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Ergonomic Assessment Tools used in Dentistry for Evaluation of Work Related Musculoskeletal Disorders (WMSDs): Review

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Abstract

Dentistry can be described as a profession with high risk for occupational hazards. The risks range from physical and psychological stress to various respiratory and bacterial infections, radiation hazards, and especially work-related musculoskeletal disorders. Prevention of musculoskeletal disorders is an essential component of promoting health and quality patient care by dentists. Various instrumental and observational techniques are used to measure the degree of discomfort and stress from various postures. The most commonly used observational methods include the Ovako Working Posture Assessment System (OWAS), Posture, Quick Exposure Check (QEC), Rapid Upper Limb Assessment (RULA), Strain Index (SI), Occupational Repetitive Actions (OCRA), NIOSH Lifting Equation, Rapid Entire Body Assessment (REBA).

Keywords: Ergonomics, Work related Musculoskeletal Disorders (WMSDs),Ovako Working Posture Assessment System (OWAS), Posture, Quick Exposure Check (QEC), Rapid Upper Limb Assessment (RULA), Strain Index (SI), Occupational Repetitive Actions (OCRA), NIOSH Lifting Equation, Rapid Entire Body Assessment (REBA)

Introduction: The development of Work related Musculoskeletal Disorders (WMSDs) in dental professionals can be attributed to a variety of factors that include sitting for long periods in certain restricted areas,

awkward posture, repetitive movements and excessive force with slender instruments resulting in a cumulative trauma disorders (CTDs).[8]

Prevention of Musculoskeletal Disorders is an essential component to promote health and quality of patient care by the dental professional.[9]Various instrument based and observational methods are used to measure the levels of discomfort and postural strain caused by different body postures. The observational techniques are more commonly used which include Ovako Working Posture Assessment System (OWAS), Posture, Quick Exposure Check (QEC), Rapid Upper Limb Assessment (RULA), Strain Index (SI), Occupational Repetitive Actions (OCRA), NIOSH Lifting Equation, Rapid Entire Body Assessment (REBA).[10]

Musculoskeletal issues (MSDs), work based totally musculoskeletal problems (WMSDs) and musculoskeletal risks can be severe occupational hazards, due to inappropriate running practices and disrupting characteristic whilst pain or discomfort has set in. Dental exercise may also reason MSDs because of cumulative micro-trauma and repetitive use of awkward positions.[11]

Musculoskeletal diseases (MSDs) are injuries or diseases of the muscles, nerves, tendons, joints, cartilage, and intervertebral discs. Occupational Musculoskeletal Disorder (PISD) is a disease that causes:

1. Workplace and work related to the disease; and/or
2. Work-related aggravation or persistence of pain [1]

In 1997, the National Institute for Occupational Safety and Health (NIOSH), affiliated with the US Centers for Disease Control and Prevention (CDC), published a review of the evidence for occupational MSDs. Examples of work that can cause WMSD include daily heavy lifting, daily exposure to total body vibration, daily work in the long neck flexion range, or repetitive strenuous work. The report identified good evidence of an association between work and MSDs in the neck, shoulder, elbow, hand and wrist, and back.

The Bureau of Labor Statistics of the Department of Labor characterizes MSDs as musculoskeletal system and connective tissue illnesses and disarranges when the occasion or introduction driving to the case is substantial response (e.g., bowing, climbing, slithering, reaching, and turning), overexertion, or dreary movement. MSDs don't incorporate clutters caused by slips, trips, falls, or comparative episodes. Illustrations of MSDs include: pain in the back, Sprains, strains, and tears, Carpal tunnel syndrome and Hernia.

Musculoskeletal disorders are costlier to employers because of extra leaves, lost efficiency, and expanded wellbeing care, incapacity, and worker's remuneration costs. MSD cases are more extreme than the normal nonfatal damage or illness.[12]

General Symptoms of MSD includes: Stiffness of joints, joint pain, wrist, shoulder, forearm, knee pain, pain, tingling or numbness in hands/feet, tingling in arms/legs, back**,** Neck pain ,Pain in the back or neck, Cramps**,** Swelling or swelling, Fever, Heaviness, Inability to do day to day work, Weakness or clumsiness in the hands, inability to holding tools.

General signs of MSDs includes: Reduced range of motion, disfigurement, reduced grip strength, Loss of muscle function & Paresthesias.

In dentistry, dynamic and static activities expose dentists to musculoskeletal disorders. Dentists are usually unaware of the risks posed by improper ergonomics and its role in musculoskeletal health.[13]

Finsen et al. conducted a study including several Danish dentists in order to evaluate the risk factors posed by MSDs. That study revealed that 65% of dentist suffered

from neck & shoulder pain and 59% of participants had back pain. [11]

In 1999, the National Institute of Occupational Health in Denmark, Copenhagen, conducted an investigation entitled "Biomechanical aspects of neck posture during dental work" and declared that enhanced knowledge of neck anatomy could help u understand how various tissues are subjected to pressure[14]

Thornton et al. inferred that following the biomechanical principles should be extended to the clinical settings &programs regarding awareness about ergonomics should be expanded to include clinical principles.[15]

Saremi and colleagues demonstrated that neck and shoulder pains were the most common complications for dentists, and concluded that greater than 30% of dentists were in the category of high-risk individuals for these disorders[14].

NasleSeraji and co-workers also noted that pains in the neck and back region is one of the most prevelant ergonomic hazards among dentists, with a higher rate of occurrences in women than men[16].

Mojabi et al. concluded that shoulder pain, back pain, neck pain and combined neck, back and shoulder pain was present in 10%,18.6%,27.1% and 11.5% of these cases, respectively[17].

The Rapid Upper Limb Assessment (RULA): The Rapid Upper Limb Assessment (RULA) (McAtamney and Corlett, 1993) is an ergonomics-based workplace risk assessment tool that allows you to calculate the risk of musculoskeletal strain to the upper limbs and neck.

- RULA is easy and quick to use and does not require costly equipment to analyze.
- RULA is designed for quick analysis.
- REBA as a tool is checked and tested by McAtamney and Corlett and many others as dependable.
- The end result is a relative risk assessment rather than an absolute risk assessment and RULA is intended to be part of a broader ergonomics screening.
- RULA is a screening tool that evaluates biomechanical and postural loading of the entire body with special consideration to the neck, trunk, and upper limbs.
- A RULA evaluation requires less time to finish and the scores obtained reconcile an action list which indicates the level of action needed.

RULA's useful scoring system allows you to take a snapshot of the riskiest posture you have adopted during the task. The scoring system is divided into four levels of action that provide clues to the urgency of the case examination.

Action level one. Score of 1-2 = Acceptable

Actions level two. Score of 3-4 = Investigate further

Action levels three. Score of 5-6 = Investigate further and change soon

Actions level four. Score of 7 = Investigate further and change immediately

RULA is developed to assess strength, posture and movement in sedentary occupations, such as manufacturing, retail, computer and laboratory work, or activities where the person sits or stands without moving for long time.

Merits of RULA

- Excellent for upper limb tasks.
- Measurement of risks to the musculoskeletal system.
- Assessment of outcomes such as suitability of equipment and productivity.
- Excellent for training workers in high-risk postures.
- Well suited for predominantly static tasks.

- Shows an objective figure before and after intervention (useful for arguing to colleagues or management).
- Reasonably accurate and reliable.
- Fast and simple to use.
- Has been shown to improve productivity.
- Useful for presenting information to management (gives a figure; is 'objective')
- Can be compared before and after intervention.
- Reasonably precise and dependable.
- Can show the association between score and regional pain.

Demerits s of RULA

- Tasks that strain the whole body cannot be asses.
- The posture of the wrist does not take into account the position of the function, in which the wrist is somewhat extended.
- Variety of tasks.
- Organizational and psychological factors are not taken into account.
- Occasional discrepancy in scores when the limbs are at the boundaries of two areas.
- Difficult to capture with a photograph. (Video film recording is ideal)
- Limited to access at one time. One must choose the most extreme posture.
- May require multiple RULA assessments for one task.
- Not ideal for tasks that involve the entire body.

Quick Exposure Check (QEC)

The Quick Exposure Check [QEC] was developed at the Robens Centre for Health Ergonomics to meet practitioners' needs for a practical method to assess exposure to WMSD risk factors in the workplace. It was developed using a participatory ergonomic approach involving 200 practitioners. It was developed, tested, modified and validated based on simulated and real work tasks. The tasks covered a wide range of work activities, e.g. manual handling, repetitive tasks, static or dynamic tasks, seated or standing tasks and tasks with low or high visual demands[19].

QEC assesses exposure of the four body areas at greatest risk to the major risk factors for WMSD. QEC was developed for occupational safety and health professionals, safety officers or health and safety managers in small and medium-sized enterprises. (SMEs)

1. It evaluates the change in exposure to musculoskeletal risk factors before and after an ergonomic intervention.
2. It includes both the practitioner (observer) and workers (who have direct experience of performing the job) in carrying out the assessment and identifying opportunities for change.
3. It promotes job improvement and enables comparative consideration of the impact and potential cost benefits of a range of alternative measures.
4. It raises awareness of musculoskeletal risk factors in the workplace among managers, engineers, designers, health and safety professionals and workers.
5. It compares exposure between two or more people performing the same task or between people performing different tasks.

The QEC assessment inspires consideration of changes to workplaces, tools, equipment and working practices to eliminate or at least reduce exposure. This should be done in discussion with the worker(s). Those who are regularly involved in performing the task may have good suggestions for improvement in work.

Consultation at this stage helps to introduce changes to the workplace. Once a change has been made, exposure should be reassessed to confirm the effectiveness of the measure in reducing risk factors for WMSD. This can be done immediately after the change, rather than waiting to see changes in the prevalence of reported WMSDs, which can take many months to become noticeable.

The role of this guide

QEC enables the assessment of physical work activities in collaboration with the worker. It has been designed to be quick and easy to use and does not require extensive training before use. A one-page assessment sheet contains questions for both the practitioner (observer) and the worker to quantify the risk for WMSDs. Exposure levels for the four main body areas can be assessed and form the basis for intervention and reassessment.

The guide is intended to:

1. provide background information on QEC
2. Provide information on prioritising tasks for assessment and conducting a basic task analysis
3. explain each question and describe the range of answers
4. show how to carry out assessments
5. Promote a systemic approach to the delivery of interventions.

Classification of the assessment

QEC exposure scores are based on combinations of risk factors identified by the observer for each body area and on the subjective responses of the worker. These scores represent a hypothetical relationship between the increased level of exposure and the potential health consequences. Current epidemiological evidence is insufficient to define the actual relationship for different work situations. Nevertheless, the existing scoring system provides a basis for comparing exposure levels before and after an intervention. In addition, increasing exposure is indicated by darker shading in the boxes on both the assessment and rating sheets.

The assessment results should be used to determine the comparable levels of exposure for each body part and identify where exposure is highest and consequently prioritise the problems that should be addressed through intervention.

The goal of an intervention is to decrease exposure levels. If changes to a task are planned, an assessment should be made based on the proposed improvements. This will show the potential benefits of the intervention and whether exposure to risk factors for another part of the body is being unintentionally increased. A reassessment should always be carried out after an intervention has been implemented.

To assess the exposure assessment

1. Use the Exposure Assessment sheet to determine the scores for each body area. For example, in the top left corner of the sheet for the back:

The first table shows the scores for the posture (A1-3) and weight (H1-4) combinations. Determine the corresponding load combination, e.g. the combination A2 and H2 would be scored with 6 points, for A3 and H3 with 10 points. Record this in the 'Score 1' box in the bottom right corner.

Do this for the correct combination of factors for the reverse side, i.e. you either calculate points 1 to 5 OR or points 1 to 3 plus point 6.

Then add up the total score for the back.

2. Replicate this steps for each body area and other factors (e.g. driving, vibration, etc.).

3. Carry out these steps both after the initial assessment and after each intervention.

Exposure scores for body areas

The total score for each body part results from the interactions between the exposure values for the respective risk factors and their subsequent addition. It is important to note which interactions contribute most to the total score for each body part.

The exposure scores for back, shoulder/arm, wrist/hand and neck were divided into four exposure categories: Low, Moderate, High or Very High. Even if the exposure value is low, it should be noted that one or two interactions may contribute disproportionately to the value (i.e. a value of 8 or more). For moderate, high and very high values, there are likely to be multiple interactions that should be identified and reduced. It is also possible that one or two interactions may reach the highest exposure levels (i.e. 10 or 12).

This should be urgently remedied to reduce the extent of exposure to these factors. These interactions should be observed and evaluate as continued exposure may result in damage to the body.

Exposure levels for other factors:

- Exposure levels for driving, vibration and work pace were divided into three exposure categories: Low, Moderate and High.
- For stress there is a fourth category: Very High.

For moderate, high or very high levels, the level of exposure should be reduced[19].

REBA Method

The Rapid Entire Body Assessment (REBA) method was developed in 2000 by Dr Sue Hignett and Dr Lynn McAtamney20 from the University of Nottingham, England.

The Rapid Entire Body Assessment (REBA) method is a postural analysis tool and observation-based method for assessing harmful static and dynamic conditions caused by various activities.

Part of the REBA analysis is a worksheet based on which scores A, B and C are calculated. The final REBA score is obtained by adding score C and an activity.

Point A is derived from the first spreadsheet based on the analysis of neck, boot and legs together with the loading score (in dental practice the loading forces are much lower than 5 kg, so the loading score is 0), point B is derived from the analysis of upper arm, forearm and wrist together with the linkage score (the linkage score includes grip and grasp). The final REBA score is a combination of score C and an activity that includes static, repetitive and unstable exercises. Based on the REBA score, risk levels are determined for each student[20].

REBA risk and action level table

Action Level	REBA Score	Risk Level	Action (Including further action)
0	1	Negligible	None necessary
1	2-3	Low	May be necessary
2	4-7	Medium	Necessary
3	8-10	High	Necessary now
4	11-15	Very high	Necessary NOW

The Rapid Entire Body Assessment Tool uses a systematic process to assess both the upper and lower parts of the musculoskeletal system for biomechanical and MSDs risks related to the work task being assessed.

A one-page worksheet can be used to assess the required or selected posture, effort, type of movement or action, repetition and coupling.

REBA was developed with the following aims:

1. To give a simple postural analysis system that takes into account the risks to the musculoskeletal system in a variety of tasks.

2. To split the body into segments that can be assessed individually in terms of postures and planes of movement.
3. Providing an assessment system for muscle activity caused by static, dynamic, rapidly changing or unstable postures.
4. Considering coupling as an important variable in load handling.
5. The output of an action level indicating urgency.
6. Providing a user-friendly assessment tool that requires little time, effort and tools.

Rapid Entire Body Assessment drawbacks:

It does not consider task duration, recovery time available or hand-arm vibration risk assessment.

The assessor can only assess the most awkward posture of a worker at a given time, which requires the use of representative postures.

It requires separate assessment of the right and left sides of the body, although in most cases you can quickly determine which side of the body is at greatest MSD risk.

The OWAS Method

The Ovako Working Posture Assessment System (OWAS) was developed in Finland, in the company OVAKO OY, a leading European manufacturer of steel bars and profiles. This system has been used to assess the workload in the repair of melting furnaces[21].

The OWAS recognize the most common back postures of workers (4 postures), arms (3 postures), legs (7 postures) and the weight of the load handled (3 categories).

All this gives up to 252 possible combinations. Therefore, each posture adopted by a worker was assigned a four-digit code depending on the classification within the previous postures for each body part and the load[21].

Occupational Repetitive Action (OCRA) Method

The Occupational Repetitive Action (OCRA) method is one of the methods used to determinethe ergonomic risk of repetitive work, especially for the upper limbs. Occhipinti and Colombini raise the OCRA method to analyse workers' abilities for their work, which includes all the risk factors for the upper limbs (repetitions, rigid gestures, etc.). The OCRA method uses a value index called the OCRA Index22. The OCRA index is a result of the ratio between the sum of the actual technical activities (ATA) and the reference technical activity (RTA) for a work shift. The OCRA index uses a different level of clarification in the analysis than the OCRA checklist.

OCRA Index is a quantitative method used for identifying the way of work in repetitive work, especially those that have risk for upper limbs. OCRA Index method evaluates 4 major risk factors based on duration from each factor. The 4 factors include the following.

1. Repeatability
2. Power or force
3. Body posture and types of movement
4. Absence of recovery phases

The strain Index (SI)

The strain index was proposed by Moore and Garg[23] in 1995 as a means of assessing workplaces for risk of work-related musculoskeletal disorders (WRMSD) of the distal upper extremities (hand, wrist, and elbow).Divide a workplace into tasks. For each task and hand, assess the six workplace risk factors by assigning them to a category.

After defining the six task variables for the task to be assessed and deriving the corresponding multiplier, the multipliers are multiplied together to obtain the stress index score (SI score).

SI score = (load intensity multiplier) * (load duration multiplier) * (load per minute multiplier) * (posture multiplier) * (work rate multiplier) * (duration per day multiplier).

Jobs associated with distal upper limb disorders were found to have a value greater than five.

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