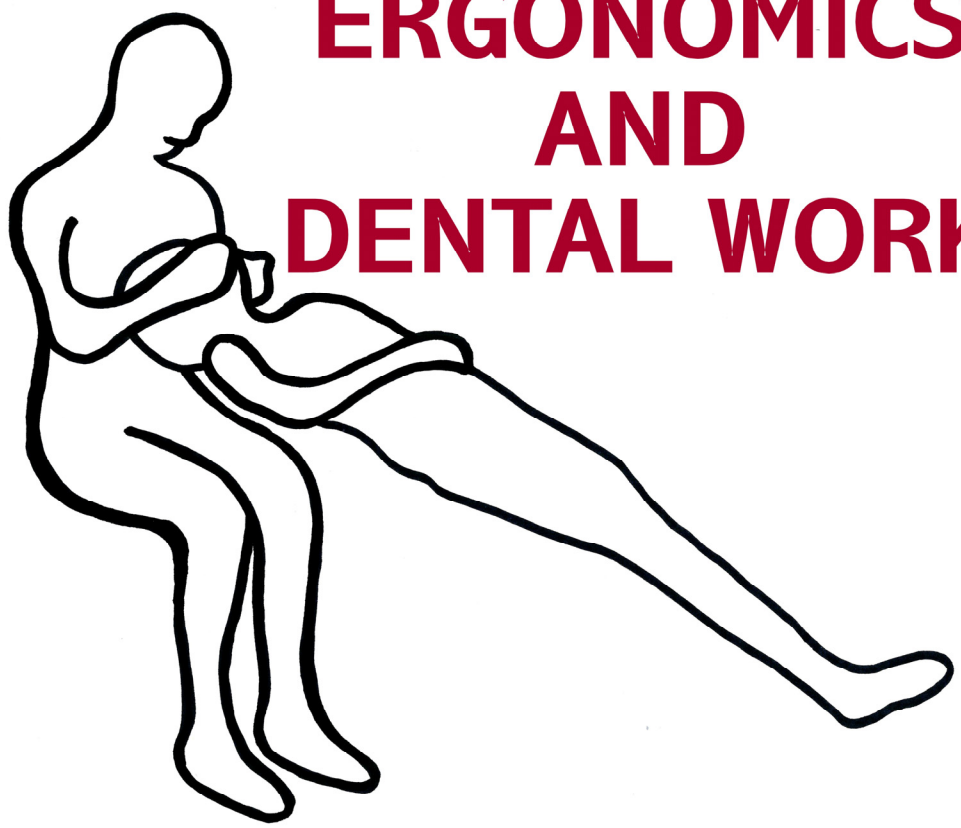
Occupational Health Clinics for Ontario Workers | Centre de Santé des Travailleurs(ses) de l'Ontario

ERGONOMICS AND DENTAL WORK



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Occupational Health Clinics for Ontario Workers are dedicated to the identification and prevention of work-related illnesses. At the core of each clinic is a dedicated staff trained in occupational medicine, who are available to provide medical examinations for a full range of work-related illnesses. The clinics are open to anyone with a possible occupational health problem.

For more information about OHCOW please visit their website at OHCOW.on.ca.

Application of Ergonomics

Through ergonomic advances made over the years, dental professionals have been able to modify and optimize their working environments. Ergonomic improvements in seating, instrumentation, magnification, lighting, and glove use have offered a proactive measure for ensuring a proper balance between job requirements and worker capabilities.

Seating

Perhaps the most important equipment purchase made by dental professionals, is the seat. Proper seating is a complex subject about which there is much misunderstanding. Research findings indicate that dentists who sit 80 to 100% of the day are at an increased risk of developing low back pain (Mangharam, 1998). Prolonged sitting in a poorly designed chair with inadequate lumbar support or adjustability has been found to be a contributing factor to muscular fatigue and low back pain (Johanning, 1998).

Studies have shown that the seat moves almost every minute throughout a typical treatment session, as the clinician is continually adjusting their positioning to improve visual access and accommodate patient movement. As a result, the support base itself must be capable of sustaining the repeated stress. A seat should be constructed of a rigid cast frame that will not distort with time and use. This rigid base must accommodate five casters to prevent rearward tipping, however the base should not be as wide as that of an office chair. The compact base ensures that the wheels do not interfere with the feet, foot controls, or patient chair (Sanders, 1997). The seat pan should be wide enough to allow for some shifting and movement. Twenty-five percent wider than the total breadth of the buttocks is considered adequate for the majority of people. The front edge of the seat should taper off and away from the legs so as not to impede circulation and nerve supply to the leg.

The seat should also be height adjustable. When the feet are resting flat on the floor the angle between the spine and the thighs should be 90 to 110 degrees. An angle less than 90º flattens the lumbar curve of the spine and an angle greater than 110º gives the feeling like you are slipping off the seat. Variations in footwear (high heeled shoes to flats) should have the clinician altering their seat height day to day depending on what they are wearing. Researchers recommend that a shorter clinician have a seat adjustment range from 16 to 21 inches, while taller individuals have a range of 21 to 26 inches. In an ideal situation, a clinician should be able to function from a height range where their thighs are parallel with the floor and the legs are in fully supported position (Sanders, 1997).

While arm support is a controversial subject, many clinicians and experts feel that they are essential to health and comfort. The capability for highly supportive arms that function through a wide range of motion is an option that most modern dental stools provide. If elbow rests are present, they should be positioned just

below seated elbow height so that when the shoulders are not elevated when using the rests. They should not impede access to the patient while keeping their elbows at the side. Arm support may be fixed in length but should allow rapid height adjustment and full articulation. Some researchers have found the use of elbow rests to reduce upper trapezius muscle load as well as the frequency and range of arm abduction during regular dental tasks (Marchand, 2001).

When selecting a dental stool, ensure it meets the above criteria and allows you to work in a neutral body position. With numerous designs currently available on the market, each chair has its own unique advantages and disadvantages. As a result, it is important to speak with product specialists and try the chair under real working conditions before committing to purchase. The following images show various chair designs currently available on the market. It is recommended that each manufacturer be contacted directly for further information.

Brewer Operator Stool

Posiflex Stool

Kobo Chair

Patient Chair

When seating a patient, optimal results will be achieved when their oral cavity is positioned at a height equal to the seated height of the clinician's heart. Positioning the oral cavity above heart level will limit vantage and increase the rate of shoulder fatigue. On the other hand, positioning the oral cavity below the recommended height will result in non-neutral working postures including over declination of the head, forward and/or lateral bending of the torso, and inability of the clinician to access free movement in the clock positions.

When the patient is properly positioned your shoulders, elbows, and wrists should be in a neutral position, meaning that:

- your upper arms are close to your body
- your elbow / forearm angle is close to 90º
- your wrists are in line with the forearm with no more than 20-30º extension

Instrumentation

The design of dental instrumentation can play a key role in the prevention of negative health effects for its users. Dental clinicians are typically responsible for selecting and maintaining their own instruments and equipment. Although instrument design has come a long way since its beginning, dental professionals often select instruments based on familiarity rather than actual quality or specific properties (Sanders, 1997). The goal of proper instrument selection should be to reduce force exertion while allowing for neutral joint positioning.

The following table summarizes critical areas to consider when selecting new or evaluating existing instrumentation.

Handle shape and size	• Dental instrument diameter ranges from 5.6 to 11.5 mm. Larger handle diameters reduce hand muscle load and pinch force, although diameters greater than 10 mm (3/8 inch) have been shown to offer no addition advantage (Dong, 2006). • Alternating tools with different diameter sizes allows the user to reduce the duration of prolonged pinch gripping. Sleeves that fit over the handles of mirrors have been shown to reduce grip force (Simmer-Beck, 2006), but may not have the same effect on scaling instruments due to the extra force required when scaling. • "No. 4" handle lessens pinch gripping and can be purchased for most instruments. • A round handle, compared to a hexagon handle will reduce muscle force and compression.
Weight	• Lightweight instruments (15 g or less) help reduce muscle workload and pinch force (Dong, 2006).

Balance / Maneuverability	• The instrument should be equally balanced within the hand so that the tendency to deviate the wrist is reduced. • Balancing an instrument is improved using a third digit rest compared a fourth digit rest since it does not engage the wrist as much while guiding and positioning the hand piece. The second digit (index finger) can detect very fine movements and should be placed close to the operating point. By not using the fourth digit as a stabilizer of the hand piece reduces the number of fingers in the oral cavity, improves the ability to position instruments, and involves as few joint segments as possible thereby improving the degree of control and providing enhanced tactile ability.
Ease of operation	• The easier it is to operate a tool, the better. Less time is spent searching for buttons, thereby reducing the risk of error. Less time is also spent learning how to use the device. Simple activation is also important, such as using a foot pedal or handle turn to activate the tool as they do not require the operator to hold a button in a sustained pinch grip for extended periods of time.
Sharpness	• As a tool becomes dull, additional force is required to perform tasks. As a result, it is important to maintain sharpness of the instruments.
Texture	• Knurled handles such as diamond-shaped or criss-cross patterns serve to reduce pinch grip force due to an increase in tactile sensation as a result of the knurl.

Additional tips for instrument selection:

- Hollow or resin handles are preferred
- Round, textured/grooves (knurled), or compressible handles are preferred
- Colour-coding may make instrument identification easier
- Carbon steel construction (for instruments with sharp edges) is preferred

Dental Hand Pieces
When selecting hand pieces, look for:

- Lightweight, balanced models (cordless preferred)
- Sufficient power
- Built-in light sources
- Angled vs. straight-shank
- Pliable, lightweight hoses (extra length adds weight)
- Swivel mechanisms
- Easy activation

Equipment Layout
Dental equipment should be located in a manner which allows you to maintain a neutral working posture. It should require minimum adjustment and effort to access so as to reduce postural deviation while working. Frequently used items should be kept within a "comfortable distance" (22–26 inches for most people) and not above shoulder height or below waist height. Frequently used items such as the syringe, hand piece, saliva ejector and high volume evacuator should be positioned so they are within a normal horizontal reach which is the arc created while sweeping the forearm when the upper arm is held at the side. Items that are used less frequently used should be placed within the maximal horizontal reach which created when the arm is fully extended. The following image shows the difference between a normal and maximum work area.

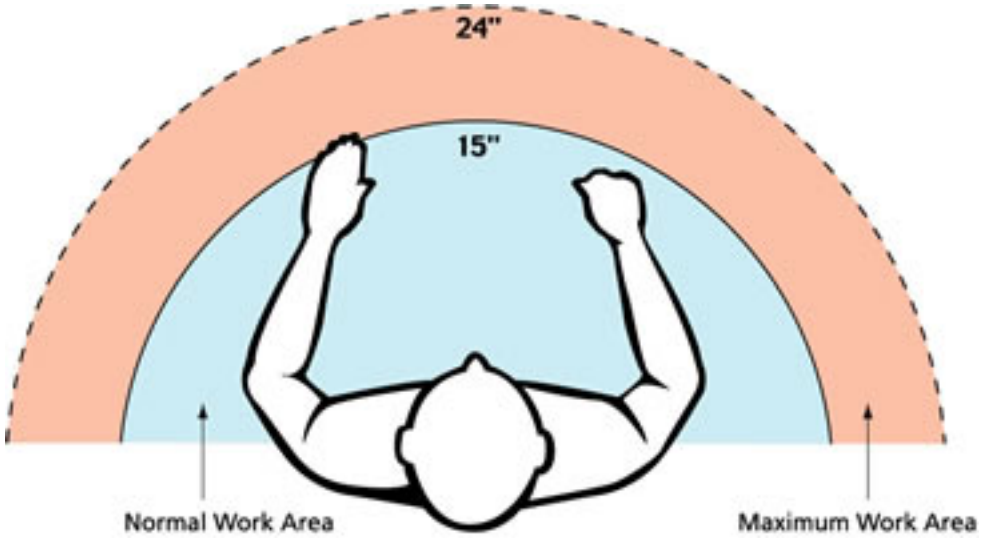

Figure 7: Preferred working area of the hands
Source: Esslab

Ultrasonic Tools
While ultrasonic tools can serve to reduce prolonged pinch gripping they do expose the clinician to hand-arm vibration. Research has been controversial regarding the relationship between the use of ultrasonic scalers and the development of musculoskeletal problems. While some studies indicate that prolonged use of this equipment can be hazardous due to the negative effects associated with vibration, other researchers suggest that its use is preferable to the heavy hand forces experienced during manual scaling. As result, educators suggest using ultrasonics for heavy calculus build-up, but limiting the overall usage of this vibrating tool (Sanders, 1997).

Cord Management
The added weight of cords can often influence the level of muscle fatigue experienced by a clinician. Additionally, coiled hoses can cause the hands and wrists to do more work if the coils have too much resistance to deformation. As a result many hygienists tend to wrap the cord around their arm or try to pinch it between their ring finger and smallest finger in order to support the weight. Other individuals use a variety of creative methods to counterbalance cord weight. While none of these techniques have been scientifically tested basic recommendations do exist to assist with cord management (UBC, 2008).

Firstly, it is recommended that retractable or coiled hoses be avoided and replaced with a pliable hose which consists of a swivel mechanism in the barrel. Newer 360 degree swivel cords also provide increased flexibility for managing the cord. Positioning heavier cords over the arm or across an armrest can also be beneficial for reducing muscle strain (UBC, 2008).

Syringes and Dispensers
When selecting look for:

- Adequate lumen size
- Ease in cleaning
- Textured/grooved handles
- Knurled handles (no finger cut-outs)
- Easy activation and placement

Mouth Mirror
Mouth mirrors have been referred to as the most important, yet underutilized instruments within dental practice. Good mirrors coupled with proper use can significantly increase one's opportunity to maintain a neutral working posture.

If you are unable to visualize the operating site directly while maintaining a neutral posture, you must use a mirror to prevent awkward body positioning, specifically of the neck and back. Intraoral mirrors can also be used to reflect additional light on the operating site even when a direct view is possible. It is important to remember that a mirror should be held lightly and lowered into the

mouth with the handle held no more than 45 degrees from the vertical plane (University of British Columbia (UBC, 2008).

With the respect to retraction, the mirror's face (or back of the face) may be used to retract the tongue or cheek however its handle should never be used. The handle is poorly designed for comfortable retraction (both for the patient and for the clinician) and could potentially harm soft tissues within the oral cavity. If static retraction is required, it is recommended that a proper retraction tool be used, such as those commonly used in oral surgery practices (UBC, 2008).

Magnification

In an attempt to clearly see the operating field some clinicians may be tempted to compromise their working posture by bending closer to the patient. Deviation away from a neutral working posture in order to magnify or clarify the view of the operating field is both undesirable and unnecessary. Through the use of various magnification systems, dental professionals are able to increase their working distance and assume more of an upright body posture. As a result, surgical magnification can play a significant role in reducing awkward working postures, specifically forward neck and trunk flexion (Rucker, 1998).

Today there are several distinct categories of surgical magnifiers available on the market. Stationary or fixed microscopes are generally wall or ceiling mounted and used for high magnification (5x to 20x). While such magnification levels serve a specific purpose they are rarely used in general clinical practice. It is important to remember that the more the magnification power the smaller the field of view, the smaller the depth of field and the less light available for vision. Reducing these components of the magnification system often leads to a compromise in the clinician's working posture as they typically begin to lean forward to see the operating area. As a result *less magnification is typically recommended* for general clinical practice (UBC, 2008).

Surgical telescopes comprising of multi-lens systems offer lower magnification levels (2x to 3x) which are preferred due to their portability and ease of use. These devices are commonly referred to as "surgical loupes" and can be mounted to a headband or onto the operator's glasses. Through the use of such magnification systems dental practitioners are able to maintain a neutral working posture while increasing their visual acuity, level of motor control, and diagnostic ability (UBC, 2008).

BUYER BEWARE

Purchasing the right magnification system may seem like a daunting task as numerous manufacturers exist on the market, all offering multiple product lines. However, being well informed and speaking to knowledgeable product representatives is the best way to ensure that the product you select meets all of your needs and most importantly allows you to work in a neutral posture.

When selecting surgical telescopes many critical features and personal preferences should be taken into consideration. The following table provides a recommended guideline of the components which should be further examined and discussed with a product specialist during your selection process.

Components of a Magnification System

Critical Features	Personal Preferences
• Optical declination angle • Coaxial alignment • Working distance • Depth of field	• Power of magnification • Size of the field of view • Size of magnification scotoma • Weight of telescopes • Distribution of weight • Adjustability of system • Infection control

Lighting

Light positioning is a critical factor affecting your posture during clinical operation. The goal of proper lighting is to produce even, shadow-free, colour-corrected illumination concentrated on the operating field. This not only serves to increase visibility but can also reduce awkward working postures. For optimal illumination the light-line must be as close to the sight-line as possible. The greater the deviation of the light-line from the sight-line the greater shadowing (UBC, 2008).

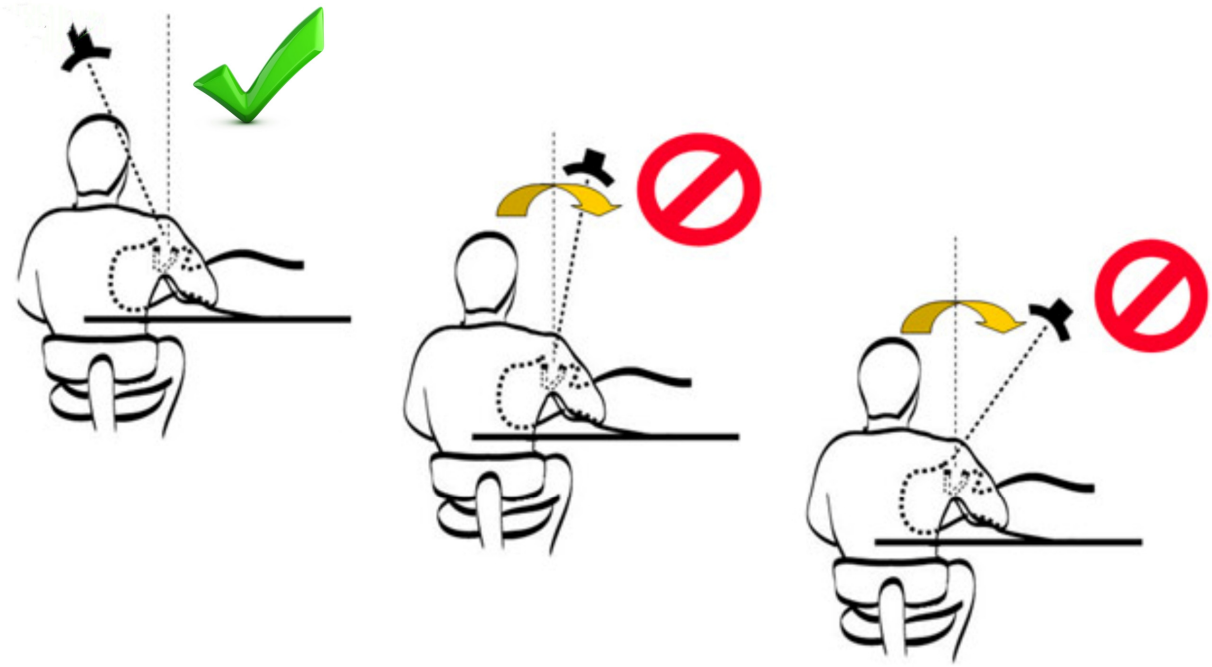

Figure 8: Optimal overhead light positioning
Source: UBC, 2008

Typically, a single light source can provide sufficient unshadowed viewing for a supine patient. For both mandibular and maxillary treatment, the light source should be directly above and slightly behind the patient's oral cavity. This position will insure that the light-line just barely clears your head throughout a full range of o'clock positions. Once the patient has been properly situated, the light source can be positioned as far above the clinician's head so as to just allow it to be reached. This ensures that it can still be repositioned if needed however it is out of the way from being accidentally moved.

Gloves

Gloves are commonly worn due to universal precautions. Gloves must be of proper size, lightweight, and pliable. Poor fitting gloves can cause pain in the hands, particularly at the base of the thumb. This is often due to compression of the tissues when gloves are either too small or too loose as "bunching" occurs. When used for extended periods of time, gloves must be pulled into a working position, which may compress the back of the hand, strain muscles at the base of the thumb, and reduce blood flow to the hand.

Properly fitted gloves should fit hands and fingers snugly, should not feel tight across the wrists and be hand-specific (right vs left-hand design). Ambidextrous (non-hand specific) gloves are molded with the hand in a flat (neutral) position, restrict thumb opposition, and actually exert one third more force than hand-specific gloves across the palmar region of hand. While ambidextrous gloves can be used for brief examinations, hand-specific gloves are recommended for most dental tasks.

An additional factor in proper glove selection is material. While latex gloves have been known for creating the most natural fit, sensitivity or allergies have created an issue for some clinicians and patients. Fortunately, alternative glove materials, such as vinyl, are available, however they can result in poor fit. A more recent alternative has been the use of chloroprene gloves which provide a very high puncture resistance and have been shown to be more flexible than vinyl (Guignon, 2001).

Compressed Air

- Improves visibility of the field of operation during instrumentation
- Permits easier recognition of location and material of restorations
- Allows easier identification of decalcification
- Allows easier identification of supragingival deposits (e.g. calculus appears chalky and contrasts to tooth colour)
- Deflects the free gingival margin to allow visual sighting of subgingival deposits (e.g. calculus)

Working Posture and Techniques

A neutral working posture is defined as one which supports **uncompromised musculoskeletal balance** of the clinician. This consists of dynamic positioning where the clinician operates in different locations around the oral cavity, rather than static operation. Changing positions not only serves to improve vision and access into the oral cavity but also shifts work to other muscle groups. By using the clinician's stool to navigate around the patient, static and awkward postures can be avoided (UBC, 2008).

It is important to ensure that the clinician's access to the oral cavity is truly unimpeded. You should be able to move freely with your legs beneath the patient's head and headrest to avoid twisting or forward bending of the torso. If this is not possible, you may be forced to spread your thighs and knees apart and lean forward or twist with the knees together on one side. Either of these positions compromises a neutral working posture and should be avoided (UBC, 2008). As a result, most clinicians attempt to use a wide range of positions around the patient's head, often referred to as the "o'clock positions".

Figure 9: Clock positions
Source: UBC, 2008

For right-handed clinicians, working in the range from 7 to 9 o'clock is commonly associated with twisting of the trunk and neck as well as working with an elevated elbow posture in order to gain access. The mirror image (3 to 5 o'clock) is equally problematic for left-handed clinicians. In an attempt to reduce such postural deviations a conservative range from 10 o'clock to approximately 12:30 is preferred and shown below (UBC, 2008).

Figure 10: Preferred working ranges
Source: UBC, 2008

Working Technique

Within the scientific community there is a great deal of discussion surrounding current working techniques used by dental professionals. Researchers have found that "currently accepted techniques" can increase the risk MSDs as they employ same or similar patterns of muscle activity. In doing so, these techniques can increase the rate of muscle fatigue and lead to the development of a MSD.

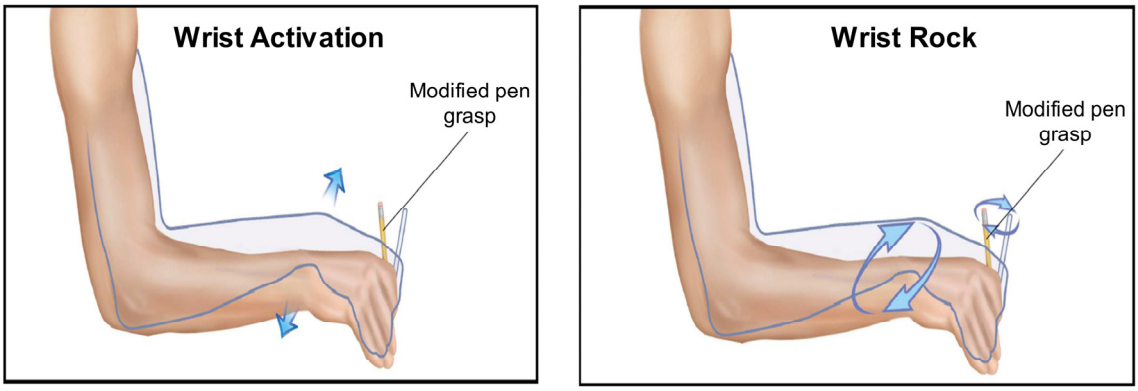

Figure 11: Wrist motions in the Currently Accepted Techniques
Source: Meador, 1997

More recently, discussion has shifted towards the use of a “biocentric technique” which shifts the work load from the small muscles of the hand and forearm to the larger muscle groups of the upper arm and shoulder. The four power strokes unique to this technique include rocking, power, push-pull, and swing strokes, coupled with the wrist activation and wrist rock which are common to the currently accepted technique. Using this technique allows the clinician to maintain a neutral upper extremity position (shoulders level, upper arm vertical, and forearm horizontal) while still offering options for accommodating patients' anatomical variations. Researchers believe the biocentric technique reduces muscular fatigue by varying task performance (Meador, 1997).

Biocentric Technique #1

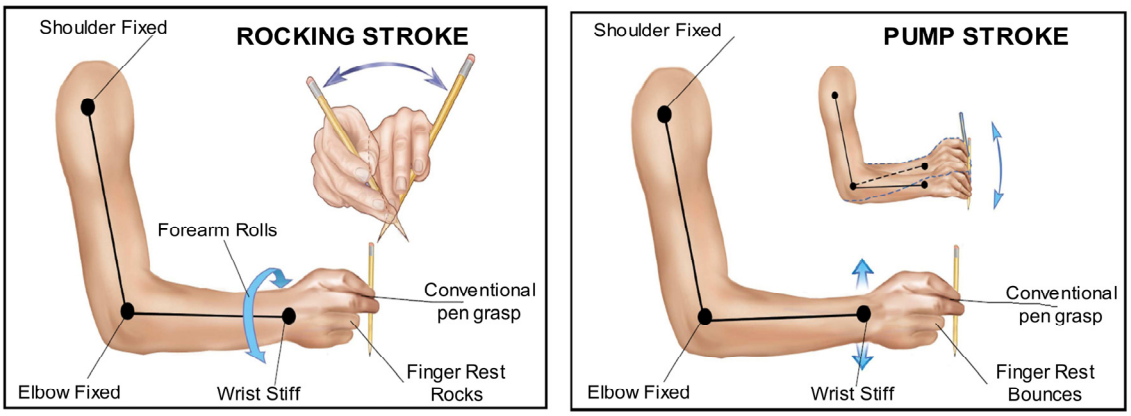

Figure 12: Arm and hand positions in the Biocentric Technique #1
Source: Meador, 1997

Biocentric Technique #2

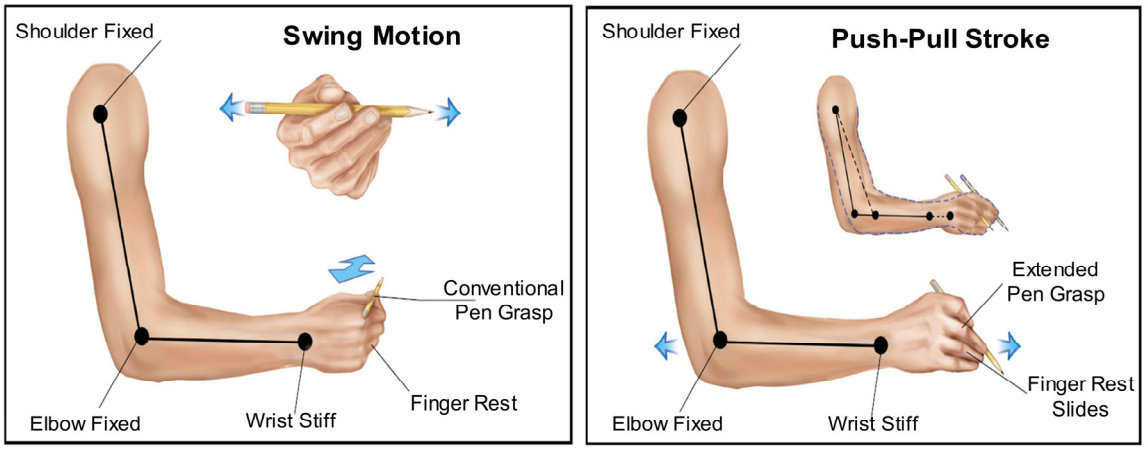

Figure 13: Arm and hand positions in the Biocentric Technique #2
Source: Meador, 1997

Additional tips for improving technique include:

- Alternate grip pressure and techniques used to grip items
- Use “strokes” controlled by larger muscle groups
- Try to maintain joint neutrality

Finger Rests

In addition to increasing hand stabilization, the use of 2-finger rests has shown musculoskeletal advantages when performing scaling procedures. When researchers examined three different finger positions (no rest, 1-finger rest, and 2-finger rests) they found significant reductions in thumb pinch forces and muscle activity when using rests. More specifically, 2-finger rests always produced these reductions, as compared to not using any finger rests, while one finger rest reduced thumb pinch force and muscle activity most of the time (Dong, 2005).

Figure 14: Scaling task performed with three different finger positions
Source: Dong, 2005

As a general rule, the greater the force applied during a task, the greater the requirement for hand stability. Through the use of finger rests, dental practitioners can increase stability while also reducing muscular loading. The closer one can position their finger rest to the target area, the greater the level of micro-control will be achieved.

Future Considerations

Every dental care facility has an opportunity for ergonomic improvement. While employers should always be seeking ways to modify and optimize their workplace to reduce the likelihood of injury, dental professionals need to pay attention to body symptoms in order to make changes that will prevent long-term problems. As a result, ergonomics should be a continuous and proactive measure for ensuring the proper fit between people and their working environment.

The following section provides additional considerations which can be adopted by dental professionals to further reduce their likelihood of developing long-term musculoskeletal problems.

Scheduling
Modifying one's work schedule has been suggested as an effective preventive measure for providing sufficient recovery time and avoiding muscular fatigue.

Recommendations when scheduling include:

- Incorporate brief "stretch break" periods between patients
- Develop a patient difficulty rating scale to ensure difficult treatment sessions are not performed consecutively
- Increase treatment time for more difficult patients
- Alternate heavy and light calculus patients throughout the day
- Alternate procedures performed throughout the day
- Shorten patient's recall interval

Ambidexterity
The majority of people prefer the use of their dominant hand when performing manual operations. While this can improve efficiency, it can also result in muscular overload of the dominant hand/arm. It is recommended that individuals attempt to alternate hands throughout the workday, whenever possible. Although this may not be practical for certain precision tasks, it is possible to alternate hands when performing accessory tasks, such as reaching for tools or supplies.

Stretching
Frequent stretch breaks can prevent detrimental physiological changes that can develop while working in static or awkward postures. In an attempt to prevent injury from occurring to muscles and other tissues, dental professionals should allow for rest periods to replenish and nourish stressed structures. If breaks are too far apart, the rate of damage could exceed the rate of repair and eventually lead to the breakdown of tissue.

Stretching can serve to:

- increase blood flow to muscles
- increase the production of joint synovial fluid
- reduce the formation of trigger points
- maintain normal joint range of motion
- increase nutrient supply to vertebral disks
- create a relaxation response in the central nervous system
- warm up the muscle before beginning to work
- identify tight structures that may be predisposed to injury

Alternating postures during work provides a change from one's habitual position and prevents muscular fatigue. Stretches should be performed for the entire body, focusing on movement patterns that are opposite to the habitual positions experienced during work. Researchers suggest that dental professionals try to lean back in their stool at least four times during each treatment session as well as spend three to five minutes stretching for every patient seen throughout the day (Sanders, 1997).

Points to Remember:

- Perform a variety of stretches throughout the workday
- Stretching should be gentle and gradual
- Do not stretch a muscle to the point of pain
- Stretches can be held up to 10 seconds and repeat 3-5 times
- Breathe normally while stretching
- If you suffer from a musculoskeletal condition consult a Physician before attempting new exercises which you are unfamiliar with

The full workbook with cited sources is available on the OHCOW website at:

https://www.ohcow.on.ca/edit/files/workbooks/ERGONOMICS%20AND%20DENTAL%20WORK.pdf